Accuracy of Trans cerebellar Diameter in Comparison to Fetal Biometric Parameters for Gestational Age Estimation in Second and Third Trimester

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Abstract

A crucial part of managing pregnancy and assessing fetal growth and development in obstetrics is precisely calculating the gestational age (GA). The fetal cerebellum can be observed through USG as early as 10-11 weeks of pregnancy. Since changes in growth have little effect on the cerebellum's development, the TCD should be more accurate indicator for predicting GA. This study that aimed to evaluate the accuracy of TCD in estimation of gestational age in singleton gestation as an accurate parameter and to compare it with other routine parameters (BPD, AC and FL) in normal pregnant women. This analytic cross-sectional study that was conducted on 100 pregnant women in their second and third trimester at the Obstetrics and Gynecology clinic of Suez Canal University Hospitals in the period from October 2021 to June 2022. The whole patients were fulfilling the inclusion and exclusion criteria and counseled for the study and then thorough history taking, clinical examination were performed followed by ultrasound examination and measurements of the Trans cerebellar diameter, Biparietal diameter, Abdominal circumference and femur length were recorded. Our findings revealed a good degree of dependability, with the GA estimated by TCD and GA computed by LMP showing a high degree of agreement. The least trustworthy measure was abdominal circumference, followed by FL and BPD. Regression analysis revealed that the TCD and the LMP had the strongest correlation, while the BPD had the weakest; nonetheless, all parameters were significant predictors of the GA as determined by the LMP. The LMP method's estimation of the relationship between TCD and GA and BPD in second-trimester females revealed a stronger link between TCD and LMP than BPD. However, among females in the third trimester, the LMP method's estimation of the link between TCD, FL, and GA revealed that the TCD and LMP had the strongest correlation, while the FL and LMP had the lowest. TCD has better correlation and predictive accuracy than other fetal biometrics in GA assessment. Also, TCD more accurate than biparietal diameter (BPD) for estimation of gestational age in second trimester of pregnancy, and more accurate than femur diaphysis length (FL) for estimation of gestational age in third trimester of pregnancy.

Key words: *US, second and third trimester, FL, BPD, TCD.*

Introduction

Making an accurate Gestational Age (GA) estimation is crucial for managing expectant mothers and assessing fetal growth. In particular, understanding GA is essential for managing birth, including whether to induce labor or when to have a cesarean section prior to labor. A post-term stillbirth risk might be increased by underestimating GA, whereas an overestimation of GA could result in an iatrogenic preterm delivery [1].

The WHO recommends using last menstrual period (LMP), a low-cost, straightforward self-reported measure, to estimate GA. However, it has memory problems, particularly for women with irregular periods, undiscovered abortions, and spotting in the early stages of pregnancy. Approximately 20–50% of women are unable to correctly remember the date of LMP, according to many studies [2].

The most often used biometric markers in GA estimate are femur length (FL), head circumference (HC), abdominal circumference (AC), and bi-parietal diameter (BPD). Unfortunately, several of these fetal characteristics are generic since they rely on the particular date of LMP beginning, fetal development, and the control of the menstrual cycle. For example, fetuses with uteroplacental insufficiency have negative effects on BPD, HC, AC, and FL. This leads to growth limitation and a redistribution of cardiac output with a brain-sparing impact [3]. According to Eze et al. [4], fetuses with brachycephaly and dolichocephaly have unreliable BPD after 26 weeks of gestation, whereas fetuses with achondroplasia have shorter FL.

GA may now be determined using a new metric called trans cerebellar diameter (TCD). The cerebellum can tolerate deformation from external pressure because it is situated in the posterior cranial fossa, which is encircled by thick petrous ridges and the occipital bone. With ultrasound, the fetal cerebellum may be seen as early as 10–11 weeks. It increases in a linear relationship with GA starting in the second trimester [5].

Given that its results closely resemble those of GA by LMP, studies indicate that TCD is a reliable parameter for estimating GA in the second and third trimesters (6). Intrauterine growth restriction seems to have less of an impact on cerebellar size than on other growth metrics. Additionally, the normal fluctuation in cerebellar size across fetuses is reduced [7].

Aim of the work

This study aimed to assess the estimation of GA by using TCD in comparison with other parameters in prediction of GA in females with known LMP. It also investigates the validity of TCD for estimation of GA in 2nd trimester of pregnancy in comparison to BPD. Similarly, it investigates the validity of TCD for estimation of GA in 3rd trimester in comparison to FL.

