

Transcerebellar Diameter: An Useful Tool to Estimate Gestational Age

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Abstract

Background: Gestational age is the most important factor for obstetrician to give appropriate management of pregnant women and to evaluate fetal development. An error in estimation of the gestational age (GA) results in adverse perinatal outcome. Many ultrasound parameters are used routinely for assessment of gestational age. Use of these parameters may be limited in some cases such as fetuses with abnormalities of skull vault and growth restricted fetuses. In such cases, the transcerebellar diameter (TCD), may be used as it is least affected. This study was conducted with an objective to show that TCD is a useful tool for determining the gestational age in comparison to other already existing parameters. **Subjects and Methods:** This was a prospective study including 100 pregnant women between 15 to 40 weeks of gestation. Gestational age using TCD and other parameters was calculated and compared with gestational age based on last menstrual period (LMP). **Results:** Mean age of study group was 27.5 years. Correlation between gestational age and various ultrasound parameters showed that TCD correlated best with GA with a correlation coefficient of 0.989 and significant P value of <0.005. Mean TCD showed a linear relationship with gestational age in weeks. **Conclusion:** TCD serves a reliable parameter in estimation of GA in second and third trimesters since it shows good correlation with GA.

Keywords: Gestational age, Transcerebellar Diameter, Ultrasound.

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Introduction

The most important parameter in the management of pregnancy and monitoring fetal growth and development is gestational age. Estimation of gestational age is important to the treating obstetrician for the diagnosis of IUGR and timing of delivery.^[1] Gestational age is determined by last menstrual period (LMP) or date of conception in cases of in vitro fertilization.^[2] In this modern era, ultrasound is useful in the estimation of gestational age by using parameters like biparietal diameter, head circumference, femur length (FL) and abdominal circumference. Estimation of fetal age can also be done with several other parameters like transcerebellar diameter (TCD), orbital diameter, ear size, fetal length and renal diameter.^[3-6] Among these, TCD has been included in routine obstetrical examination along with other standard parameters as posterior fossa is not affected by external pressure like breech presentation, fetal malposition, oligohydramnios which can cause distortion of fetal head.^[1,3,7] TCD is useful in cases of skull vault abnormalities like dolichocephaly or brachycephaly and also in skeletal dysplasias where FL is unreliable. Measurement of TCD is also helpful in cases of

unknown LMP and in cases of intrauterine growth retardation as the cerebellum is least affected and maintains its size. Hence TCD can predict accurate gestational age.^[6] Many studies are done on TCD as a tool for determining the gestational age. We conducted this study to show that TCD is very useful tool to determine the accurate gestational age.

Subjects and Methods

This prospective study was conducted over a period of one year from December 2018 to December 2019. Ethical clearance was taken from the institutional research committee. Total of 130 patients who were referred from the department of obstetrics for routine ultrasound examination were included in this study. Informed consent was taken from all patients. Inclusion criteria of this study were normal singleton pregnancies of 15 to 40 weeks gestation with known LMP. Cases with congenital malformation and multiple gestations were excluded from this study.

Real time 2D ultrasound machine GE LOGIQ F6 and PHILIPS ClearVue 320 with transducer of 3-5 MHz was used in the

study. TCD was obtained in all patients in addition to the routine standard fetal parameters like BPD, HC, FL and AC.

TCD is calculated by the maximum diameter between the cerebellar hemispheres on axial scan as shown in Figure 1. Value of TCD in millimetres is equivalent to the gestational age in weeks between 14 to 40 weeks. However after 24 weeks the TCD in millimetres exceeds gestational age in weeks. The accuracy of TCD between 22 to 28 weeks is 0-2 days, for 29-36 week is 5 days and at 37 weeks is within 9 days of actual gestation. [8,9]

