Original Article

Precision of Transcerebellar Diameter in Estimation of Gestational Age Compared to Biparietal Diameter in Singleton Pregnancy During Third Trimester

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Abstract

Objective: To determine the precision of gestational age measurement in the third trimester of pregnancy by comparing the accuracy of biparietal diameter and transcerebellar diameter in singleton pregnancy taking last menstrual period as gold standard.

Methodology: The present one-time observational study was conducted from March 2022 to February 2023. There were 162 pregnant women enrolled, with a singleton pregnancy, during third trimester, came to the outpatient department of Shahida Islam Teaching Hospital, Lodhran, Pakistan. The biparietal and transcerebellar diameter of the developing fetus were estimated by radiologists and compared it with gestational age obtained by last menstrual period. McNemar test was employed to compare their significance. Intra-class correlation coefficient (ICC) was applied to establish the relationship between gestational age estimated by transcerebellar diameter and biparietal diameter with that estimated by last menstrual period.

Results: In this study we concluded significant positive correlation between the gestational age estimated by TCD and LMP ($r=0.87$) with $p < 0.001$, as well as between BPD and LMP ($r=0.71$) with $p < 0.001$. Nevertheless, the strength of the correlation between LMP and TCD outweighed the other. TCD accurately determined gestational age in 90.7% of cases, while BPD only achieved 74% of accuracy rate for gestational age assessment in third trimester.

Conclusion: The precision of transcerebellar diameter (TCD) is more than that of biparietal diameter (BPD) in gauging gestational age during the third trimester of pregnancy.

Keywords: Tanscerebellar diameter, gestational age, biparietal diameter, third trimester, singleton pregnancy.

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Introduction

Gestational age (GA) assessment plays a pivotal role in determining medical aid required during pregnancy. It serves as the foundation for determining the optimal time of deliveries and managing adverse perinatal outcomes. Research has highlighted that conclusions relying on the incorrect gestational age estimations contribute to elevated rates of maternal & fetal morbidity and mortality.[1]

The conventional approach to calculate gestational age, that relies on last menstrual period (LMP), can be impacted by the maternal menstrual cycle regularity, particularly in the last three months before conception, as well as previous hormonal contraceptive treatment. Women coming from underdeveloped nations encounter additional challenges including delayed access to prenatal care, insufficiently accurate records of their menstruation cycles, and irregularities in their menstrual patterns.[2]

Certain experts regard ultrasound-based assessment

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of gestational age as the ultimate standard in prenatal care. Within this domain, the estimation of crown-rump length (CRL) during the first trimester is widely acknowledged as the most dependable indicator.[3,4] As pregnancy continues beyond the first trimester, fetal biometric markers like as biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC) acquire significance and are commonly used.[5-7]

Regrettably, due to their reliance on typical fetal growth pattern and the menstrual cycle regularity, few of the frequently utilized parameters lack specificity. In cases of uteroplacental insufficiency, certain measurements such as biparietal diameter, head circumference, femur length, and abdominal circumference may be negatively affected in fetuses. This can result in changes in the distribution of cardiac output and trigger a brain-preserving response, ultimately leading to growth restriction.[8-10] Beyond 26 weeks of gestation, dolichocephaly and brachycephaly can compromise the reliability of BPD in fetuses. Achondroplasia is associated with a shorter FL in fetuses, and inaccuracies in FL measurement by ultrasound may also arise when there is oligohydramnios.[1]

On ultrasound, cerebellum can be easily observed in the posterior fossa with vermix as a rectangular echogenic central structure, linking two oval hypoechoic symmetrically assembled hemispheres starting from 14th week of intrauterine gestation.[11] The size of fetal cerebellum exhibits a direct correlation with the intrauterine gestational age of the fetus.[12,13] Unlike in fetuses with intrauterine growth restriction (IUGR), the cerebellum remains unaffected due to the brain's adaptive response.[14] Consequently, the TCD has been identified as a dependable sole parameter for estimating gestational age in the later stages of pregnancy.[15,16]

This study compared the accuracy of transcerebellar and biparietal diameter measurements in the third trimester of a singleton pregnancy, using the latest menstrual cycle as the gold standard, to estimate gestational age.

In this study we wanted to establish a relationship between gestational age estimated by last menstrual period (LMP) and transcerebellar diameter (TCD) and compared it with the gestational age estimated with biparietal diameter (BPD), so that we could establish a single reliable parameter in determining gestational age of the fetuses in third trimester, in women with unsure of their last menstrual period and had not have any first trimester obstetrical scan, to minimize the possibility of maternal & fetal morbidity and mortality.

