

TRANSVERSE DIAMETER OF FETAL CEREBELLUM AS A MARKER FOR ACCURATE ESTIMATION OF GESTATIONAL AGE IN IUGR AND NORMAL PREGNANCIES DURING SECOND TRIMESTER

Anoshey Malik^{*1}, Muqaddas Fatima², Rabnawaz Afzal³, Ayesha Farooq⁴

^{*1,2,3,4}BS Radiography and Imaging Technology, Afro Asian Institute Lahore, Affiliated with GC University, Faisalabad

^{*1}anosheymalik@gmail.com, ²muqaddasfatima505@gmail.com, ³rabnawazafzal6232@gmail.com, ⁴ayeshafarooq4848@gmail.com

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Corresponding Author: *

Anoshey Malik

Abstract

Background: During the second trimester of both IUGR and normal cases, the transverse diameter of the fetal cerebellum has the potential to estimate GA with great accuracy.

Objective: In the second trimester of both IUGR and normal pregnancies, gestational age was estimated using the transverse diameter of the fetal cerebellum.

Methods: A comparison study was conducted with a total of 100 patients. The data were collected from Faysal Hospital Lahore. Procedures involving the Toshiba XARIO XG, utilizing a convex probe in the frequency range of 3-5 MHz, were employed. All women (n = 100), in their second trimester of pregnancy (between 14 and 28 weeks), were included in the study. Women in their first and third trimester were excluded (1st trimester: n = 50; 3rd trimester: n = 50). SPSS version 21.0 was employed for statistical analysis and data were presented in terms of mean and standard deviation.

Results: The transverse cerebellar diameter (TCD) correlated well with gestational age (GA). There was consistency regarding TCD and GA amongst both IUGR and non-IUGR patient cohorts. A comparison between IUGR and non-IUGR patient cohorts demonstrated statistically significant results, confirming TCD as a consistent and reliable indicator of GA regardless of fetal growth status.

Conclusions: The transverse cerebellar diameter (TCD) is a reliable measure for GA with a direct correspondence, even in cases of intrauterine growth restriction (IUGR). TCD, unlike other standard biometric measures, remains stable in the presence of fetal growth disturbances, and thus is a critical parameter in the assessment of fetal health. TCD, in combination with the abdominal circumference, may be useful in the identification of IUGR, but different population-based reference values would be required to account for variations in ethnicity, nutrition, and the environment. Therefore, TCD is an indispensable parameter for accurate GA estimation that greatly enhances obstetric practice and understanding globally.

01 INTRODUCTION

Gestational Age (GA) is one of the most important parameters in prenatal care, having a great impact on all obstetric management. Parental interventions and parental management aren't easy as one think so precise determination of gestational age (GA) is crucial for guiding decisions regarding parental interventions and managing potential complications, ultimately safeguarding the health of both the mother and the infant. The fetal growth estimation error can have a negative impact, which including retrieval of errors for fetal growth abnormalities, undue induction or delayed interventions opportunities

(Vesel, L. et al., 2019).

In obstetric practice, precise GA calculation is especially important when intrauterine growth restriction (IUGR) is present. IUGR is a common condition, where the fetus cannot grow to the expected size, typically as a result of an abnormal process (placental insufficiency, maternal disease, fetal defect). It has been linked to an increased risk of "stillbirth", "pre-term" delivery, "neonatal morbidity", and also "long-term consequences" such as "neurodevelopmental disorders" and also "grownup onset" conditions like hypertension, diabetes. (Kliegman, R. et al., 2010).

