

Correlation Study of Transverse Cerebellar Diameter with Gestational Age in Normal and Growth Restricted Fetuses (IUGR).

Mona Al Sayed Elkafrawy¹, Amal Abdel Mageed Ahmed², Ahmed Hassan Soliman³

¹Obstetrics and Gynecology Department, Faculty of Medicine (Girls), Al Azhar University, Cairo, Egypt

²Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine (Girls), Al Azhar University, Cairo, Egypt

³Radiodiagnostic Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt
drsaad53@yahoo.com

Abstract: Background: Measurement and demonstration of fetal cerebellum is a new and unique parameter of fetal brain growth which is useful in assessing gestational age. Cerebellum lies in the posterior cranial fossa and easily visualized sonographically. Transverse cerebellar diameter (TCD) is more accurate and a better predictor of gestational age in normal as well as in intrauterine growth restricted fetuses (IUGR). The TCD in IUGR fetuses does not affected and so can be used in measurement of gestational age (GA). So, Determination of fetal age is of significant not only in obstetrics management but also in medicolegal cases. **Aim of this work:** This study aims to confirm the relationship between gestational age and TCD in prediction of gestational age by TCD in normal and IUGR fetuses, and assesses the reliability of TCD measurement. **Material and Methods:** This study was conducted on 330 pregnant women between 14 – 40 weeks fulfilling the inclusion criteria .300pregnant women with normal pregnancy and 30 pregnant women with IUGR pregnancy all of them aiming for routine ultrasound and antenatal care at Alzhraa University Hospital. Ultrasound was done for measuring of TCD, BPD, HC, AC and FL to detect gestational age and weight of the fetus, all data were collected and analyzed. **Results:** in normal pregnancy TCD increases with advancing of age, with a linear relationship between TCD and gestational age, also in pregnancy with IUGR increases with increasing gestational age. Transverse cerebellar diameter in millimeter was found equivalent to gestational age till age of 26 weeks, where the mean of TCD was 17.39mm in 14-20weeks of gestation, 24.44 mm in 21-27 weeks, 32.04mm in 28-37 weeks and 42.73 mm in 35-40 weeks of gestation. The correlation coefficient between gestational age and TCD in normal pregnancy was found to be 0.792 with statistically significant P value 0.000, and regression analysis was 85% and 84% in normal and IUGR pregnancy respectively. **Conclusion:** This study shows that there is a highly significant correlation between transverse cerebellar diameter and gestational age in normal and IUGR fetuses indicating that TCD is a good marker for estimation of gestational age. Thus it can serve as highly valuable and trustworthy parameter in the fetal age estimation and help investigating authorities to solve legal problems in relation to fetuses.

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1. Introduction

The accurate knowledge of gestational age is a keystone in an obstetrician's utility to successfully manage the antepartum care of a patient and is of critical importance in antenatal tests for successful planning of appropriate therapy and intervention. Failure can be resulted in iatrogenic prematurity which is associated with increased perinatal morbidity and mortality⁽¹⁾.

The objective knowledge of the expected date of delivery (EDD) is essential in management of all pregnancies particularly the methods of delivery, management of high risk pregnancy, elective caesarean section for previous section deliveries. The obstetrician calculates the expected date of delivery as

280 days or 40 weeks from 1st day of last menstrual period (LMP).

In women with regular period, this method is fairly accurate, but if cycles are irregular miscalculation may be made a higher perinatal mortality and that has been reported in patients whose expected date not known⁽²⁾.

Accurate fetal age estimation has medico-legal implications too, especially in cases of criminal abortion, alleged infanticide, still born or dead born baby, marriage, divorce, inheritance and in medical termination of pregnancy. In cases of criminal abortion or infanticide, the age of the fetus is integral to the prosecution⁽³⁾.

It is of utmost importance as medical doctors, being expert witnesses to the courts of law, need to give an opinion regarding the viability of the infant. Such evidence is used to determine whether or not to file a case against the suspect, and if a case should be filed, under which section of the Penal Code the accused should be charged. Furthermore, in case of sexual abuse, the court may need to know the period of gestation of the infant/ fetus, to date the crime⁽⁴⁾.

Ultrasonography of fetal measurements are highly reliable in 1st and 2nd trimester of pregnancy but reliability of any ultrasound method, greatly diminishes as gestation advances. In third trimester, reliability of any single ultrasound parameter is poor⁽⁵⁾. Many pregnant women come for their first antenatal check up in the third trimester who are unsure of date and do not possess early dating scan, so management decision become different. Ultrasound parameter of TCD is considered as reliable predictor for gestational age in third trimester⁽⁶⁾. The cerebellum is the largest part of hind brain lies in the posterior cranial fossa. It lies dorsal to the pons and the medulla, separated from them by free size of cerebellum. TCD is less affected by deviation in fetal growth restriction or growth acceleration⁽⁷⁾.