Methodology

The present observational study was carried out at Shahida Islam Teaching Hospital, Lodhran, Pakistan from March 2022 to February 2023 after approval was secured from the Research Ethics Committee of Shahida Islam Medical Complex Lodhran (No: SIMC/H.R./7154/22).

Sample size was estimated using website http://www.raosoft.com/samplesize.html with margin of error set at 6.36%, confidence interval 90%, population of pregnant women in third trimester taken as 5000. Response distribution was set at 50%. Recommended sample size was 162.

These 162 pregnant women with singleton pregnancies, falling within the 29 to 38 weeks of gestational age range, were enrolled from the outpatient clinic of Gynaecology and obstetrics of Shahida Islam Teaching Hospital, Lodhran. All women participating in the study provided informed written consent after receiving explanations about the study's objectives and associated risks before enrolment. All participants were confident about the first date of their last menstrual period (LMP), had no history of abnormal menstruation over six months leading to pregnancy.

The women, who were unsure about the date of their last menstrual period (LMP), multiple gestations, those who experienced intrauterine fetal demise (IUFD), intrauterine growth restriction (IUGR), anomalous fetus and those who had irregular menstruation or utilizing hormonal contraceptive within last six months before becoming pregnant were excluded from this study.

Before enrolling in the study, all participating women underwent a comprehensive history assessment, physical examination, and a preliminary ultrasound evaluation. The ultrasound measurements were conducted using an ultrasound machine (LOGIQ S6, General Electrical (GE), Japan) equipped with a 3.5–5 MHz convex probe. The measurements of the transcerebellar diameter were taken by visualizing the fetal cerebellum through a transverse view within the posterior fossa. The transcerebellar diameter was acquired by positioning the callipers of the ultrasound unit on the outermost boundaries of cerebellum displayed on the screen. (as shown in Figure 1)

The estimation of the biparietal diameter was carried out in the fetal brain's axial sections at the level of thalami and cavum septum pellucidum, spanning from the outermost surface of the proximal cranium to the inner surface of the distal cranium (as shown in Figure 2) Physicians, unaware of the ultrasound measurements, conducted the history assessment and gestational age calculation. Similarly, radiologists remained unaware of the gestational age estimation relied on the first day of last menstrual period. Both sets of data remained concealed until after the statistical analysis was completed.

Statistical analysis was conducted using SPSS Statistics version 22. Data were gathered, organized and subsequently following statistical tests were used to analyse the data; means and standard deviations were used to present numerical data, whereas percentages were used to present categorical data. To compare the percentage of patients with accurately estimated gestational age (GA) between the transcerebellar diameter (TCD) and the biparietal diameter (BPD), the McNemar test was employed. A significance level of $P < 0.05$ was regarded statistically significant. Measurements taken with BPD and TCD is said to be corresponding if it falls ±10 days from the gestational age taken by last menstrual period (LMP). The relationship of GA measured by TCD and BPD with GA measured by LMP had been assessed using the intra-class correlation coefficient (ICC). The ICC values were interpreted as follows: bad relationship (0-0.3), average relationship (0.4-0.6), strong relationship (0.7-0.8), and close to the perfect agreement (>0.8).