Patients and methods

The analytic cross-sectional study was conducted on 100 pregnant women in their second and third trimester at the Obstetrics and Gynecology clinic of Suez Canal University Hospitals in the period from October 2021 to June 2022. The study protocol and patients informed consent were reviewed and approved by ethical committee of Suez Canal university. Pregnant women on second and third Trimester, with known LMP, Singleton Pregnancy, Fetal growth restriction or with hypertension were included in the study. While women with multiple gestation, gestational age < 13 weeks, with history of Diabetes or with hydrocephalus or Congenital Anomalies were excluded from the study.

Informed consents were obtained from the pregnant women who were included in the study. All participants were subjected to detailed history taking, general examination, abdominal examination and Ultrasound to assess (fetal viability, biparietal diameter, abdominal circumference, femur length and trans cerebellar diameter). Measurements are taken by Mindray DC30 convex probe with probe frequency 3-5 MHz. The transducer frequency was chosen to guarantee adequate penetration and resolution.

Figure 1: Voluson™ P8 ultrasound.

In all patients, TCD was measured according to Chavez et al. and Bhimarao et al. [8,9]. While BPD, AC and FL were measured using standard techniques according to American Institute of Ultrasound in Medicine practice guideline for the performance of obstetric ultrasound examinations [10].

Measurement of biparietal diameter

The BPD is measured at the level of the thalami and cavum septi pellucidi or columns of the fornix. The cerebellar hemispheres should not be visible in this scanning plane. The measurement is taken from the outer edge of the proximal skull to the inner edge of the distal skull.

Figure 2: Showing BPD measurement in pregnant women 23wks+4days of gestation.

Measurement of abdominal circumference

At the skin line on a true transverse view at the level of the junction of the umbilical vein, portal sinus, and fetal stomach when visible.

Figure 3: Showing AC measurement in pregnant woman 23wks+4day of gestation.

Measurement of femur length

It can be reliably used after 14 weeks of GA. It is imaged with both ends of the ossified metaphysis distinctly visible. The measurement of the longest axis of the ossified diaphysis is obtained. The long axis of the femoral shaft is most accurately measured with the beam of insonation being perpendicular to the shaft, excluding the distal femoral epiphysis.

Figure 4: Showing FL measured in pregnant woman, 36wks+6days of gestation.

Measurement of trans cerebellar diameter

Trans cerebellar is measured by transverse view of fetal intracranium through the posterior fossa that include visualization of midline thalamus, cerebellar hemisphere and cistern magna. Rotating the transducer in the axial plane centering on the thalamus to delineate the cerebellar hemispheres and placing the callipers on the outer margins of cerebellar hemispheres. Measurements are taken in mm at 90 degrees to the long axis of the cerebellum across its widest point using outer to outer method.

Figure 5: Showing TCD measured in pregnant woman, 36wks+6days of gestation.

Statistical methods:

Data were coded and entered using IBM SPSS statistics (Statistical Package for Social Sciences) software version 18.0, IBM Corp., Chicago, USA, 2009. Descriptive statistics for categorical variables included frequencies and percentage. While quantitative variables were presented as means ± standard deviation for normally distributed data. Associations between different parameters (TCD, BPD, AC and FL) and gestational age by LMP were calculated. Agreement between parameters is calculated. Pearson's correlation between GA estimated by different parameters and GA calculated by LMP is performed. in addition, multiple linear regression was analyzed. P values less than 0.05 were considered as statistically significant.

Results

The sociodemographic characteristics of the participants are shown in Table (1). The pregnant females' mean age was 29.4 ± 6.4 years, with a range of 18 to 39 years. Furthermore, 60% of the ladies resided in cities. the individuals' average anthropometric measurements. The participants' average height was 167.9 ±10.6 cm, and their average weight was 85.8 ±12.3 kg. The mean BMI of the female recruits was estimated to be 30.8 ± 6.1.

Table 1: Socio-demographic and baseline measurements data among the studied group (n = 100):

Socio-Demographic Data	No.	%
Age (years) **Mean (±SD)** **Range (min – max)**	29.4 18	± 6.4 39
Residence **Urban** **Rural**	60 40	60% 40%
Weight (kg)	85.8±12.3	
Height (cm)	167.9±10.6	
BMI (kg\m²)	30.8± 6.1	

The findings of the obstetric evaluation performed on the pregnant women who were polled are shown in table (2). With a mean systolic blood pressure of 116.1 ± 9.8 mmHg and a mean diastolic blood pressure of 74.3 ± 11.6 mmHg, the majority of participants (80%) were multiparous. According to the distribution of the females by week of gestation, 40% of the females were in the 13th to 27th week of gestation, and 60% of the females were in the 28th to 40th week.

