ORIGINAL ARTICLE

Fetal Transcerebellar Diameter Measurement for Prediction of Gestational Age at the Third Trimester

Taher M. Mostafa, El-Sayed M. Ibrahim, Eslam M. H. Mohamed *

Department of Obstetrics and Gynecology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***The trans-cerebellar diameter (TCD) refers to the largest horizontal measurement of the fetal cerebellum. The fetal cerebellar hemispheres are situated in the posterior cerebral fossa, which exhibits resistance to external pressure & growth irregularities.***

Aim and objectives: ***To evaluate if the TCD can serve as reliable predictor of GA in fetuses in 3rd trimester.***

Patients and methods: ***This prospective cross section research was carried out on 100 pregnant women with: maternal age among 25 and 35 years old, singleton pregnancy and at third trimester from the obstetrics & gynecology department of Al-Azhar University Al-Hussein and Sayed-Galal hospital. It lasted for one year.***

Results: ***Sensitivity of TCD use was 95% and specificity was 85%. Mean age was 27.52 ± 2.84. Mean BMI was 26.47±4.6. Mean parity was 1.18 ± 0.58. Mean gravidity was 2.65 ± 1.58. Mean GA-LMP was 31.24±1.66. Mean GA-TCD was 31.21±1.72. Mean GA-FL was 30.53±1.7. Mean GA-AC was 30.65±1.72. Mean GA-HC was 30.58±1.74. Mean GA-BPD was 30.53±1.72. There was a significant relationship between GA by the last menstrual period (LMP) & gestational age measured by fetal diameters. P-value was <0.00.***

Conclusion: ***The trans-cerebellar diameter is a dependable and singular sonographic foetal biometric measurement that can be used to accurately determine the GA during the 3rd trimester of pregnancy.***

Keywords: Trans-cerebellar diameter (TCD); Gestational Age; BPD

1. Introduction

In order to ensure sufficient obstetric & neonatal care, it is crucial to accurately determine GA. This includes the ability to diagnose conditions such as growth restriction or intrauterine growth retardation, as well as manage post-term pregnancies (≥42 weeks of gestation). The use of prenatal corticosteroids for preterm labour and the decision to provide critical care to severely premature infants are contingent upon accurate measurement of GA.[1]

Foetal growth restriction (FGR), also identified as intrauterine growth restriction (IUGR), is diagnosed when a foetus has an estimated weight under the 10th percentile for its GA. The prevalence of foetal growth restriction is believed to be between three percent & ten percent. The growth potential of the foetus is determined by both the foetal genome and the intrauterine environment. Both maternal & placental factors exert an effect on the intrauterine environment.[2]

The traditional method for determining GA, which relies on LMP, may be affected by the consistency of menstrual cycles, particularly in the 3 months leading up to conception, as well as previous use of hormonal contraception. For women in impoverished nations, the lack of reliable records of menstruation and anomalies in the menstrual cycle pose extra difficulties.[3]

In order to avoid such unfortunate incidents during pregnancy, several techniques for evaluating the growth of the foetus in the uterus were devised. The most optimal and effective method for investigation that is straightforward, dependable, precise, non-intrusive, and secure is prenatal ultrasonography. The availability of ultrasonography enables precise measurement of GA, diagnosis of congenital defects, evaluation of foetal growth, and assessment of foetal health & maturity.[4]

Accepted 10 February 2025.
Available online 30 April 2025

* Corresponding author at: Obstetrics and Gynecology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: ealammo303@gmail.com (E. M. H. Mohamed).

https://doi.org/10.21608/aimj.2025.446512

The primary metrics commonly employed for assessing foetal growth involve biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). An infrequently utilised criterion, the Trans Cerebellar Diameter (TCD), was unexpectedly discovered to be a valuable measure for determining GA while it was being examined for evaluating foetal cerebellum growth & associated abnormalities.[5]

The foetal cerebellum can be observed via ultrasound imaging as early as 10-11 weeks. Starting from the second trimester, it increases in size in direct proportion to the length of the pregnancy. TCD refers to the largest horizontal measurement of the foetal cerebellum. The foetal cerebellar hemispheres are situated in the posterior cerebral fossa, which is resilient to external pressure & growth variations. Consequently, it serves as a more reliable signal for determining GA.[6]

The goal of the current research was to assess the reliability of Transcranial Doppler (TCD) as a predictor of gestational age (GA) in foetuses throughout the third trimester.

2. Patients and methods

This prospective cross section research was carried out on 100 pregnant women from the obstetrics & gynecology department of Al-Azhar University Al-Hussein and Sayed-Galal hospital. It lasted for one year.