The predicted gestational age by TCD between 22 – 28 weeks is within 0 – 2 day, between 29 – 36 weeks is within 0 – 5 days and 37 weeks is 0 – 9 days of actual gestation, so TCD nomogram predicts gestational age with accuracy of 94% in the third trimester⁽⁸⁾.

This study aimed to confirm the relationship between gestational age and TCD in prediction of gestational age by TCD in normal and IUGR fetuses, and assesses the reliability of TCD measurement.

2. Patients and Methods

This study was conducted on pregnant women attending the outpatient clinic of obstetrics and gynecology Al Zahraa University Hospital from Jun 2015 to July 2015.

Three hundred and thirty pregnant women were prospectively studied, 300 women with normal pregnancy (according to the normal sure last menstrual period) and 30 pregnant women with IUGR pregnancy (according to the criteria for growth retardation as below 10 th percentile for birth weight were subjected) and all of them aiming for routine antenatal care and ultrasound examination.

All pregnant women with gestational age from 14 – 40 weeks gestation. Only those who were certain of their last menstrual period and had normal singleton pregnancy were included, but those with maternal condition such as diabetes, hypertension, sickle cell hemoglobinopathy and other congenital anomalies were excluded.

All measurements were made by scanning the patients using Sono Ace R3 (Medison company limited) real time ultrasonographic machine with linear and sector array 3.5 MH₂ frequency transducers.



Fig. (1): Measurement of TCD (measurements were obtained by placing the calipers of the ultrasound machine at the outer-to-outer margins of the cerebellum).

The transverse cerebellar diameter was obtained by placing electronic caliper at outer margins of

cerebellum. The land marks of the thalami, cavum, septum pellucidum and third ventricle were identified

thereby slightly rotating the transducer below the thalamic plane. The posterior fossa is revealed with the characteristic butterfly like appearance of cerebellum. The cerebellum appear as two lobules on either side of midline in posterior fossa⁽⁹⁾.

BPD, FL, HC and abdominal circumference (AC) were measured in all cases to calculate fetal gestational age and detect the correlation between all these parameters with GA, also to know the correlation between TCD and other parameters. Then regression analysis and correlation coefficient in normal and IUGR pregnancy were detected showing its relation to gestational age, and finally all data were collected and statistically analyzed.

3. Results

This study was conducted at department of obstetrics and gynecology, Alzhrara University Hospital on 330 pregnant women, 300 women with normal pregnancy and 30 pregnant women with IUGR pregnancy.

This study shows that the mean age of pregnant women in normal pregnancy was 21.9 ± 3.18 years and women with IUGR was 22.8 ± 3.38 years with no statistically significant differences ($P = 0.26$) (table 1). 120 women with normal pregnancy were PG, 80 women were G2, 60 women were G3 and 40 women were G4 compared to 10, 8, 6 and 6 women with IUGR pregnancy respectively (table 2), with no statistically significant difference regarding the parity. At 14-20 weeks gestation, the mean TCD was 17.39 mm, 24.44 mm at 21- 27 weeks gestation, 32.04mm at 28-34 weeks gestation and 42.73 mm at 35-40 weeks gestation (table 3).

The minimum diameter TCD at 14-20 weeks was 13mm and maximum was 24 mm, at 21-27 weeks gestation the minimum TCD was 22mm and maximum was 28mm, at 28 - 37 weeks the minimum TCD was 30mm and maximum 34mm and at 35 - 40 weeks gestation the minimum TCD was 34 mm and maximum was 50 mm .with the observation that the

measurement of TCD in millimeter up to 26 weeks was equal to gestational age by weeks (table 3).

This study shows graphical representation of the correlation between gestational age and transverse cerebellar diameter (TCD) with a linear relationship in normal and IUGR pregnancies (figure 2).

Correlation coefficient between gestational age and TCD was found to be 0.797 which was statistically significant ($P < 0.00$). This means there is a high degree of correlation between gestational age and TCD (table 7). On the other hand the regression analysis of TCD with gestational age was 0.86 which indicates that, 86% of transverse cerebellar diameter can be explained by gestational age, which was very large significantly used in predicting the gestational age with $P < 0.000$. That means there is a highly significant relationship between TCD and gestational age as shown in (Table 5) $TCD = 0.527 \times GA + 12.189$.

In IUGR pregnancy regression analysis between TCD and gestational age was 0.84 with statistically significant. This means that 84% of TCD can be explained by gestational age, which was very large significantly used in predicting the gestational age (table 6).