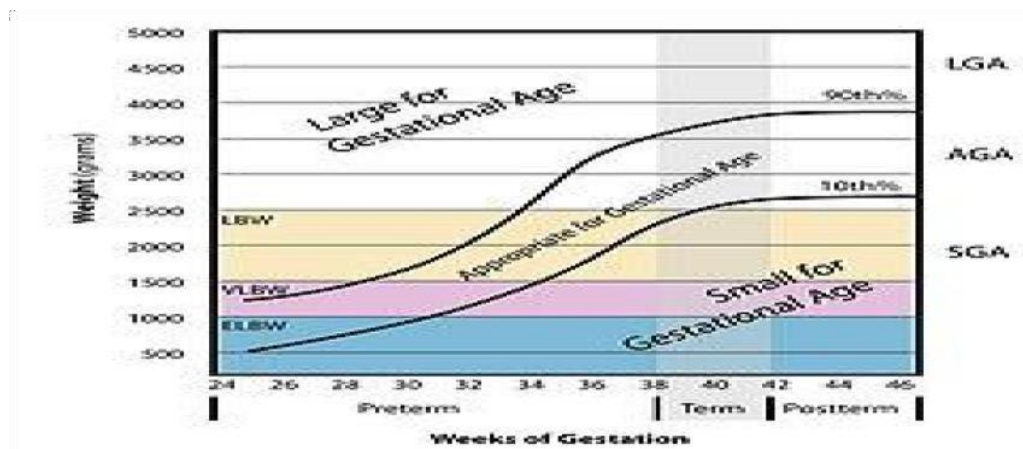


Image 1: Week of Gestational

This is important to know GA accurately for these pregnancies, to differentiate between the normal small-for-gestational-age (SGA) fetus and the growth restricted fetus, since the management is very different for these two groups.

The first day of the last menstrual period (LMP) or fetal biometric ultrasound measurements have traditionally been used to estimate GA. The LMP method is readily available and easy, however it can be inaccurate in women with irregular periods, poor memory of periods or who use hormonal contraceptives prior to becoming pregnant (Mahendru, A. et al., 2016).

Such limitations highlight the need for more reliable methods to determine GA, particularly in

populations where LMP data may be unavailable or inaccurate. Ultrasound-based estimation has become the gold standard for GA determination, especially in the first trimester when fetal growth is relatively uniform. Many measurements are used & have been validated in a variety of populations, including the diameters of the head and abdomen and the length of the femur.

Then accuracy becomes less as they progress in pregnancy. In the case of IUGR, for instance, asymmetrical growth patterns, such as the brain-sparing effect which swaps blood supply between the fetal brain and other structures, can change the normal measures and therefore, provide a wrong GA assessment (Simcox, L. E., 2019).

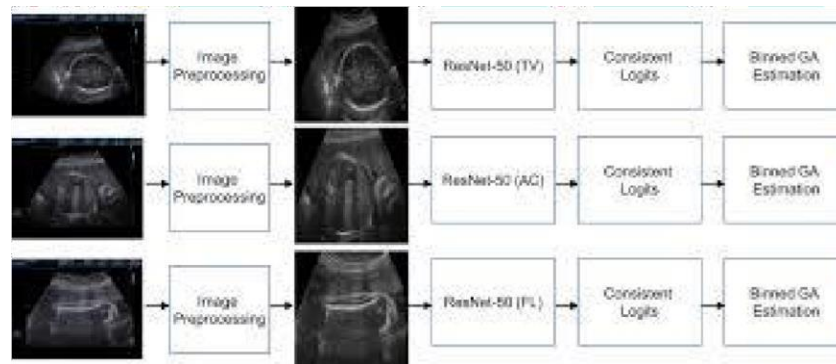


Image 2: Machine learning for Fetal Gestation Age

The fetal cerebellum has been proposed as a potential alternative to estimate the GA in recent years. The cerebellum is a crucial part of the developing fetal brain, controlling the motor movements, balance and cognition. This is an ideal candidate for the accurate estimation of GA mode, because of its predictable growth curve throughout the gestation. That has good predictability to growth mode during the gestation period, especially the second trimester so it is an ideal candidate for the accurate estimation of GA. Through the so-called brain sparing phenomenon, the brain growth and development of fetuses is spared in various pathologies that affect pregnancy, such as IUGR, and in these cases, cerebellum growth processes stay unaffected on the way (XuF. et al., 2020).