Inclusion Criteria: Maternal age between 25 & 35 years old, singleton pregnancy, third trimester, and agreed to participate in the research.

Exclusion Criteria: Multiple pregnancy, fetal congenital anomalies, any obstetric problem like antepartum hemorrhage, any medical or metabolic problem, and patients' refusal to participate.

Ethical Consideration: The study protocol has been submitted to the Institutional Review Board at Al-Azhar University Hospitals for approval. The Ethical Committee of Al-Azhar Faculty of Medicine granted approval. Prior to enrolling in the trial, the cases provided informed consent. Data confidentiality was maintained. Every participant possessed the prerogative to discontinue their involvement in the trial without any repercussions on their treatment. The study maintained a strict adherence to confidentiality & personal privacy at all levels.

Sample size: To get the sample size for this study, the following formula by Yamane7 was used:

N is the population size

e is the level of precision

Therefore, =86.27

Thus, the sample size was increased to 100 subjects to account for any drop-out cases during follow-up.

Methods:

All patients were subjected to the followings: Complete history taking, general examination, abdominal & pelvic examination, abdomen palpation throughout pregnancy: (Fundal height (level), fundal grip, lateral or umbilical grip and pelvic grip) and assessment of the membranes.

Measurements of all fetal biometric parameters were obtained utilizing an Ultrasound machine equipped with 3 or 5 MHz abdominal transducers present at the department of Gynecology & obstetrics Al-Azhar university hospitals.

Biparietal diameter (BPD) procedure:

The measurement of BPD should be taken on the axial plane that passes across the thalami & cavum septum pellucidum. The transducer must be positioned at a right angle to the centre axis of the skull, ensuring that the hemispheres & calvaria exhibit a symmetrical appearance. The callipers should be positioned at the outside edge of the near calvarial wall & the inner edge of the far calvarial wall. The positioning of the cerebellar hemispheres should be adjusted so that they are not aligned with the plane of the image.

Abdominal circumference (AC) procedure:

This transverse section of the upper abdomen should clearly show the foetal landmarks of the foetal gut, umbilical vein, & portal sinus. Do not do an AC measurement on a shortened abdomen, and ensure that the callipers are placed directly on the visible skin surface. The kidneys & umbilical cord insertion should not be perceptible. The umbilical vein should not be visible beyond the level of the skin.

Head circumference (HC):

Head circumference (HC) is a fundamental biometric measurement employed to evaluate the size of a foetus. HC is used with the BPD, AC, & FL to calculate an approximation of the foetal weight. During the second trimester, it is possible to make an extrapolation to determine the GA & estimated due date (EDD).

Measurement:

HC is measured on the same plane as BPD, namely on the axial plane that passes through the thalami & cavum septum pellucidum. The transducer should be positioned at a right angle to the central axis of the head to ensure symmetry in the appearance of the hemispheres & calvaria. The cerebellar hemispheres should not be included in the picture plane, since this indicates that the probe is positioned too low, resulting in an erroneous measurement of the foetal head size. If US equipment is capable of measuring an ellipse, it can be used to draw this shape around the outer edge of the calvarium. Alternatively, HC may be meassured from BPD & occipitofrontal diameter (OFD) as: HC = 1.62 × (BPD + OFD)

Femur length (FL) technique:

FL is a fundamental biometric measurement employed to evaluate the size of a foetus. FL, along with the BPD, HC, & AC, are used to calculate an approximation of the weight of the foetus. During the 2nd trimester, it is possible to estimate the GA & determine EDD. FL can be utilised to determine the length of the foetus, which is also an indicator of foetal development, using the equation 3: Fetal length in centimeters = 6.18 + 0.59 x femur length in millimeters.

Fetal Transcerebellar Diameter (TCD) Measurement: The cerebellum was located in the posterior fossa & observed at the level of BPD with slight rotations of the transducer in the posterior & inferior directions. The TCD was measured using electronic callipers in an outer-to-outer manner. TCD was assessed using a transverse view of the fetal intracranial anatomy, specifically focusing on the posterior fossa. This involved visualizing the midline thalamus, cerebellar hemisphere, & cisterna magna. The measurements were acquired by positioning callipers of US devices on the outer edges of the cerebellum on the screen.

The investigation was conducted using the usual methodology, which often involved a quick session lasting approximately 15 minutes or less. Particular emphasis was placed on selecting an environment conducive to capturing the optimal image. In order to reduce the inaccuracy resulting from the calliper approach, an attempt was made to magnify the image.

