Research Article

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester

Ahmed S. Sanad[1], Ayman M. Youssef[1], Rehab E. Mohamed Abo Elnaga[1] and Ahmed B. Mousa[1].

[1] Department of Obstetrics & Gynecology, Faculty of Medicine, Minia University

Abstract

Background: The cerebellum, the largest part of hind brain, lies in the posterior cranial fossa. In the embryo cerebellum appears at the end of the fifth week as a swelling overriding the fourth ventricle. Assessment of gestational age (G.A.) is important in the management of pregnancy. The aim is to assess the reliability of trans-cerebellum diameter in compare with the femur length in predicting gestational age. **Methodology:** This is descriptive, cross-sectional study carried out on seventy-one pregnant women with history of reliable menstrual cycles (sure of dates, regular cycles, no history of hormonal contraception at last 6 months, no history of abortion or delivery at last 3 months) and did not suffer from any complications for the mother or fetus, referred for routine ultrasound examination in ultrasound department of El Minia University maternity hospital, FL was used as standard method to estimate gestational age to be compared with the other gestational age that obtained with TCD. **Results:** among pregnant women in the GA 28-32 and 32-36 weeks, there was non-statistically significant difference between GA as estimated by TCD and as estimated by other assessed fetal biometry (SFH and FL). we found that TCD can correctly predict GA in early 3rd trimester (28-36 weeks) at cut-off point >34.9 mm with a sensitivity of 94%. **Conclusions:** The result of the study revealed that is there is no significant difference between gestational age obtained with FL and TCD. The study recommended that the TCD can be used as routine measurement in estimation of the gestational age in the third trimester.

Keywords: Gestational Age, Femur Length, Trans-cerebellar Diameter, Third trimester.

Introduction

Accurate estimation of gestational age (GA) is critical for effective obstetric planning and also aids in estimating foetal malformation or growth retardation. Failure can result in iatrogenic prematurity or postmaturity, both of which have been linked to increased perinatal morbidity and mortality[1] . Ultrasound foetal biometry is highly reliable in the first and second trimesters of pregnancy[2,3] but the reliability of any ultrasound method decreases as gestation progresses. Many studies [2] show that the reliability of any single ultrasound parameter is poor in the third trimester. The cerebellum, which is the largest part of the hind brain, is located in the posterior cranial fossa. It is located dorsal to the pons and medulla, separated by the fourth ventricle. The cerebellum is roughly spherical, but its median is somewhat constricted.

The foetal biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) are the most commonly used biometric parameters for estimating gestational age [6] .These parameters have few limitations because conditions that change the shape of the skull affect BPD, which

is a well-accepted indicator of GA[7.] The main issue is that measuring BPD in a foetus with an abnormal skull shape, such as dolichocephaly or brachycephaly, is difficult. Femur length varies with ethnicity and skeleton congenital anomalies [8] . As a result, transverse cerebellar diameter (TCD) was developed as an alternative parameter of foetal brain growth and gestational age estimation [5] .

Because the cerebellum is located in the posterior cranial fossa and is surrounded by dense petrous ridges and the occipital bone, it can withstand extrinsic pressure deformation better than the parietal bones[5]. Because ultrasound can easily visualise the foetal cerebellum, imaging the posterior fossa is becoming an integral part of many routine foetal sonograms [9] Several authors working on transverse cerebellar diameter (TCD) have found it to be a better marker for GA estimation than other clinical and biometric parameters [10,11,12] . The current study attempted to evaluate foetal cerebellar development ultrasono-graphically, which aids in determining foetal gestational age.

Patients and methods
Ethical Consideration :
The ethical committee of Obstetrics & gynecology department , Faculty of Medicine gave its approval to conduct the current study. Before enrolling in the study, all women gave verbal informed consent after the study's goals were clarified. The confidentiality of the data base was ensured.

