
Original Article

Accuracy of Transverse Cerebellar Diameter measurement by Ultrasonography in the evaluation of fetal age

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Abstract:

Background: Perinatal mortality a concern in the developing countries and intrauterine growth restriction (IUGR) is an important cause. Therefore early diagnosis of IUGR babies is the key to prevent complications as well as mortality. Multiple biometric parameters including trans-cerebellar diameter can be used to predict the gestational age. Thus, the present study was designed to measure and compare the trans-cerebellar diameter and evaluates the usefulness of transverse cerebellar diameter as against the conventional parameters and to find out the usefulness of transverse cerebellar diameter in antenatal diagnosis of intrauterine growth retardation.

Methods: A cross-sectional study was conducted on normal antenatal women of 15-40 weeks gestational age referred for antenatal ultrasonography between January to December 2015. Total 250 patients were examined. Data collected was compared with the conventional parameters.

Results: Good correlation was found between transverse cerebellar diameter (TCD) and other parameters. Also TCD showed a linear relationship between the cerebellar growth and the gestational age. It was found to be better than BPD in circumstances like excessive molding and dolicocephaly. Also TCD measurement was not fraught with problems as encountered in FL measurement. The mean TCD/AC ratio was 13.866%. So it was found that TCD can be used as a reliable parameter for determination of gestational age in mass studies.

Conclusion: There is good correlation between TCD and other parameters in normal pregnancies at 15 to 40 weeks of gestation. This implies that, TCD is a better parameter for gestational age assessment compared to BPD and FL.

Keywords: Gestational age, Transverse cerebellar diameter, fetal maturity

Introduction:

The commonest problem an obstetrician faces frequently, is the assessment of fetal maturity for either prolonging the pregnancy or terminating it for complications. Gestational age of a fetus and expected date of delivery can be determined by various methods such as menstrual history and Clinical examination. Obstetric sonogram is indicated if there is uncertainty regarding the gestational age and is presently the most effective way to date pregnancy. Accurate assessment of gestational age of fetus, major congenital anomalies, fetal growth, wellbeing and maturity all have become possible due to the availability of ultrasound [1].

Ultrasonography helps in evaluating the duration of pregnancy based on measurement of the fetus, using size as an indirect indicator of menstrual age. Currently the various parameters which are being used, include the biparietal

diameter (BPD), head circumference (HC), abdominal circumference (AC) and Femur length (FL) [2, 3, 4]. However the variability in assessing the gestational age with these parameters goes on increasing with increasing gestational age [5, 6, and 7]. In cases of intrauterine growth retardation the biparietal diameter, head circumference/ abdominal circumference (HC/AC) ratio and estimated gestational age can be used to assess fetal maturity only if correct gestational age is known. Transverse cerebellar diameter (TCD) measurement is highly accurate in correct assessment of gestational age especially in cases where the last menstrual periods are not exactly known [8].

The purpose of the current study is to evaluate the usefulness of transverse cerebellar diameter as against the conventional parameters such as fetal length and bi-parietal diameter in assessing gestational age in normal pregnant mothers between 15 to 40 weeks and its usefulness in antenatal

diagnosis of intrauterine growth retardation. The cerebellum and posterior fossa are aligned perpendicular to the plane of maximum extrinsic compression than the parietal bones [9] and can be a more accurate parameter for the determination of gestational age.

Methodology:

A cross-sectional study was conducted from 1st January to 31st December 2015 in the department of Radio-diagnosis, at GSL Medical College, Rajahmundry. Total 250 antenatal women of gestational age 15-40 weeks (estimated from their last menstrual period) were included in this study. All were referred to the facility for antenatal ultrasonography. Those patients with congenital malformation and multiple pregnancies were screened and excluded from this study.

All the statistical analysis was performed by using SPSS Software trial version 21. All descriptive statistical data were presented in the form of mean \pm standard deviation. Chi square test was done to find the association between the categorical variables. Correlation and regressions was performed to find the relation between the continuous variables. P value less than 0.05 was considered as statically significant.

PHILIPS HD 11 System with the transducer of 3.5 MHz convex array transducer was used in this study. During the procedure, each patient was placed in supine position. The transducer was placed on the skin surface after applying the coupling agent.

During the sonographic technique, the cerebellar view was obtained by rotating the transducer in the axial plane centered on the thalamus to show the cerebellar hemispheres. This view shows the Cerebellum, the Cisterna Magna and the Cavum Septum Pellucidum.

Results:

Among the 250 cases studied, the age distribution was from 18 to 35 years. The mean age was found to be 22.476 \pm 2.67 yrs. Parity distribution among the 250 pregnancies where 149 were primigravida, 82 were gravida 2, 17 were gravida 3 and 2 were gravida 4. For all the 250 pregnant women, all the parameters i.e. TCD, BPD, AC, FL and HC were measured ultrasonographically in millimeters.

Regression analysis was used to find out the correlation between TCD and each of the other parameters. R² (correlation coefficient) values and p values were calculated. Good correlation was found between TCD and other parameters (p value < 0.001)

The correlation was found best for TCD vs. FL (R²: 0.958). The correlation for TCD vs. BPD, HC, AC and FL was almost similar (R²: 0.952, 0.948, 0.953 and 0.958 respectively). All the correlations were found to be statistically significant (Table 1). Thereafter in the 250 normal pregnancy cases each parameter i.e. BPD, HC, AC, FL and TCD was correlated with GA. The analysis showed that of all parameters TCD shows best correlation with gestational age. The relationship for each correlation was

curvilinear (Graph 1).