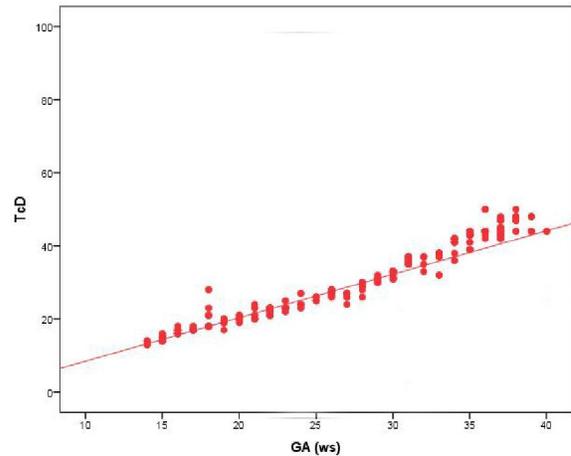


Fig. (2): Relationship between TCD and GA.

Table (1): Comparison between studied groups as regard age.

	Normal pregnancy	IUGR	P value
Mean age \pm SD	21 ± 3.18	22.8 ± 3.38	0.26

Table (2): Comparison between studied groups as regard age.

	Normal pregnancy	IUGR pregnancy
PG	120	10
G2	80	8
G3	60	6
G4	40	6
Total	300	30

Table (3): Mean of TCD (mm) during different gestational age.

Gestational age (weeks)	Number	TCD		One way ANOVA
		Mean±SD	Range	Coefficient of variant
14-20ws	69	17.39±2.79	13-22	10.2
21-27ws	70	24.44±12.26	22-28	9.2
28-37ws	86	32.04±7.16	30-34	8.2
35-40ws	85	42.73±7.58	34-50	4.8

Table (4): Correlation of TCD with BPD, FL, AC, HC in normal pregnancy

	TCD(mm)	
	R2	P value
TCD vs BPD	0.91**	0.000
TCD vs HC	0.89**	0.000
TCD vs FL	0.88**	0.000
TCD vs AC	0.86**	0.000

Table (5): Correlation of GA with BPD, HC, FL, AC and TCD in normal pregnancy.

	GA (weeks)	
	R2	P value
GA vs BPD	0.89**	0.000
GA vs HC	0.85**	0.000
GA vs FL	0.86**	0.000
GA vs AC	0.81**	0.000
GA vs TCD	0.86**	0.000

Table (6): Correlation of GA with BPD, HC, FL, AC and TCD in IUGR pregnancy.

	GA (weeks)	
	R2	P value
GA vs BPD	0.47	0.462
GA vs HC	0.43	0.432
GA vs FL	0.42	0.017
GA vs AC	0.17	0.467
GA vs TCD	0.84**	0.002

Table (7): Coefficient dependent variable = TCD mm

	Unstandardized coefficients		Standardized coefficients	Independent t test	
	B	SE	Beta	T	Significant
Constant	11.189	0.752	0.797	16.203	0.000
GA(weeks)	0.527	0.24		22.362	0.000

4. Discussion

Determination of GA is important in obstetric for management of pregnancy and evaluation of fetal development. Higher perinatal mortality has been reported in patients whose expected date of delivery is not known. An error in gestational age (GA) estimation can result in premature and postmaturity. Extremes of fetal growth contribute disproportionately to overall perinatal infant morbidity and mortality⁽¹⁰⁾. Accurate gestational dating is of paramount importance and the cornerstone of management of pregnancies especially those with fetuses who have growth disturbances (IUGR and large fetuses).

Methods to determine the date of pregnancies should be simple and straight forward, irrespective of GA⁽¹¹⁾.

Gestational age estimation has important clinical, legal, and ethical implications. When encountered with a malformed fetus or recurrent abortions, knowledge of the fetal age becomes essential in guiding future parental and obstetric decision making. With regards to the law, establishing fetal age is a critical step while assessing the viability of the fetus in order to qualify a homicide in court. The World Health Organization has set this viability after 20 weeks of gestation⁽³⁾.

In this study we have scanned 300 uncomplicated pregnancies and thirty intrauterine growth retarded pregnant women between 14 to 40 weeks of gestation. The mean age for normal pregnant women was 21 ± 3.18 years and 22.8 ± 3.88 years in IUGR pregnant women with no significant difference between the studied groups table (1). In this study 120 pregnant women were PG, 80 were gravida 2, 60 women were gravida 3 and 40 women were gravida 4 in normal pregnancy while in IUGR pregnant women 10 women were PG, 8 women were G2, 6 were G3 and 6 women were gravida 4 with no significant differences between both groups of the study (table 2).