This present study was a cross-sectional study done on 71 pregnant women with history of reliable menstrual cycles (sure of dates, regular cycles, no history of hormonal contraception at last 6 months, no history of abortion or delivery at last 3 months) and did not suffer from any complications for the mother or fetus, pregnant women sub divided in 2 groups .Group 1 is from (28 to 32 wk) & Group 2 from (32 to 36 wk). They referred for routine ultrasound examination in ultrasound department of El-Minia University maternity hospital during the period from August/2021 to March/2022. Pregnancies with congenital anomalies,

intrauterine fetal death & medical disorders like hypertension and diabetes mellitus, and antepartum hemorrhage were excluded from the current study.

- All enrolled women had been evaluated as: complete history taking, particularly for (menstrual history, obstetric history, medical illness that affects pregnancy, and vaginal bleeding). By convex probe 3.5 MHz using (VOLUSON S8), the fetus examined in the following sequences, firstly the patient lie supine with exposed abdomen, mesured SFH then the probe is applied to the center of the abdomen vertically to determine the fetal lie and presentation, then the FL is measured and the gestational age was calculated, TCD was measured in mm which is equivalent to gestational age.

- **TCD measurement:** The TCD was measured from the sub-occipito-bregmatic view in which the anterior horn of the lateral ventricles and cavum are visualized at front of the head together with the cerebellum at the back. The lateral ventricle view required for the BPD was obtained, then rotate the probe slightly downward, toward the fetal neck. The posterior horns of the lateral ventricles will disappear from view to be replaced by cerebellum. Then cerebellum is measured from one outer margin to the other outer margin in transverse.

Statistical Methods of Analysis:
The collected data was coded, entered, and analyzed using the IBM software statistical package for social sciences (SPSS) (version 25). For categorical variables, descriptive statistics were in the form of frequency and percentage, while for numerical variables in the form of mean and standard deviation. (mean ± SD). The proper statistical significance mea-sures were used: (Independent Sample t-test, Chi-Square (χ2) test and Pearson's correlation analysis; {r- values: 0 to 0.3 positive or negative (slight), 0.3 to 0.7 (moderate) and 0.7 to 1 (strong). Statistical significance was described at a p-value of less than or equal to 0.05. Simple charts were used to demonstrate some findings.

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester

Results

The current study was a cross sectional observational study that conducted on 71 pregnant women with history of regular cycles, no history of hormonal contraception at last 6 months, no history of abortion or delivery at last 3 months before pregnancy. Their age was ranged from (18) to (39) with an average age of (26.56±4.8) years old, all of them was with regular menstrual cycle (100%), regarding history of previous delivery; (20%) of them have never given birth while (80%) of them have given birth before, with a number ranging from one to six times with a median of (2 times) and an average previous delivery (1.83 ±1.2 times). Regarding history of previous abortion, among the studied women, 22% had never experienced a miscarriage, while 78% had had a previous abortion, with several previous abortions ranging from one to five times, a median of (1 time) and an average previous

abortion of (1.60 ±1.1 times). Regarding the GA as calculated by the 1st day from the LMP, it was ranged from 28 weeks to 35 weeks with an average GA of (31.59 ±2.27) weeks.

Table (1) shows the association between FL (weeks) and GA among the studied pregnant, mean FL (weeks) was significantly (p=0.001) associated with GA, it was 29.6±1.07 in pregnant with GA 28-32 weeks, 33.6±1.1 in pregnant with GA 32-36 weeks. Also, there was a statistically significant strong linear positive correlation between FL (weeks) and GA (r=0.99, p=0.001).

Regarding the association between TCD (mm) and GA among the studied pregnant, mean TCD (mm) was significantly (p=0.001*) associated with GA, it was 29.7±1.2 in pregnant with GA 28-32 weeks, 33.7±1.2 in pregnant with GA 32-36 weeks. There was strong positive significant correlation; it was 0.93 (0.001*) in pregnant with GA 28-32 weeks, 0.95 (0.001*), in pregnant with GA -32-36 weeks.