Table 2: Obstetric characteristics of the studied group (n = 100):

Obstetric characteristics	No.	%
Parity **Nulliparous** **Multiparous**	20 80	20% 80%
GA (weeks) **13 – 27** **28 – 40**	40 60	40% 60%
Obstetric characteristics	Mean	SD
Blood pressure (mmHg) **Systolic** **Diastolic**	116.1 74.3	± 9.8 ± 11.6
TCD (mm) **(Mean ±SD)**	31.4	± 5.3
BPD (mm) **(Mean ±SD)**	70.99	± 11.91
AC (mm) **(Mean ±SD)**	275.43	± 66.26
FL (mm) **(Mean ±SD)**	62.12	± 19.8

The estimated GA as determined by various factors and methodologies is shown in Figure (6). With a mean of 30.42±4.15, the GA, as determined by the date of the last menstrual cycle, varied from 21 to 40 weeks of gestation. The mean GA was determined by TCD estimation to be 31.4±5.3 mm, the BPD estimations to be 70.99±11.91 mm, the AC to be 275.43±66.26 mm, and the FL to be 62.12±19.8 mm.
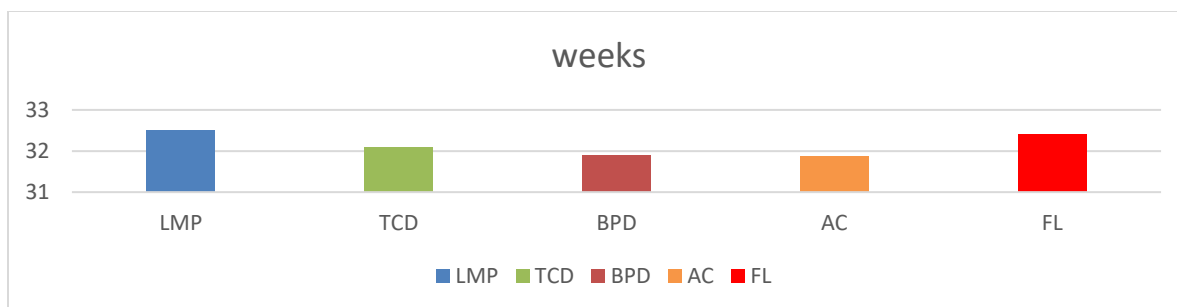
Figure 6: The obstetric parameters estimation of GA among the studied group.

The degree of agreement between the various ultrasonographic parameters and the GA predicted by the LMP is shown in Table (3). The TCD had the best intraclass correlation (0.987), indicating good dependability with strong statistical significance (p = <0.001). However, the abdominal circumference (0.826) was the least accurate measurement. However, every parameter was remarkably dependable.

Table 3: Agreement between the GA estimated by TCD, FL, BPD, AC compared to GA estimated by LMP among the studied group (n=100):

Parameters	Kapa coefficient	Intraclass correlation	Confidence interval	P value
TCD	0.986	0.991	0.979 - 0.995	<0.001
BPD	0.932	0.911	0.899 – 0.944	<0.001
AC	0.914	0.889	0.877 – 0.895	<0.001
FL	0.961	0.934	0.923– 0.951	<0.001

* Paired t-test, statistically significant values will be in bold

The relationship between the various factors and the GA calculated using the LMP approach was shown in Figure (7). The AC and the LMP had the lowest connection (r = 0.889), while the TCD and the LMP had the greatest correlation (r = 0.986). Nonetheless, every association was statistically significant, robust, and favorable.
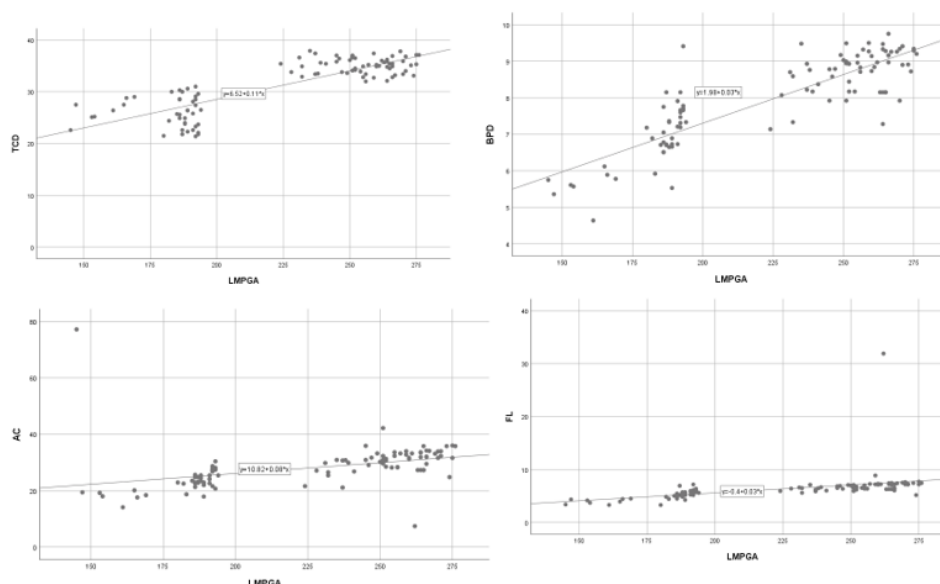