3. Results

Table 1 showed that Mean GA-LMP was 31.24±1.66. Mean GA-TCD was 31.21±1.72. Mean GA-FL was 30.53±1.7. Mean GA-AC was 30.65±1.72. Mean GA-HC was 30.58±1.74. Mean GA-BPD was 30.53±1.72

Table 1. Measurement of TCD, FL, AC. HC, & BPD

	MEAN ± SD
GA-LMP	31.24±1.66
GA-TCD	31.21±1.72
GA-FL	30.53±1.7
GA-AC	30.65±1.72
GA-HC	30.58±1.74
GA-BPD	30.53±1.72

Table 2 revealed that significant relationship was noted between GA by LMP & GA measured by fetal diameters. P value was <0.001.

Table 2. Correlation among GA calculated by LMP & TCD, FL, AC. HC, & BPD.

PARAMETERS	GA BY LMP (WEEKS)	
	r	P-value
GA-TCD	0.961*	<0.001
GA-FL	0.952*	<0.001
GA-AC	0.962*	<0.001
GA-HC	0.953*	<0.001
GA-BPD	0.964*	<0.001

P value >0.05 data is not significant. P value <0.05 data is significant.

Table 3 showed that sensitivity of TCD use was 95%. Specificity was 85%

Table 3. ROC curve analysis of TCD

TEST RESULT VARIABLE(S):	TRANS-CEREBELLAR DIAMETER					
AREA	sensitivity	specificity	Std. Error[a]	Asymptotic Sig.[b]		
0.276	95%	85%	0.105	0.079	0.070	0.482

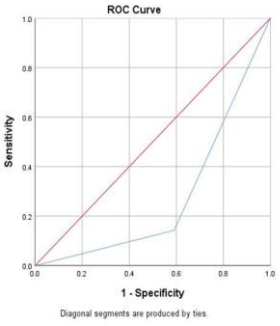

Figure 1. ROC curve

4. Discussion

Estimating GA is a crucial factor in determining medical care throughout pregnancy. It serves as the foundation for determining the correct schedule of delivery & handling problems. Research has demonstrated that making decisions based on incorrect estimates of GA leads to increased rates of morbidity and mortality for both the foetus & the mother. [8]

Ultrasonography is widely regarded as the most accurate technique for determining GA throughout pregnancy. Specifically, the measurement of crown-rump length (CRL) in 1st trimester is considered the most reliable indicator. [9]

Due to the influence of racial characteristics, genetics, nutrition, & various environmental factors on foetal dimensions, it is important to note that biometric curves derived from one population may not provide an accurate estimation of foetal GA when applied to a different population. [10]

Regarding mean gestational age as measured by different parameters, the current study showed that the mean GA-LMP was 31.24±1.66. Mean GA-TCD was 31.21±1.72. Mean GA-FL was 30.53±1.7. Mean GA-AC was 30.65±1.72. Mean GA-HC was 30.58±1.74. Mean GA-BPD was 30.53±1.72.

Comparable with the current study, Bakry et al.,[11] enrolled 200 pregnant women at the 3rd trimester, with a mean age of 25.34 ± 3.22 years, and an average BMI of 26.57± 4.76 kg/m2. The study showed that the average GA by LMP was 31.33±1.69, mean GA-TCD was 31.01±1.74, mean GA-FL was 30.73±1.77, mean GA-AC was 30.75±1.74, mean GA-HC was 30.68±1.75 and mean GA-BPD was 30.63±1.73.

Regarding the correlation among GA assessed by LMP & TCD, FL, and AC. HC, & BPD, the present research revealed that there was a significant relationship between gestational age by LMP & gestational age measured by fetal diameters. P value was <0.001.

In concordance with the current study Bakry et al.,[11] revealed that A strong relationship was noted among GA determined by LMP & the estimates obtained from BPD & TCD measurements (r equals 0.969, P below 0.001 & r equals 0.963, P below 0.001; correspondingly). In addition, a significant positive relationship was observed with other biometric data, namely FL, AC & HC.

Also, Ali et al.,[12] showed that Significant positive correlations were found among GA as indicated by LMP & TCD (r equals 0.98, $p < 0.001$) in addition to among LMP & BPD (r equals 0.87, $p < 0.001$). However, in comparison to the present research, the positive relationship among GA as identified through LMP & TCD is larger than the association with GA as defined by BPD; the contrast with the current study may be due to the difference in GA.

To validate the use of TCD in the measurement of GA at the 3rd trimester, ROC curve analysis was performed and showed that sensitivity was 95%. Specificity was 85%.

Consistent with the present investigation Maher et al.,[13] revealed that In comparison to other US measures (BPD, HC, FL, & AC), TCD demonstrated the best accuracy (95%) with corresponding sensitivity, specificity, PPV, & NPV of 94.29 percent, 95.71 percent, 95.65 percent, & 94.37 percent.