Transverse diameter of the fetal cerebellum (TDFC) has been found to be a reliable biometric indicator for dating pregnancies. Numerous studies have shown that TDFC measurements correlate strongly with GA across a wide range of gestational ages. This correlation is applicable to normal as well as abnormal pregnancies like IUGR, where traditional biometric parameters may not be reliable. The robustness of TDFC as a marker of GA stems from its relative independence from external factors such as maternal nutrition, placental function, or fetal growth anomalies (Patil, S. et al., 2018).

The integration of Transverse diameter of fetal cerebellum (TDFC) into routine ultrasound assessments offers several advantages over traditional methods. Firstly, the cerebellum's

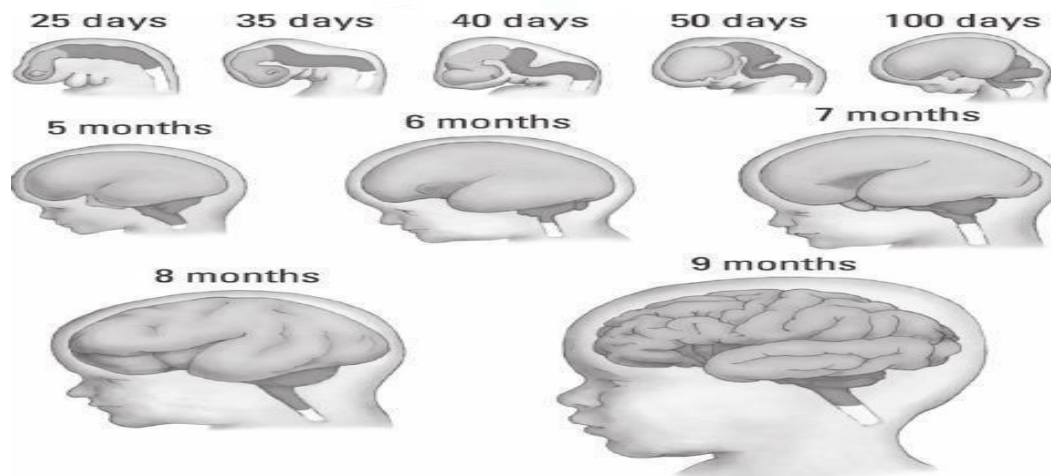
unique growth trajectory during the second trimester allows for precise dating of pregnancies during this critical period. Secondly, TDFC measurements are less affected by fetal growth abnormalities, maternal health conditions, or placental insufficiency, making it a more reliable marker in high-risk pregnancies finally, the development of ultrasound technology has made high-resolution visualization of the fetal brain possible, thus allowing the accurate and repeatable TDFC measurement (Gonzalez, L. et al., 2023).

For the low-resource regions, where an access to high-dollar testing machines might be limited, TDFC is an accessible and affordable option to estimate GA. Additionally, the TDFC can give the healthcare provider an additional method for fetal evaluation, and therefore increase the accuracy of fetal care, especially in situations where, existing evaluation methods are not as effective. Furthermore, its application extends beyond GA estimation to include assessments of fetal neuro development, providing a valuable window into the processes underlying brain maturation (Sanad, A. S., 2022).