Table (2) and Table (3) demonstrate a comparison of mean GA as estimated by TCD with that assessed by FL and by SFH among the studied pregnant women. Among pregnant women in the gestational age 28-32 weeks, there was non-statistically significant difference between GA as estimated by TCD and as estimated by FL or SFH. Also, among pregnant women in the gestational age 32-36 weeks, there was non-statistically significant difference between GA as estimated by TCD and as estimated by FL (Figure-1) or SFH. That indicates that TCD is very accurate in the early 3rd trimester period.

A correlation between GA as estimated by TCD and as estimated by FL among the studied pregnant women demonstrates that there was a statistically significant positive linear correlation between TCD, and GA estimated by FL and by SFH/F, (Figure 2,3).
TCD in prediction of GA according to GA weeks groups, can correctly predict GA in early 3rd trimester (28-36 weeks) at cut-off point >34.9 mm with a sensitivity of 94%.

Table (1): The association and correlation between femoral length (FL) for GA groups among the studied pregnant women; (N= 71):

	Group 1 (28-32 wks) N= 38	Group 2 (32-36 wks) N= 33	p-value
Mean ±SD	29.63 ± 1.08	33.69 ±1.12	<0.001*
Min – Max	28.0 – 31.0	32.0 – 35.0	
Correlation	r= 0.975, p<0.001*	r= 0.988, p<0.001*	

p-value ≤0.05 is considered statistically significant by independent sample t-test analysis
r: Pearson's Correlation Coefficient

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester

Table (2): Comparison of mean GA as estimated by TCD with that estimated by SFH/F among the studied pregnant women; (N= 71):

	Group 1 (28-32 wks) N= 38	Group 2 (32-36 wks) N= 33
SFH/F (weeks)	29.632 ±1.076	33.636 ±1.14
TCD (mm)	29.823 ±1.182	33.738 ±1.21
p-value	0.477	0.716

Table (3): Comparison of mean GA as estimated by TCD with that estimated by FL among the studied pregnant women; (N= 71):

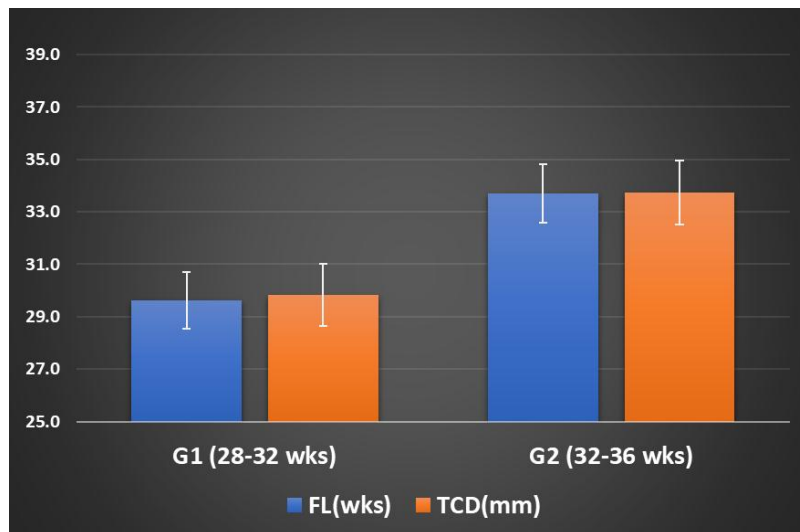|	Group 1 (28-32 wks) N= 38	Group 2 (32-36 wks) N= 33
FL (weeks)	29.6 ±1.076	33.6 ±1.12
TCD (mm)	29.8 ±1.182	33.7 ±1.2
p-value	0.477	0.858

Figure (1): comparison of mean GA as estimated by TCD with that measured by FL among the studied pregnant women