Discussion results confirmed the reliability of TCD in the prediction of GA in the 3rd trimester, & this comes in agreement with Ali et al.,[12] who concluded that TCD is a dependable and singular sonographic fetal biometric measurement that may be used to accurately determine the GA during the 3rd trimester of pregnancy.

Moreover, Solyman et al.,[14] concluded that TCD is accurate parameter for evaluating GA in 3rd trimester, exceeding the accuracy of FL measurements in the latter stages of pregnancy. Incorporating measurements of TCD with other standard measures might reduce the margin of error in determining the actual GA.

In addition, Zakaria et al.,[8] showed that the TCD technique is the most accurate approach for evaluating GA in the 3rd trimester, with FL being the next most accurate, & the BPD being the least accurate. Furthermore, the accuracy of TCD (89%) was merged with that of FL (81%).

Limitations: The current research was limited by a small sample size, being single center research & relatively short follow up period. Further researches with larger sample size & longer follow-up are needed to confirm our findings.

4. Conclusion

The TCD is a dependable and singular sonographic fetal biometric measurement that may be used to accurately determine the GA during the 3rd trimester of pregnancy.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. Hawken S, Olibris B, Ducharme R, et al. Validation of gestational age determination from ultrasound or a metabolic gestational age algorithm using exact date of conception in a cohort of newborns conceived using assisted reproduction technologies. AJOG Glob Rep. 2022;2(4):100091.
2. Vayssière C, Sentilhes L, Ego A, et al. Fetal growth restriction and intra-uterine growth restriction: guidelines for clinical practice from the French College of Gynaecologists and Obstetricians. Eur J Obstet Gynecol Reprod Biol. 2015; 193:10-18.

3. Marchand C, Köppe J, Köster HA, et al. Fetal Growth Restriction: Comparison of Biometric Parameters. J Pers Med. 2022;12(7):1125. Published 2022 Jul 11.
4. Kamphof HD, Posthuma S, Gordijn SJ, Ganzevoort W. Fetal growth restriction: mechanisms, epidemiology, and management. Maternal-Fetal Medicine. 2022 Jul 25;4(03):186-96. doi: 10.1097/FM9.0000000000000161
5. Lei T, Zheng J, Papageorghiou AT, et al. Ultrasound in the prediction of birthweight discordance in dichorionic twins. Acta Obstet Gynecol Scand. 2021;100(5):908-916.
6. Manzo L, Orlandi G, Gabrielli O, et al. Fetal Cerebellar Area: Ultrasound Reference Ranges at 13-39 Weeks of Gestation. J Clin Med. 2023;12(12):4080.
7. Yamane, Taro. Statistics, An Introductory Analysis, 2nd Ed., p. 886. New York: Harper and Row (1967).
8. Zakaria AM, Mohamed AH, Eldarder AK. Comparison between transcerebellar diameter, biparietal diameter and femur length for gestational age measurement accuracy in third trimester of pregnancy. The Egyptian Journal of Hospital Medicine. 2019 Jan 1;74(1):17-22.
9. Self A, Daher L, Schlussel M, et al. Second and third trimester estimation of gestational age using ultrasound or maternal symphysis-fundal height measurements: A systematic review. BJOG. 2022;129(9):1447-1458.
10. Aggarwal N, Sharma GL. Fetal ultrasound parameters: Reference values for a local perspective. Indian J Radiol Imaging. 2020;30(2):149-155.
11. Bakry OA, Taher Ismaeil M, Mohammed Attia A. Fetal Transcerebellar Diameter Compared to Biparietal Diameter for Precise Gestational Age Evaluation In The Third Trimester Of Pregnancy. Al-Azhar Medical Journal. 2022 Aug 1;51(4):1987-2002.
12. Ali MA, AbdElSalam NasrElDin E, Moussa M. Transcerebellar diameter versus biparietal diameter for the measurement of gestational age in third trimester. J Ultrason. 2022;22(88):e39-e43.
13. Maher MA, Waly MM, Elsheikhah A, Kamel A. The Accuracy of Transcerebellar Diameter in Assessment of Gestational Age in Normal and Growth Restricted Fetuses and Diagnosis of Intrauterine Growth Restriction. The Egyptian Journal of Hospital Medicine. 2022 Oct 1;89(1):4535-9.
14. Solyman AE, Shaban DS, Abdullah MS, et al. Ultrasound-determined fetal transcerebellar diameter in relation to gestational age during third trimester of pregnancy. Menoufia Medical Journal. 2022;35(3):1442-6.