Despite its promise, the use of TDFC as a routine tool for GA estimation is not without challenges. The accuracy and repeatability of TDFC measurement may be affected by some factors, such as dependence on operators, different measurement procedures and ultrasound equipment. To address these concerns, there should be standardized protocols and sonographers must be fully trained in the field of

measurements. Moreover, there is a need for further studies to create normative curves of TDFC in various populations and consider factors, like ethnicity, maternal conditions, and environmental factors (Sharma, H., 2021). It must be noted, however, that ultrasound imaging of fetuses is not entirely without its drawbacks and limitations, and can also be operator dependent and subjective. Continued research is needed to enhance the use of TDFC in clinical practice to improve measurement methods, validate with other populations, and integrate TDFC into current prenatal care plans. The main aim of this study is to assess the role of TDFC as a marker for accurate estimation of GA in normal and IUGR pregnancy in the second trimester. The aim of this study is to determine the validity and reliability of TDFC in different clinical

situations after synthesizing the existing data, (re-)defining measuring procedures and analyzing thoroughly. The research findings could be used to improve the accuracy of prenatal care, fetal monitoring, and the best interests of mothers and their babies. Fetal cerebellar development is important not only for clinical purposes, but also for studies of fetal neurodevelopment. Because of its importance for motor development, cognition and emotional regulation and its rate of maturation, the cerebellum is a good indicator of fetal maturity. The aim of this study is to find the prenatal growth dynamics which will be explained by the association of Transverse cerebral diameter (TCD), GA and postnatal outcome. These results could help come up with new ways to monitor and improve the health of fetuses (Azad, M. B., 2021).



In conclusion, the transverse cerebellar diameter is a major step forward in fetal biometry and is a good solution for the shortcomings of the classical definition of Gestational age (GA). It is a critical tool for enhancing fetal and maternal outcomes with its clinical strength, reliability, and wide applicability. With the progress of fetal medicine, these results will help to better understand intrauterine development and the factors that affect the health of newborns, setting new standards in obstetrics and furthering the science of prenatal care.

OBJECTIVE: To evaluate the transverse

cerebellar diameter of fetuses was compared in cases of intrauterine growth restriction (IUGR) as well as in normal pregnancies in the second trimester period to determine the gestational age accurately.

HYPOTHESIS

3.2.1 : Null hypothesis (H₀)

In both normal and IUGR pregnancies, the transverse diameter of the fetal cerebellum is not significantly reliable indicator of gestational age during the second trimester.

3.2.2 : Alternative Hypothesis (H₁)

Due to its strong correlation with GA, the

transverse diameter of the fetal cerebellum is significantly reliable sign of accurate GA estimate in both normal and IUGR pregnancies throughout the second trimester of GA.

3.3 : Problem Statement

For proper treatment and a thorough assessment of the mother's and the unborn child's health during the whole gestation period, accurate gestation estimate is essential. Pregnancy intrauterine growth restriction (IUGR) may not be a good indicator for common biometric measurements like biparietal diameter, femur length and abdominal circumference, particularly during the second trimester. The transverse diameter of the fetal cerebellum, which is very resistant to developmental constraints, may be a more accurate indicator of gestational age. However, there aren't much local research that compares the transverse cerebellar diameter of second-trimester IUGR pregnancies with normal pregnancies. The purpose of this research was to determine if the cerebellum's transverse width may be a trustworthy measure of gestational age in both normal and IUGR fetuses.

MATERIALAND METHODS

The study was conducted as a comparative study at Faysal Hospital, Lahore, over a period of seven months following approval of the research synopsis. A total sample of 100 participants was selected through convenient sampling. The study included married females aged 22–35 years with singleton pregnancies in the second trimester (14–28 weeks), a known last menstrual period (LMP), and either normal pregnancy or

diagnosed intrauterine growth restriction (IUGR). Pregnancies in the first or third trimester, multiple pregnancies, congenital fetal anomalies, and pregnancies associated with underlying diseases were excluded. Data were collected using a structured data collection sheet. Ultrasonographic examinations were performed using a Toshiba Xario XG ultrasound machine with a 3–5 MHz convex transducer through a transabdominal approach. Participants were examined in the supine position, with a small amount of ultrasound gel applied to the abdomen to facilitate adequate transmission of sound waves and image acquisition.