The American Institute of Ultrasound in Medicine assessed theoretical harms in its safety assessment and concluded that the benefits to patients of the prudent use of diagnostic US far outweighs any potential risk⁽¹²⁾. Many traditional biometric parameter usage in determination of gestational age is vogue, viz. bi parietal diameter (BPD), femur length (FL), head circumference (HC) etc, but they have their own limitations and gradually usage of transverse cerebellar diameter (TCD) in estimating of gestational age is emanating in the field of radiology and it has already been well established in ultrasound literature as a reliable parameter⁽¹³⁾.

The characteristic image of cerebellum by ultrasonography appear as two lobules on either side of midline, located in posterior cranial fossa. TCD, bi parietal diameter, femur length, abdominal circumference and head circumference were measured in all cases to assess the gestational age of fetus and to detect the correlation between all these parameters and gestational age. Also an attempt was made to find the correlation between TCD and other parameters.

In this study the correlation between TCD and gestational age by sonographic evaluation of cerebellar growth reveals linear relationship between TCD and gestational age. This agrees with Mustafa et al. who demonstrated that close relationship of TCD was observed with gestational age in 2nd trimester⁽⁹⁾. Also Mukesh et al. reported in his study linear relationship of TCD was observed with gestational age⁽¹³⁾.

Also in this study measurement of TCD in millimeter is equivalent to gestational age in weeks from age of 14 to 26 weeks. This agrees with Reece et al. who found in their studies that TCD from 15 weeks to 24 weeks of gestation in millimeters was equivalent to gestational age in weeks, and agrees with Mukesh et al. who reported that the measurement of TCD in millimeter was equal to gestational age in weeks during 14 -24 weeks^(13,15).

Correlation coefficient between TCD and gestational age was 0.797 with statistically significant P value < 0.000. This agrees with Mukesh et al. and

Goal et al. who reported that when they studied on 650 cases between 14-40ws the correlation coefficient between gestational age to TCD was found to be 0.972305 with statistically significant p value < 0.001 which highly significant^(13,14).

In normal pregnancy there was a good correlation between BPD, HC, FL, AC, and gestational age with regression analysis equal 0.91, 0.89, 0.88, and 0.86 respectively and significant p value, but in IUGR pregnancy, there was a good correlation only between gestational age and TCD with regression analysis equals 0.84 and significant p value. So, TCD in normal and IUGR cases gives good correlation with gestational age with no limitation, so 86% of normal cases of gestational age and 84% of IUGR cases gestational age can be explained by TCD.

This agrees with Reece et al. who studied on nineteen pregnant women with clinical suspicious of intrauterine growth retardation with the gestational age. Multiple biometric parameters were obtained including the transverse cerebellar diameter. A prenatal diagnosis of intrauterine growth retardation was made in all cases based on the TCD being consistently correlated with gestational age as predicted by last menstrual period, where as most of other measurements were consistently discrepant by more than 2.5 weeks and the estimated fetal weight of all fetuses was equal to or less than the tenth percentile for gestational age. They suggested that the growth of TCD is unaffected by intrauterine growth retardation⁽¹⁵⁾.

The inability to ascertain gestational age by ultrasound parameters in the third trimester has proved to be a major cause of undiagnosed fetal IUGR. They suggested that the growth of transverse cerebellar diameter is unaffected by intrauterine growth retardation⁽¹⁶⁾. The measurement of TCD in the fetus continues to be useful indicator for GA even in presence of abnormal skull shape or fetal growth restriction. In some cases with dolichocephaly or brachycephaly, TCD also may be a more reliable predictor than biparietal diameter since the posterior fossa is not affected by external pressure including fetal malposition, breech presentation or oligohydramnios, which may induce distortion of the fetal head⁽¹⁷⁾. So TCD measurement of fetus is resistant to these effects on other fetal measurements, the TCD therefore represents an independent biometric parameter that can be used in both singleton and multifetal pregnancies to assess normal and deviation of fetal growth⁽¹⁸⁾.

Conclusion

Estimation of gestational age by different parameter of pregnant mother who not sure of their last menstrual period may be faithfully and not

reliable but can be estimated by using TCD because the estimation of gestational age by TCD is good correlated with gestational age in normal pregnancy with high significant value ($r=85\%$, $p=0.000$).

Also transcerebellar has an advantage in cases of IUGR pregnancies as it correlates well with gestational age comparing to other growth parameters with significant value ($r=84\%$, $p=0.002$). Finally we would like to conclude that TCD is advised to be added as a routine measurement for the estimation of gestational age.

This study will not only help obstetricians in determining gestational age but also to medicolegal experts and thus will help in administration of justice.

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