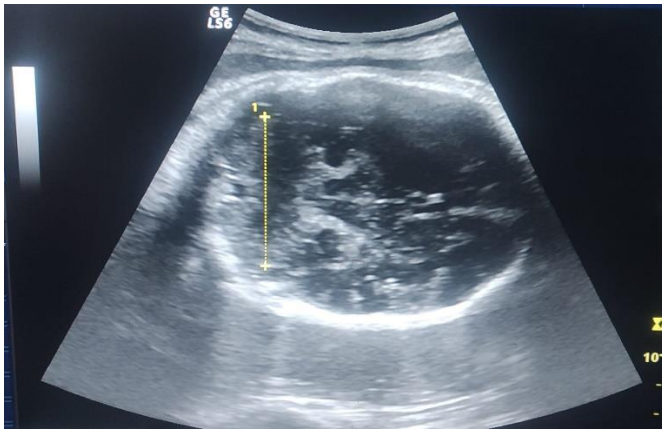

Figure 1. Sonographic measurement of transcerebellar diameter

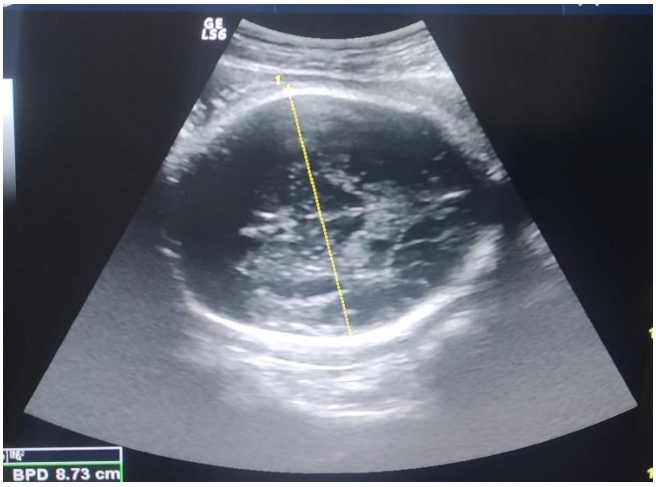

Figure 2. Sonographic measurement of biparietal diameter. (BPD)

Results

This study included 162 pregnant women having singleton pregnancies between 29 and 38 weeks of gestational age. Table 1 displays their demographic characteristics. The gestational age determined using the last menstrual period (LMP) varied between 29 to 38 weeks (34.1± 2.3 weeks). On the other hand, the gestational age estimated through transcerebellar diameter (TCD) ranged from 29 to 37 weeks (33.8± 2.21 weeks) and the gestational age estimated by biparietal diameter (BPD) ranged from 30 to 37 weeks (33.4± 2.0 weeks).

Table I: Demographic characteristics.

		Min	Max	Mean±SD
Age in years		17	41	27.6±5.2
AFI (cm)		8	32	14.7±4.3
		N		%
Parity	1	46		28%
	2	73		45%
	3	29		17.9%
	4	7		4.3%
	5	7		4.3%
Total		162		100

The strength of the correlation between LMP and TCD outweighed the correlation between LMP and BPD. TCD accurately determined gestational age in 90.7% of cases, while BPD only achieved 74% accuracy rate for gestational age assessment (Table II). Nevertheless, a significant positive correlation was observed between the gestational age estimated by TCD and LMP ($r=0.87$) with $p < 0.001$ as well as between BPD and LMP ($r=0.71$) with $p < 0.001$. Additionally, the intra-class correlation coefficient demonstrated complete relationship between the gestational age determined by TCD and BPD, and the gestational age determined by

LMP, indicating that both methods are reliable measures of gestational age (Table III & Table IV).

Table II: Correspondence between TCD & BPD in regard to approximate gestational age estimation.

		N	%	P-value
Correspondence by BPD	Yes	120	74%	0.001
	No	42	25.9%	
correspondence by TCD	Yes	147	90.7%	0.001
	No	15	9.2%	

Table III: Intraclass corelation co-efficient for relationship of GA estimated by BPD and LMP.

	Intraclass Correlation	95% confidence interval (CI)		F Test	
		Lower bound	Upper bound	value	sig
Single measures	0.713	0.628	0.781	5.959	0.000
Average measures	0.832	0.771	0.877	5.959	0.000

Table IV: Intraclass corelation co-efficient for relationship of GA estimated by TCD and LMP.

	Intraclass correlation	95% confidence interval (CI)		F Test	
		Lower bound	Upper bound	value	sig
Single measures	0.877	0.836	0.909	15.300	0.000
Average measures	0.935	0.911	0.952	15.300	0.000

Discussion

In developing nations, a significant portion of women lack consistent access to routine prenatal care. Consequently, numerous pregnant women seek medical attention at hospitals during the third trimester, often without any documentation that could aid in determining their gestational age. This situation presents doctors with the challenge of accurately estimating gestational age in such cases, in order to facilitate appropriate pregnancy management. Ultrasound assessment becomes a vital tool in situations where women are uncertain about their menstrual history Nonetheless, it has been observed that variations of up to two weeks might occur when calculating gestational age in the third trimester using specific ultrasound measurements, such as head circumference (HC), abdominal circumference (AC), or biparietal diameter (BPD).[7]