Ethical principles established by the GC University of Faisalabad Ethical Committee were followed throughout the study. Written informed consent was obtained from all participants, and confidentiality and anonymity were maintained during data collection, analysis, and reporting. Participants were informed about the study procedure and their right to withdraw at any time without consequences. Data were securely maintained, with physical records stored in restricted-access facilities and electronic data protected by passwords. All relevant sources were appropriately cited to maintain academic integrity. The collected data were entered, analyzed, and tabulated using Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics were used to summarize the study variables, while an independent-samples t-test was applied to compare the relevant continuous variables between the study groups. Statistical significance was assessed at an appropriate significance level.

RESULTS

TABLE 01

Age and Gestational Age Statistics Table

	N	Minimum	Maximum	Mean	Median	SD
AGE	10	25.000	34.000	29.540	29.500	2.467
	0					6
GA WEEKS	10	16.000	24.000	21.000	21.000	1.974

Table shows the age and gestational age statics that out of total 100 patients The minimum age was 25 & maximum age was

34 years, while the minimum gestational age was 16 weeks and maximum was 24 weeks.

TABLE 02

Independent samples t-test

Sample 1		
Variable		AFI_CM
Filter		IUGR="NO"
Sample 2		
Variable		AFI_CM
Filter		IUGR="YES"
	Sample 1	Sample 2
Sample size	50	50
Arithmetic mean	11.3600	9.8800
95% CI for the mean	10.8314 to 11.8886	9.4634 to 10.2966
Variance	3.4596	2.1486
Standard deviation	1.8600	1.4658
Standard error of the mean	0.2630	0.2073
F-test for equal variances		P = 0.099

Table 02 shows the both sampling IUGR or without IUGR comparison with AFI, while table 03 or 04 shows that the by applying T- test the comparison between both groups with AFI is significant. There is no significant difference between them.

Difference	-1.4800
Pooled Standard Deviation	1.6745
Standard Error	0.3349
95% CI of difference	-2.1446 to -0.8154
Test statistic t	-4.419
Degrees of Freedom (DF)	98
Shapiro-Wilk test	W=0.9797 1
for Normal distribution	accept Normality (P=0.1250)

Table shows that the two tailed probability test comparison between both groups with AFI which is

Also, significant and the P= (0.0001) value is less. The standard deviation is 1.6745.

FIGURE

Fig1: Whisker boxplot shows the graph representation of the AFI with or without IUGR pregnancy

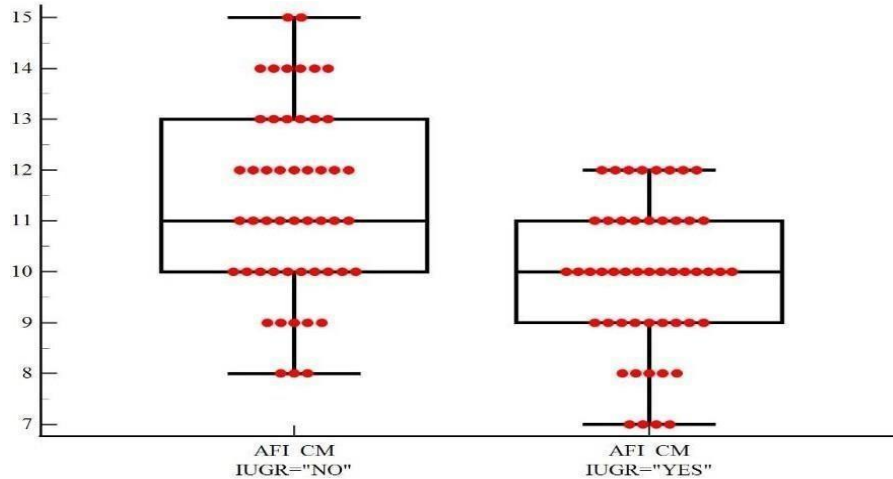


TABLE 03

Independent samples t-test

Sample 1	
Variable	GA_WEEKS
Filter	IUGR="NO"
Sample 2	
Variable	GA_WEEKS
Filter	IUGR="YES"