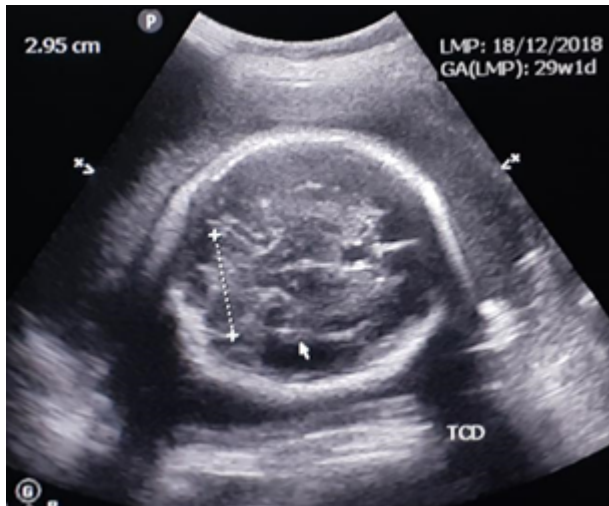


Figure 1: Showing measurement of Transverse Cerebellar Diameter

Statistical Analysis

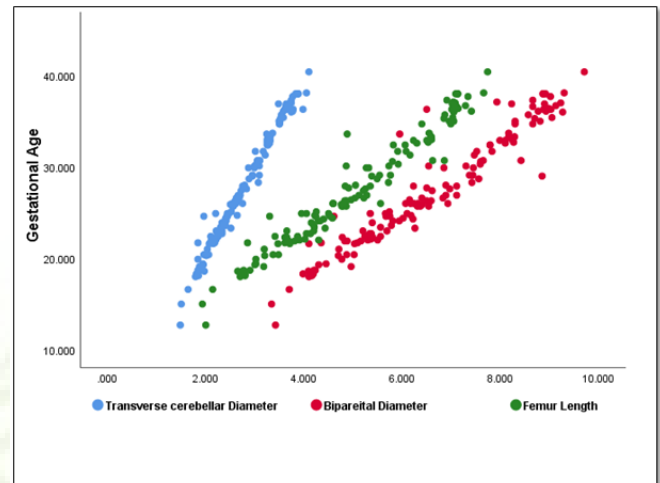
Continuous variables were summarised as mean, categorical variables were summarised as frequency. Pearson's correlation coefficient was calculated between gestational age determined by LMP and TCD as well as other foetal biometric parameters. Bias, limits of agreement and their corresponding 95% CIs were calculated to assess agreement between the gestational age determined by LMP, TCD and other parameters using Bland and Altman analysis. Subgroup analysis of subjects based on gestational age was also performed. P value of less than 0.05 was considered statistically significant. Statistical analysis was performed using R software. [10]

Results

The study was done in 130 normal pregnancies with known LMP. The age of the patients ranged from 18 to 37 years. Mean age of study group was 27.5 years. Patients were divided into different age groups and 15-25 years age group predominated in the study [Table 1]. Mean TCD was calculated in different

gestational age groups and maximum mean TCD was seen in 31-40 year age group measuring about 35.4 mm [Table 2].

We studied correlation between gestational age and various ultrasound parameters and found that TCD correlated best with GA [Table 3] with correlation coefficient of 0.989 and P value of <0.005. Mean TCD showed a linear relationship with gestational age in weeks as depicted in scatter plot [Graph 1].



Graph 1: Scatterplot for GA vs TCD, BPD, FL

Relation between biparietal diameter and gestational age was compared using Pearson correlation. Biparietal diameter was found to increase in a linear pattern against gestational age with a strong correlation [Graph 1]. Pearson correlation coefficient (R) came out to be 0.956 with a determination coefficient (R²) of 0.913936 and the test was significant with a p value of <0.005.

On comparing Head circumference (HC), we found a correlation coefficient (R) of 0.962 with a determination coefficient (R²) 0.913936 [Graph 2]. Abdominal circumference (AC) steadily increased with gestational age in linear progression [Graph 2] with correlation coefficient (R) of 0.983 and a determination coefficient (R²) of 0.966289. Finally Femur length (FL) also correlated well with the gestational age with a correlation coefficient of 0.977 [Graph 1].

Bland-Altman agreement plots for gestational age determined by Arithmetic Ultrasound Age (AUA) and TCD compared with gestational age by LMP showed no systemic difference [Graph 3 and 4]. The bias was 0.3 (0.06 – 0.44) for AUA and lower and upper limits of agreement (LOA) were -1.9 (-2.18 to -1.54) and 2.4 (2.04 to 2.69) respectively. The bias was lower for TCD i.e 0.02 (-0.144 to 0.190), lower and upper LOA were -1.9 (-2.16 to -1.58) & 1.9 (1.63 to 2.20) respectively [Table 4].

Table 1: Age distribution of patients.