The accuracy of cerebellar diameter in detection
                                             of the expected date of delivery in comparison
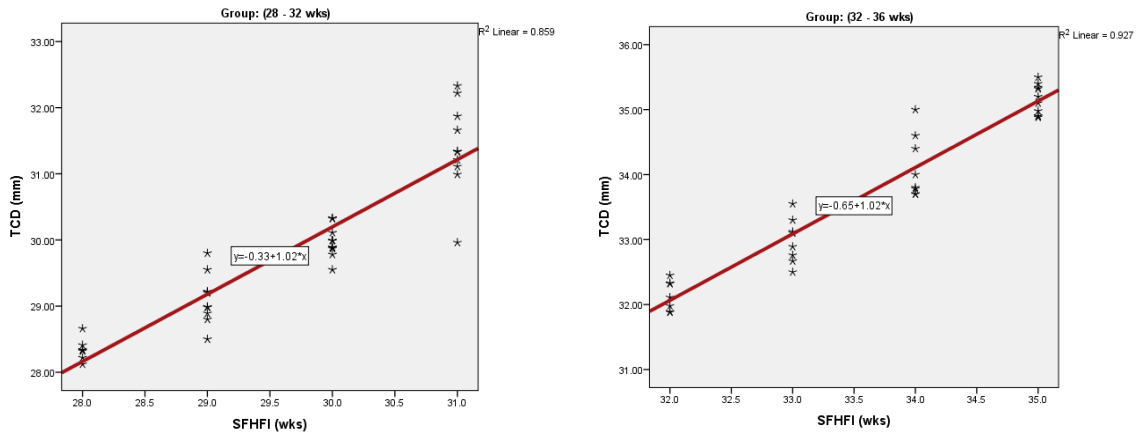   with femur length in third trimester

Figure (2): A correlation between GA as estimated by TCD and as estimated by SFH/F among the studied pregnant women
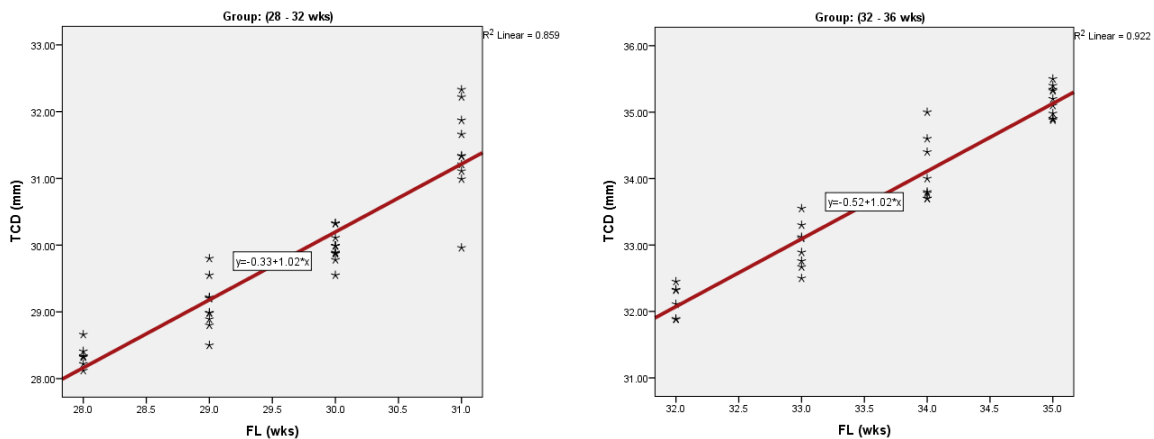

Figure (3): A correlation between GA as estimated by TCD and as estimated by SFH/F among the studied pregnant women

Discussion

More accurate methods for dating pregnancies have emerged with the development of diagnostic ultrasonography, most used biometric indices for dating pregnancies are the BPD, HC, AC and FL [2] . Among these, FL parameter is considered superior to other parameters in predicting GA accurately as it can resist to external deformation better, however newer parameters are constantly being explored for their efficiency e.g. TCD, Humerus length, fetal kidney length, nasal bone length, three dimensional fractional limb volume, umbilical venous Doppler in growth restricted fetuses, etc [13] .

Fetal TCD is one such fetal parameter that has evolved as a superior one in predicting GA in both singleton and twin gestations [10] . The aim of the current study was to assess the reliability of TCD in compare with the femur length in predicting gestational age.