	Sample 1	Sample 2
Sample size	50	50
Arithmetic mean	21.4600	20.5400
95% CI for the mean	20.9755 to 21.9445	19.9345 to 21.1455
Variance	2.9065	4.5392
Standard deviation	1.7049	2.1305
Standard error of the mean	0.2411	0.3013
F-test for equal variances		P = 0.122

Table shows the both sampling IUGR or without IUGR comparison with gestational age, while table below shows that by applying T- test the comparison between both groups with gestational age is significant the value of P=0.122 and the standard deviation of sample 1 is 1.7049 and sample 2 2.1305.

Difference	-0.9200
Pooled Standard Deviation	1.9295
Standard Error	0.3859

95% CI of difference	-1.6858 to -0.1542
Test statistic t	-2.384
Degrees of Freedom (DF)	98
Two-tailed probability	P = 0.0190
Shapiro-Wilk test for Normal distribution	W=0.9631 reject Normality (P=0.0068)

Table shows that the two tailed probability test comparison between both groups with gestational age which is also significant and the P=0.0190 value is less and pooled standard deviation is 0.3859.

FIGURE

Fig 2: Whisker boxplot shows the graph representation of the GA with or without IUGR pregnancy

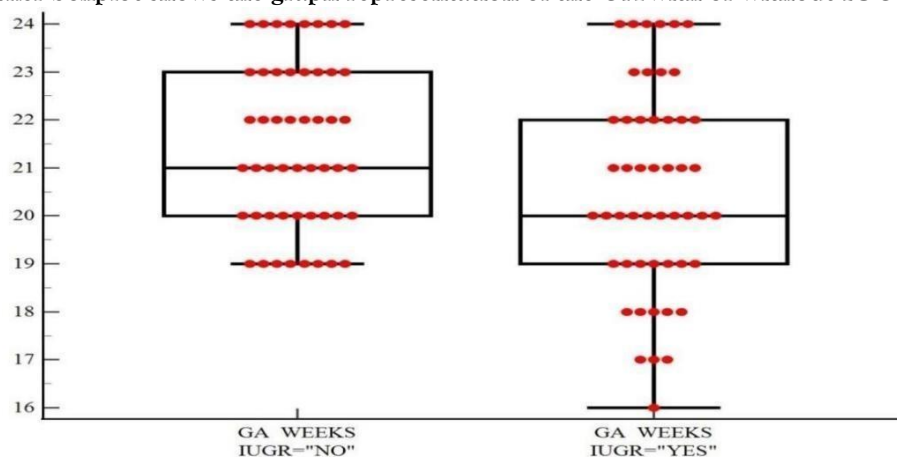


TABLE 04

Independent samples t-test

Sample 1	
Variable	TCD_mm
Filter	IUGR="NO"
Sample 2	
Variable	TCD_mm
Filter	IUGR="YES"

	Sample 1	Sample 2
Sample size	50	50
Arithmetic mean	21.4600	20.5400
95% CI for the mean	20.9755 to 21.9445	19.9345 to 21.1455
Variance	2.9065	4.5392
Standard deviation	1.7049	2.1305
Standard error of the mean	0.2411	0.3013
F-test for equal variances		P = 0.122

Table shows the both sampling IUGR or without IUGR comparison with TDC, while table below shows that by applying T- test the comparison between both groups with TDC is significant. And the $P=0.0122$ value is less. The standard deviation of sample 1 is 1.7049 and sample 2 2.122.

Difference	-0.9200
Pooled Standard Deviation	1.9295
Standard Error	0.3859
95% CI of difference	-1.6858 to -0.1542
Test statistic t	-2.384
Degrees of Freedom (DF)	98
Two-tailed probability	P = 0.0190
Shapiro-Wilk test for Normal distribution	W=0.9631 reject Normality (P=0.0068)

Table shows that the two tailed probability test comparison between both groups with TDC which is also significant and the $P=0.0190$ value is less and standard deviation 1.9295.