Age Group (years)	No of Patients	Percentage
15-25	93	71.53%
26-35	36	27.69%
35-45	1	0.76%
Total	130	100%

Table 2: Mean TCD during different gestational age

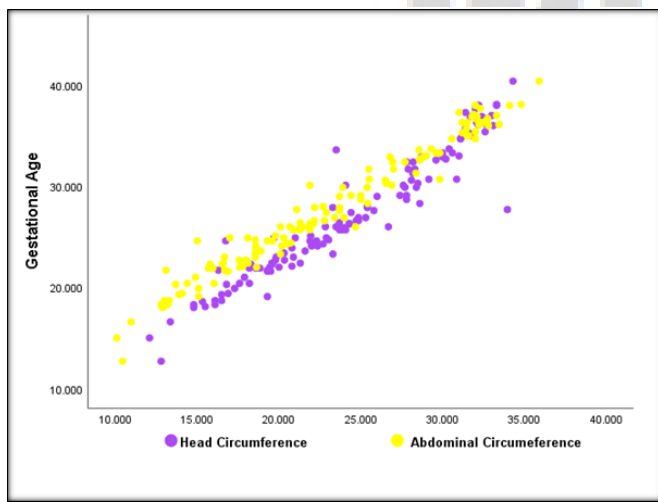
Gestational age in weeks	No of cases	Minimum TCD in mm	Mean TCD in mm	Maximum TCD in mm
15-20	22	14.8	18.8	22.2
21-30	66	20.7	25.7	32.7
31-40	42	25.9	35.4	41

Table 3: Correlation between Gestational age & various parameters

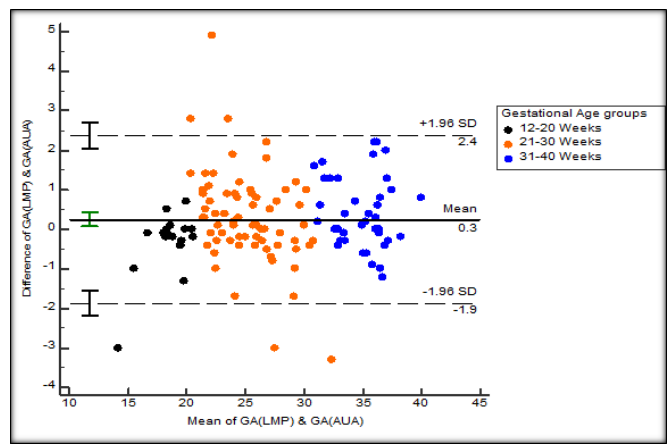
Parameter	Correlation Coefficient (R)	Determination Coefficient (R ²)	P value
Transverse Cerebellar Diameter	0.989	0.978121	<0.005
Bi Parietal Diameter	0.956	0.913936	<0.005
Head Circumference	0.962	0.925444	<0.005
Abdominal Circumference	0.983	0.966289	<0.005
Femur Length	0.977	0.954529	<0.005

Table 4: Mean Bias, Limits of agreement and corresponding 95% CI for Gestational age by AUA and TCD compared to that of LMP.

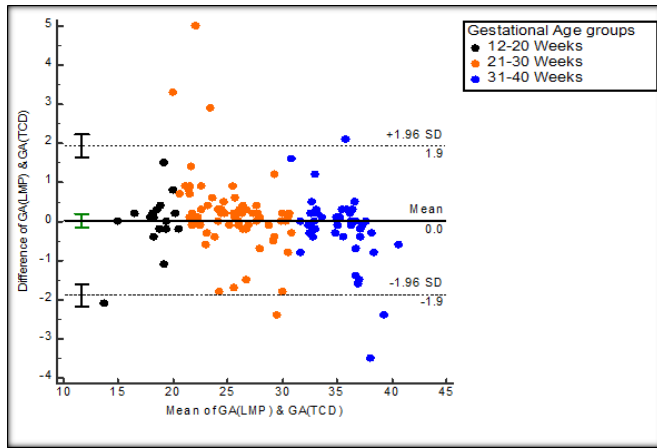
	Bias (Mean difference) (95% CI)	Lower LOA (95% CI)	Upper LOA (95% CI)
AUA	0.3 (0.06 to 0.44)	-1.9 (-2.18 to -1.54)	2.4 (2.04 to 2.69)
TCD	0.02 (-0.144 to 0.190)	-1.9 (-2.16 to -1.58)	1.9 (1.63 to 2.20)



Graph 2: Scatterplot for GA vs HC, AC



Graph 3: Bland Altman plot for agreement between Gestational age by LMP and AUA



Graph 4: Bland Altman plot for agreement between Gestational age by LMP and TCD

Discussion

Accurate estimation of the gestational age is paramount in the management of pregnancy. Knowing gestational age, helps clinician to date the pregnancy and differentiate normal from abnormal growths. Errors in the estimation of gestational age results in prematurity and post maturity which in turn contribute to perinatal and infant morbidity and mortality.