Figure 7: Correlation of TCD, FL, BPD, AC with GA estimated by LMP among the studied group.

Table 4 showed how TCD was associated with BPD and GA in second-trimester females as determined by the LMP technique. The TCD and the LMP showed the strongest link (r = 0.933), whilst the BPD and the LMP showed the weakest correlation (r = 0.739). Nonetheless, every association was statistically significant, robust, and favorable. The TCD and the LMP showed the strongest association (r = 0.980) in the third trimester, while the FL and the TCD showed the worst correlation (r = 0.780). Nonetheless, every association was statistically significant, robust, and favorable.

Table 4: Correlation of TCD with BPD and GA estimated by LMP among the females in 2nd and 3rd trimester (n = 28):

Parameters		2nd trimester		3rd trimester	
		BPD	LMP	FL	LMP
TCD	Pearson Correlation	0.941*	0.818*	0.992*	0.826*
	P value	<0.001	<0.001	<0.001	<0.001

* Statistically significant values.

The proportion of correct GA assessments by TCD and BPD within two weeks after the projected GA determined by LMP was shown in table (5). During the second trimester, TCD has been shown to be more accurate than BPD. During the third trimester, TCD is shown to be more accurate than FL.

Table 5: Accuracy rate of the TCD (within two weeks) in comparison with the BPD during the second trimester (n = 28):

Parameters		Accurate assessment	Percentage
2nd trimester	TCD	38	95%
	BPD	32	80%
3rd trimester	TCD	58	96.7%
	FL	43	71.7%

Discussion

Assuming that ovulation occurred on day 14 of a normal 28-day menstrual cycle, the first day of the LMP is often used to calculate gestational age. The use of oral contraceptives, recent pregnancy, breastfeeding, irregular menstruation, and ambiguous or unknown dates may all alter how accurate this technique is. In these cases, GA is evaluated using an ultrasonic measurement. In the second and third trimesters, GA is often estimated using fetal BPD, HC, AC, and FL [11].

Several ultrasound measures in the third trimester, including BPD, one of the most often used metrics, exhibit a margin of error of three to four weeks from true GA. Significant biological differences in the size and shape of the embryonic skull are the cause of this. When development is restricted or accelerated and postdate pregnancy induction is anticipated, management decisions become more challenging [12].

The fetal cerebellum may be seen on ultrasonography between weeks 10 and 11. Furthermore, the fetal cerebellum expands gradually as it develops and has a linear connection with GA. The cerebellum is located in the posterior cerebral fossa and is surrounded by dense petrous and occipital bones. Therefore, the fetal cerebellum is unaffected by changes in the shape of the embryonic skull. The TCD is not affected by fetal development and is only little affected, even in cases of severe IUGR. These features make the

TCD one of the most reliable ultrasonography criteria for assessing GA, even in the third trimester [13].

We performed cross-sectional research with 100 pregnant women in their second and third trimesters who visited the Obstetrics and Gynecology clinic at Suez Canal University Hospital in order to assess a reliable technique for quantifying GA at these stages of pregnancy. The subject was evaluated while lying dorsally supine and slightly inclined after providing their informed consent. Two-dimensional ultrasounds were conducted. Fetal biometry and amniotic fluid volume were assessed. With an emphasis on LMP, each woman who was part of the study had a complete clinical examination and a detailed medical history taken.

We used the 2013 AIUM guidelines for measuring FL, BPD, and AC. TCD was assessed as the largest width of the cerebellar hemispheres by Chavez et al. and Bhimarao et al. [8&9]. Based on the date of the previous menstrual cycle, the GA ranged from 21 to 40 weeks of gestation, with a mean of 30.42±4.15.