FIGURE

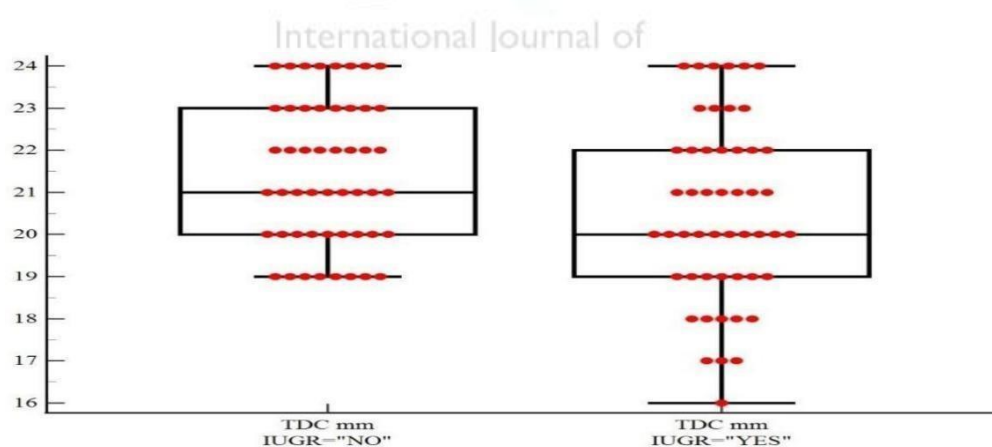


Fig 3: Whisker boxplot shows the graph representation of the GA with or without IUGR pregnancy

CONCLUSION: In the second trimester of pregnancy, the transverse cerebellar diameter (TCD) has been shown to be a very accurate measure of gestational age (GA). It is not influenced by growth restriction, which is a difference from other biometric parameters, and thus yields consistent results.

Recommendations

1. In order to more accurately determine gestational age, the transverse cerebellar diameter should be regularly measured during obstetric ultrasound exams in the second trimester.

2. In suspected IUGR situations, where conventional biometric parameters may be misleading, the fetal cerebellar measurements should be considered by radiologists and sonographers.

3. To verify the precision of the transverse cerebellar diameter diagnosis in different populations, more multicenter studies involving a greater number of patients should be carried out.

4. Local standards for fetal cerebellar measurements must be established to enhance clinical use of these standards.

Ultrasound professionals should be provided

with training workshops to improve fetal cerebellar measurement accuracy and repeatability.

Limitations of the Study

5. The study may have a small sample size, which could affect how broadly the results can be applied.

6. Collection of data from one hospital or one diagnostic center may not be representative of the total population.

7. Accurate measurement of the cerebellum may be affected by changes in fetal position during ultrasound examinations.

8. Measurement may be inconsistent because of operator dependency and variations in ultrasound equipment.

9. Only second trimester pregnancies included findings not representative of first or third trimester gestations.

10. The quality of images and measurements may be affected by maternal factors including obesity, oligohydramnios or fetal movement.

DISCUSSION

This study was designed to evaluate the TCD as a reliable measurement to estimate GA in normal pregnancies and IUGR in the second trimester. Correct calculation of GA is critical in Obstetrics to ensure the proper care of the developing fetus, the proper direction of prenatal treatment and to minimize maternal and fetal risk. Standard parameters such as FL, AC and BPD may not be as reliable in cases of IUGR. To this end, TCD was chosen for this research because the fetal cerebellum is not as constricted by development and will develop more slowly.

One hundred pregnant women with gestational ages ranging from sixteen to twenty-four weeks were enrolled in this study. The average gestational age was 21 ± 1.97 weeks, and the average mother age was 29.54 ± 2.46 years. The findings demonstrated a strong association between TCD and GA in both normal and IUGR pregnancies, suggesting that TCD is a trustworthy predictor of fetal age in both growth aberrant and

normal pregnancies.