Over recent years, there has been considerable investigation into transcerebellar diameter (TCD), yielding highly promising outcomes. These studies have demonstrated a robust association between TCD and gestational age, particularly in its latter stages.[17,18] The fetal cerebellum resides within the posterior fossa, positioned between the bony structures. The development of fetal cerebellum displays a linear dependence with advancing gestational age, remaining consistent despite alterations in fetal cranium dimensions and is unaltered by fetal development even in cases of intrauterine growth restriction (IUGR).[7] These attributes have led multiple researchers to regard TCD as single most dependable ultrasonographic variable for gestational age calculation. In fact, few researchers have suggested that it might exhibit greater reliability than other parameters, especially in instances of IUGR.[19,20]

The results of this study showed that transcerebellar and biparietal diameters had remarkably high precision (p-value <0.001) when it came to estimating gestational age in the third trimester. However, transcerebellar diameters had a stronger and positive correlation (r = 0.87) with gestational age than biparietal diameters (r = 0.71), which was determined by the first day of the last menstrual period (LMP). Thus, we can incorporate transcerebellar diameter in the routine dating scans as well as utilize it as single parameter for dating in third trimester. Age of the mother, parity and amount of liquor did not impact the results of this study.

This correlation closely resembled the patterns observed in the majority of investigations focusing on the precision of TCD in estimating gestational age in the third trimester. Similar to our study, Chavez et al. in 2007 proposed that TCD displayed elevated precision in accurately predicting gestational age for fetuses both affected by intrauterine growth restriction (IUGR) and those with larger dimensions with correlation coefficient of 0.95 and P-value=0.001.[21-23] On the flip side, Dashottar et al. noted a relatively mild correlation of transcerebellar diameter with gestational age beyond 32nd weeks of gestation. Curiously, the author did not provide any potential elucidation for this observed weak correlation.[24]

Reddy et al. included participants from 15 to 40 weeks of gestation and the significance of fetal transcerebellar diameter (TCD) in fetal biometry was examined. Similar to our study, the results of this study indicated that TCD was a valuable parameter for estimating gestational age during the second and third trimesters. Furthermore, TCD demonstrated a strong correlation (r=0.982) with gestational age based on last Menstrual Period (LMP) data with p value= 0.0004. It also

outperformed other parameters, particularly in the third trimester, as a predictor of gestational age.[20]

Similarly, George et al. concluded a high correlation (r=0.995) for accuracy of transcerebellar diameter in the estimation of gestational age in third trimester with p-value <0.001.[10]

Another study conducted in Egypt, examined a group of 150 pregnant women in their third trimester, and showed the same results as ours. Their goal was to assess the reliability of transcerebellar diameter (TCD) as a method for estimating gestational age. The researchers ultimately concluded that TCD is an accurate and dependable approach to determine gestational age during the third trimester of pregnancy.[4]

TCD is not a commonly measured parameter in routine fetal biometry assessments conducted by most physicians, and many ultrasound systems do not typically incorporate TCD-based gestational age measurements. Our study affirms, aligning with the findings of many investigations, that TCD might serve as a dependable sonographic variable for estimating gestational age during the third trimester. It advocates for the regular inclusion of TCD measurements in fetal biometry practices.

The strength of the study lies in the practice of blinding the obstetricians and the radiologists unless statistical analysis were done. Negligible studies are published to determine the versatility in the gestational age estimation from transcerebellar diameter in third trimester, which conclude it as an accurate parameter of gestational age estimation. An advantageous aspect of this research lies in the mitigation of expertise discrepancies, given that all ultrasound scans were conducted by trained radiologists. Majority of the studies compared transcerebellar diameter with either femur length or combined gestational age. Very little comparative studies determined the differences between biparietal diameter and transcerebellar diameter in third trimester.

The limitations of this study revolve around a small sample size, as there were only 162 cases analysed. Additionally, the study excluded numerous cases with irregular menstrual cycles or uncertainty regarding the date of the last menstrual period, that may affect the results of this study. Another limitation is that, this study focused solely on healthy singleton pregnancies, excluding any pregnancies with abnormalities, multiple fetuses, intrauterine growth restriction, or macrosomic babies. Therefore, it would be beneficial to conduct further studies with a larger sample size that includes growth-restricted and macrosomic fetuses to corroborate these findings and establish transcerebellar diameter as a more accurate and reliable parameter for estimating gestational age in the third trimester.

Conclusion

Transcerebellar diameter (TCD) is more precise than biparietal diameter (BPD) in determining gestational age during the third trimester of a singleton pregnancy. Thus, there is a high possibility that combining TCD with additional fetal biometric data will result in more exact gestational age estimate in the third trimester.

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