According to TCD estimate, the mean GA was 31.4±5.3 mm, the BPD was 70.99±11.91 mm, the AC was 275.43±66.26 mm, and the FL was 62.12±19.8 mm. The mean value (±SD) of GA determined by TCD was 34.01±1-2, BPD was 33.89±2, AC was 32.92±7-11, and FL was 34.02±2-7, according to a similar finding by Bavini et al. [13]. Examining the level of agreement between the several ultrasonographic parameters and the GA calculated by the LMP, the TCD showed the strongest intraclass correlation (0.987), suggesting great statistical significance (p = <0.001) and excellent dependability. The measurement that was least accurate, however, was the abdominal circumference (0.826). But all the parameters were reliable.

A previous study by El-Ebeisy et al. on women in their 14–40 weeks of pregnancy found that TCD showed worse agreement (0.79) and (0.53) with LMP than FL (0.90) and (0.76) in the early and late third trimesters, respectively [14].

TCD was linked to BPD and GA in second-trimester females in the research group, according to the LMP method. The largest association was found between the TCD and the LMP (r = 0.933), whereas the smallest correlation was found between the BPD and the LMP (r = 0.739). All of the associations, however, were strong, positive, and statistically significant. In the third trimester, there was the best link (r = 0.980) between the TCD and the LMP and the weakest correlation (r = 0.780) between the TCD and the FL. All of the associations, however, were strong, positive, and statistically significant.

According to research by Aboshehata et al. on pregnant women in the second trimester, TCD was more correlated with GA (0.995) than BPD (0.986). When compared to other biometric measurements during the second trimester of pregnancy, they similarly concluded that TCD had the strongest connection with GA [15].

In the early second trimester, TCD showed a higher association (0.944) with genuine GA than BPD (0.943) and other ultrasonographic markers, according to El-Ebeisy et al. (2019) [15]. A 2019 study by Desdicioglu et al. found that during the second trimester of pregnancy, the TCD increases in step with the GA.

One hundred pregnant women with precise dates spanning from 18 to 36 weeks of gestation were involved in a study by Kothan et al. (2019). They asserted that the TCD estimate of GA is a reliable and

cost-effective technique with a significant correlation (0.946) with GA. Additionally, they found that TCD increases linearly with GA [16].

Accordingly, after studying women in their second trimester of pregnancy, El-Sayed et al. (2021) discovered that TCD is a more accurate test for identifying GA in the third trimester. Compared to FL (0.944), they discovered that TCD had a stronger correlation with GA (0.978) [17].

In a study of 100 pregnant women in the third trimester with a GA≥28 weeks, Bavini et al. also discovered the strongest connection between GA by LMP and TCD (0.979) and FL (0.971). They concluded that even in the third trimester, the TCD is a credible measure for GA estimate [13].

It has been shown that TCD is more accurate than BPD throughout the second trimester. It is shown that TCD is more accurate than FL throughout the third trimester. In a study including women in their second and third trimesters, Rada found a significant association between GA and BPD (0.905) and FL (0.894), which supports this [18].

We determined that TCD was more accurate in the second trimester (96.43%) than BPD (78.75%) and in the third trimester (98.61%) than FL (72.22%) after assessing the accuracy of TCD, FL, and BPD based on LMP within two weeks after GA.

Aboshehata et al. [15] found that TCD was the most accurate measure (98.5%) for identifying GA in the second trimester of pregnancy. The accuracy of TCD measurement in determining GA during the third trimester was also assessed by Ali et al. (2019), who discovered that TCD had an accuracy of 98% and FL had an accuracy of 75% [19].

Reddy et al. assessed the accuracy of GA prediction using TCD and compared it with other measures in order to assess GA in 15–40 weeks of gestation. They concluded that TCD is a reliable criterion for determining GA in the second and third trimesters since its values match those of GA by LMP. He also shows that TCD is a better predictor of GA than other markers, particularly in the third trimester [5].

Therefore, according to Naseem et al. (20), who compared the accuracy of TCD and BPD in the same trimester on 327 persons, TCD is a more reliable method of estimating GA in the third trimester than BPD. TCD provided a correct evaluation for 91.7% of all patients, while BPD provided an accurate assessment for 77.2%. GA in the third trimester may be determined more accurately using TCD (80.1% accuracy) than with FL (70.9% accuracy).

Conclusion

In conclusion, TCD has better correlation and predictive accuracy than other fetal biometrics in GA estimation. Furthermore, TCD was more accurate than biparietal diameter (BPD) for estimation of gestational age in second trimester of pregnancy, and more accurate than femur diaphysis length (FL) for estimation of gestational age in third trimester of pregnancy.

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