This is in accordance with Dashottar et al. (2018) who reported TCD to be one of the most accurate biometric parameters in normal and IUGR pregnancies. They found that their measurement of TCD was very close to the actual gestational age compared to other fetal measurements. Likewise, the present study validated the reliability of TCD measurements in growth restricted fetuses, thus justifying the use of cerebellar measurements in high-risk pregnancies. Our findings were in accordance with Mishra et al. (2020), who found the strong positive correlation between the diameter of the transcerebellum (TCD) and GA with high statistical significance. They emphasized that TCD could be a good independent predictor for fetal dating. Likewise, the statistical analysis performed for the present study revealed a significant relationship between TCD and G.A. for both groups studied.

During the second and third trimesters, Ukey et al. (2016) reported TCD had about 98% accuracy in estimating the gestational age. Their results indicated that the gestational age variation is mostly due to TCD alone, and the other biometric parameters are not significant. The present study confirms these observations, in which TCD remained reliable even in cases of intrauterine growth restriction (IUGR), which is not always reliable by conventional biometric measures.

Additionally, Pavithra et al. (2017) found a strong association between TCD and standard fetal biometric parameters such as femur length (FL), head circumference (HC), abdominal circumference (AC), and biparietal diameter (BPD). They discovered that TCD is a useful metric to employ when LMP is uncertain and that it has a linear connection with GA. The same was true for the TCD measurements in the present study, which were like the GA over the course of pregnancy.

When El-Sayed et al. (2021) compared the sensitivity of TCD to other fetal biometric indices in IUGR pregnancies, it was found that the TCD was most correlated with GA. This is thought to

be due to the 'brain sparing' effect observed in cases of fetal growth restriction in the presence of which cerebellar development is relatively spared. In fact, our results corroborated this hypothesis as we found that pregnancies complicated by IUGR are stable and accurate when using TCD. Similarly, Maher et al. (2022) found that trans cerebellar diameter (TCD) is an extremely good predictor of both normal and growth restricted fetuses. In addition, they noted the significance of the TCD/AC ratio in the diagnosis of intrauterine growth restriction (IUGR). The main aim of this study was to estimate gestational age, but the results show that the TCD method can be an important instrument in the management of abnormal fetal growth and for pre-natal assessment.

In our study, the statistical analysis showed that the IUGR and non-IUGR groups differed significantly in relation to the value of the gestational age and amniotic fluid index (AFI), but not in relation to the value of the TCD. This observation further strengthens the hypothesis that TCD is less affected by placental insufficiency and fetal malnutrition than is AC and other biometric parameters. Thus, in high-risk pregnancies, fetal dating is more accurate using TCD.

The study has some important clinical implications. The use of TCD in routine second-trimester ultrasonography may help to better estimate the gestational age, especially when the last menstrual period (LMP) is unknown or fetal growth restriction is suspected.

Proper gestational dating enables appropriate clinical management decisions, such as fetal surveillance, timing of delivery, and management of pregnancy complications, to be made. Furthermore, in low-resource areas, TCD measurement is also a practical and cost-efficient approach as it is readily available and can be reproduced using standard ultrasound equipment.

However, some restrictions should be noted. The findings may not be generalizable because of the relatively small sample size and single-center study. Also, operator-dependent factors, such as

fetal position during ultrasound examination, etc., may affect the accuracy of TCD measurements. To resolve these issues, other multicenter studies with a larger number of patients are needed to establish localized reference standards and to test the usefulness of TCD in different populations. In conclusion, the results of this study confirm that the transverse cerebellar diameter is a valid, accurate, and clinically useful parameter for the estimation of gestational age in the second trimester in both normal and intrauterine growth-restricted pregnancies. Because of its relative uniformity of growth in growth-restricted fetuses, it is thus superior to many of the more traditional biometric measurements and has become important in modern obstetrical ultrasound.

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