LMP is known to correlate best with the gestational age. But when cycles are irregular and when woman is not sure about her LMP, then dating the pregnancy becomes difficult. Because of its easy availability, relatively cost effective nature, ultrasound is useful in estimation of gestational age using various conventional parameters like BPD, HC, FL and AC. However these parameters have some limitations and as pregnancy advances there is variability in predicting gestational age. BPD is not very reliable in third trimester, in cases of head moulding and abnormal skull shapes like dolichocephaly and brachycephaly. Pilu et al,^[10] investigated the ultrasonography of the posterior fossa of the fetus and confirmed the capability of ultrasound to demonstrate the anatomy of the posterior fossa. They suggested that the fetal transcerebellar diameter in utero between 17 and 40 weeks of gestation is more useful indication of accurate gestational age, particularly in case of dolichocephaly and brachycephaly and also facilitates the antenatal detection of congenital disorders. AC is affected in cases of growth retardation hence erroneous results will be obtained in cases of IUGR. Measurement of FL is also affected in cases of skeletal dysplasias resulting in errors in the estimation of gestational age. In such situations, one of the parameter which is least affected and can be used in predicting gestational age is transcerebellar diameter. And as the measurement of TCD is simple and accurate, TCD can be used as reliable USG parameter in predicting gestational age.

Transcerebellar diameter is obtained at axial cranial images, by measuring the distance between the two lateral aspects of cerebellar hemisphere.^[11,12]

We compared TCD and gestational age and found that sonographic evaluation of cerebellar growth reveals a linear relationship. Correlation co-efficient between TCD and gestational age was found to be 0.989, which was statistically significant ($p < 0.005$). This is similar to the correlation coefficient between TCD and GA found by Goel P. et al.^[13]

Another study done by R Nagesh et al demonstrated linear relationship between TCD and fetal gestational age between 15 to 40 weeks of gestation.^[14] The results of our study were concordant with the above study.

In our study, we found that TCD was well correlated with GA as compared to the other biometric parameters. This is similar to the study done by Luiz et al.^[15]

Study done by Bansal M. Bansal A et al,^[16] showed that parameter that correlated most with gestational age was transcerebellar diameter. In normally developing fetus, value of TCD increases with advanced gestational age. In our study also, values of TCD increased with advanced gestational age and TCD very well correlated with gestational age compared to other parameters.

Mcleary et al,^[7] proposed that measurement of TCD helpful in estimating gestational age between 15 to 39 weeks and also reported that TCD is useful in cases of breech presentation where deformation of skull can result in erroneous BPD values. Results of our study were concordant with this study. Good correlation was found between TCD and gestational age.

Study done by Malik R, Pandya V Ket al,^[17] showed that TCD/AC ratio is an accurate gestational age independent method of identifying the small for gestational age but not the large for gestational age infant. They reported that TCD showed 92% predictive accuracy for gestational age and TCD/AC ratio was found to be 0.14064 ± 0.059 (SD) which remained fairly constant throughout pregnancy and thus it is an useful gestational age independent parameter.

Another research done by Malik G, Waqar F et al,^[18] in 2003 reported that transverse cerebellar diameter varied in a linear fashion in third trimester, while transverse cerebellar diameter/abdominal circumference (TCD/AC) ratio remained constant in second half of pregnancy.

Limitation of our study was that we did not study on TCD/AC ratio and also we didn't compare TCD values in normal and growth restricted fetuses.

Conclusion

TCD serves a reliable parameter in estimation of GA in second and third trimesters since it shows good correlation with GA.

Measurement of TCD is also helpful in cases of unknown LMP and in cases of intrauterine growth retardation as the cerebellum is least affected and maintains its size. In cases of uncertain LMP, to estimate GA, TCD can be used as a single growth parameter.

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