The study included 71 pregnant women & revealed that the mean gestational age measured using the TCD 29.63±1.08 during the 28-32 weeks and 33.69 ±1.12 during the 32-36 weeks GA, which was less but without a statistically significant difference when compared with

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester

week difference from the GA calculated using FL, so this clarify that there was no significant difference between both measured gestational age in early third trimesters using FL and TCD.

In our study, The P value comparing TCD with BPD was found to be (0.477) in group 1 (from 28 to 32 wk) & (0.688) in group 2 (from 32 to

36 wk). The P value comparing TCD with FL was found to be (0.477) in group 1 & (0.858) in group 2 which incompatible with another study conducted by (Askr et al., 2019) in **200** patients between (29-36 wk) in there study The P value comparing TCD with BPD within 3 days was found to be (<0.001) showing that there was highly significant difference between correct assessment within 3 days by BPD and by TCD.

The P value comparing TCD with FL within 3 days was found to be (0.009) and there was a significant difference between correct assessment within 3 days by FL and by TCD[14] . In the current study we found that TCD can correctly predict GA in early 3rd trimester (28-36 weeks) at cut-off point >34.9 mm with a sensitivity of 94%, which incompatible with another study conducted by (Bassiouny et al., 2020) estimated the gestational age in third trimester of pregnancy by fetal TCD and it is accuracy in 103 patient between (31-36 wk) TCD was accurate within 88.3% of the cases , while FL was accurate in 51.5% which mean that TCD is highest statistically significant measurement which could be used in Third trimester for assessing the gestational age compared with FL&BPD without any effect of parity [15] .

In the current study, among pregnant women in the GA (28-32) and (32_36) weeks there was non-statistically significant difference between GA as estimated by TCD and as estimated by other assessed fetal biometry (SFH, BPD, HC, FL and AC), which incompatible with another study conducted by (Reddy et al ., 2017) on 100 pts between (15-40 wk) were divided into two groups based on GA (15-28 and 29-40 weeks). evaluated accuracy of prediction GA used fetal TCD and compared between TCD and other existing parameters in evaluating GA.

They showed that TCD was an accurate parameter in estimation of gestational age in second and third trimesters as its values are in close relation with that of GA by LMP. It is also better predictor of the gestational age when compared to other parameters especially in third trimester [16] .

In our study also approved that TCD seems to be good marker for GA calculation compared with other sonographic fetal Biometry (FL, HC, AC and BPD) at (28_36 wk) which is similar to a study conducted by (Zakaria et al., 2019) in 200 patients at third trimester (28-40wk) concluded that TCD is the most accurate method for assessment of gestational age in Third trimester followed by FL and the least accurate is the BPD, Also, combining accuracy of TCD (89%) and FL (81%) in our study TCD is (94%)[17] .

Conclusions
Based on the findings of the current study and the similar studies we can conclude that TCD is an accurate method for assessment of gestational age in third trimester as FL. By combining accuracy of TCD (94% in the current study) and that of FL we can be near certain of gestational age in most of our patients. Furthermore, we recommend conducting this study on larger sample size for further documentation of the proposed assumption.

References
1. Karrar, Ayat Osman Mohammed Ahmed. "Estimation of Gestational Age in Third Trimester by Fetal Kidney Length Using Ultrasonography." PhD diss., Sudan University of Science and Technology, (2019).
2. DeYoung, Tracey H., Sharon K. Stortz, Robert H. Riffenburgh, Garrett M. Wren, Trimble L. Spitzer, Monica A. Lutgendorf, and Andrew S. Thagard. "Establishing the most accurate due date in dichorionic twin gestations by first and second trimester ultrasound." Journal of Ultrasound in Medicine 40, no. 11 (2021): 2319-2327.

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester

3. Waseem, Nazeeha, Rehan Afsar, Narjis Batool, and Waqas Aleem. "The ultrasound evaluation of fetal biometry in intrauterine growth restriction: a narrative review." Annals of Allied Health Sciences 6, no. 2 (2020).

4. Shoja, Mohammadali M., Rebecca Ramdhan, Chad J. Jensen, Joshua J. Chern, W. Jerry Oakes, and R. Shane Tubbs. "Embryology of the craniocervical junction and posterior cranial fossa, part II: embryogenesis of the hindbrain." Clinical Anatomy 31, no. 4 (2018): 488-500.

5. Kumari, Veena, Memoona Rehman, Erum Majid, Bader Faiyaz Zuberi, Saira Nazeer, and Saba Khan. "Transcerebellar Diameter: an effective tool in estimating gestational age." Pakistan Journal of Medical & Health Sciences 16, no. 06 (2022): 6-6.

6. Marchand, Carolin, Jeanette Köppe, Helen Ann Köster, Kathrin Oelmeier, Ralf Schmitz, Johannes Steinhard, Arrigo Fruscalzo, and Karol Kubiak. "Fetal Growth Restriction: Comparison of Biometric Parameters." Journal of Personalized Medicine 12, no. 7 (2022): 1125.

7. Mishra, Sanjay, Surajit Ghatak, Pratibha Singh, Dushyant Agrawal, and Pawan Garg. "Transverse cerebellar diameter: a reliable predictor of gestational age." African Health Sciences 20, no. 4 (2020): 1927-32.

8. MacKenzie, Andrew P., Courtney D. Stephenson, and Edmund F. Funai. "Prenatal assessment of gestational age, date of delivery, and fetal weight." Consultado 18 abril (2019).

9. Nagaraj, Usha D., and Beth M. Kline-Fath. "Clinical Applications of Fetal MRI in the Brain." Diagnostics 12, no. 3 (2022): 764.

10. Sinha, Parul, Mansi Gupta, Rakhi Sharma, and Kumkum R. Srivastava. "Comparison of Estimation of Gestational Age by Transverse Cerebellar Diameter with Biparietal Diameter in Third Trimester of Pregnancy." Journal of South Asian Federation of Obstetrics and Gynaecology 12, no. 4 (2020): 236.

11. Hassan Ahmed Mohamed Ibrahim, Waleed, Ismael Mohamed Mera, Abd El-Hamed Sedek, and Abd El-Monsef. "Ultrasound Measurement of Transcerebellar Diameter (Tcd)/ Abdominal Circumference (Ac) Ratio In Normal And Growth Restricted Fetuses Above Twenty Weeks of Gestation." Al-Azhar Medical Journal 50, no. 3 (2021): 1933-1944.

12. Fiorentino, Maria Chiara, Francesca Pia Villani, Mariachiara Di Cosmo, Emanuele Frontoni, and Sara Moccia. "A Review on Deep-Learning Algorithms for Fetal Ultrasound-Image Analysis." arXiv preprint arXiv:2201.12260 (2022).

13. Singh, Amandeep, Gauravdeep Singh, and Kamlesh Gupta. "Estimation of gestational age by using fetal kidney length and transcerebellar diameter in comparison with other biometric indices." Donald School J Ultrasound Obstet Gynecol 15 (2021): 4-9.

14. Askr, A. A., Mahmoud, M. S., & Salloum, A. A. M. .Comparison between taans cerebellar diameter, biparietal diameter and femur length for gestational age measurement accuracy in the 3rd trimester. The Egyptian Journal of Hospital Medicine, (2019). 74(1), 87-93.

15. Bassiouny, Y., & Hassan, A. Estimation of Gestational Age in Third Trimester of Pregnancy by Fetal Transcerebellar Diameter and its Accuracy Article type. The Egyptian Journal of Fertility of Sterility, (2020) 24(3), 33-40.

16. Reddy, Ramireddy Harikiran, Kumar Prashanth, and Mahale Ajit. "Significance of foetal transcerebellar diameter in foetal biometry: a pilot study." Journal of clinical and diagnostic research: JCDR 11, no. 6 (2017): TC01.

17. Zakaria, A. M., Mohamed, A. H., & Eldarder, A. K. M. 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) 74(1), 17-22.

The accuracy of cerebellar diameter in detection of the expected date of delivery in comparison with femur length in third trimester