There was good correlation between gestational age and TCD (R² = 0.978, p value < 0.0001) & other parameters which was also found to be statistically significant (Table- 2).

All parameters showed best correlation with gestational age. The relationship for each correlation was curvilinear. This relationship is best described with quadratic and linear equations (Table - 3).

Discussion:

Gestational age dating is of utmost importance for management of pregnancies. Among the various clinical criteria; LMP preceded by normal cycle is known to be the best only if the LMP is known. Ultrasonography is routinely used for dating of pregnancy. The biometric parameters used for gestational age assessment are BPD, HC, AC and FL. However each of these parameters has their own limitation. The variability in predicting gestational age with these parameters goes on increasing as the pregnancy advances [9, 10, and 11].

TCD is a unique parameter for estimating the gestational age of fetus. In this study 250 normal pregnant patients with known LMP were scanned between 15 to 40 weeks of gestation. There was no statistically significant difference between the two groups with regard to age and parity.

In each patient BPD, HC, AC, FL and TCD were measured ultrasonographically. The gestational age was then correlated with each of the measured parameters. In this study it was noted that early sonographic visualization of cerebellum occurred as early as 14 weeks. On ultrasonography the characteristic image of cerebellum appears as two lobules on either side of midline in the posterior cranial fossa.

Fetal trans-cerebellar diameter is dependent upon the ethnic origin of the patient. Different ethnic groups show slightly different measurements of trans-cerebellar diameter. The values obtained in our study where all the patients were South Indian were compared with the study conducted by Hill et al [12] and it was observed that many of the values reported in our study are slightly smaller. This is probably due to difference in ethnic origin of patients.

Mcleary et al [13] studied the measurement of trans-cerebellar diameter with ultrasonography in 225 normal fetuses ranging from 15 to 39 weeks of gestational age and found it closely correlate with BPD. They proposed that the trans-cerebellar diameter may be useful in estimating fetal age, particularly in breech presentation where extrinsic pressure may deform the skull and decrease the biparietal diameter.

Similar results were found in the present study. There was good correlation between BPD and TCD (R² = 0.952, p value < 0.0001). Therefore TCD may be preferred over BPD in assessing gestational age of fetuses in circumstances where head is deformed for e.g. as in molding or dolicocephaly.

Reece et al. [14] prospectively studied ultrasonography of 371 normal pregnant women, with gestational ages ranging from 13 weeks to 40 weeks. They found curvilinear relationships between the transverse diameter of the cerebellum and the gestational age (R² = 0.948; P = 0.001),

the biparietal diameter ($R^2 = 0.956$; $P = 0.0001$), and the head circumference ($R^2=0.969$; $P = 0.0001$). A nomogram of cerebellar measurements estimating gestational age was generated. They concluded that throughout pregnancy normative cerebellar measurements allows for estimation of gestational age that is independent of the shape of fetal head. The result of this study is in concurrence with the above observation. In the present study there was good correlation between TCD and gestational age. ($R^2 = 0.978$, p value < 0.0001). Also good correlation was found between TCD and BPD ($R^2 = 0.952$, p value < 0.0001) and between TCD and HC ($R^2 = 0.948$, p value < 0.0001). In this study TCD nomogram was established from ultrasonographically measured data which can be used for estimating the gestational age of fetus.

Smith et.al [15] demonstrated that the fetal cerebellum can be visualized with ultrasound throughout the second trimester. Nomograms of trans-cerebellar diameter measurements against gestational age showed good correlation, and narrow confidence limits.

The present study also showed similar results. It was noticed that early visualization of cerebellum by ultrasonography occurred as early as 14 weeks. Good visualization was seen in each case; however, measurements were easier to perform in second and early third trimester. There was good correlation between gestational age and TCD ($R^2 = 0.978$, p value < 0.0001).

Guan B [16] found curvilinear relationship between TCD and gestational age ($R^2 = 0.99624$, p value less than 0.0005). He concluded that the function of the TCD in the evaluation of fetal growth and development is better than any other parameter. The growth of TCD slowed down in primary symmetric IUGR and was unaffected in asymmetric IUGR.

Similar results were obtained in present study. We noticed curvilinear relationship between TCD and gestational age ($R^2 = 0.978$, p value < 0.001). In the study by Nery et al [17]. The correlation of TCD with BPD, HC, AC and FL were statistically significant with the P value of 0.92, 0.92, 0.89 and 0.90 respectively. Similarly in the present study the correlation of TCD with other fetal biometric parameters such as BPD, HC, AC and FL were statistically significant with the R^2 value of 0.952, 0.948, 0.953 and 0.958 respectively.

In the present study, the relationship of fetal TCD to gestational age was considered in normal fetuses only. The fetal TCD / AC ratio is a gestational age independent method of assessing fetal growth [18, 19, and 20].

In normal pregnant women the TCD / AC ratio was fairly constant with the mean of 13.68 \pm 0.96 irrespective of gestational age. [21] In the present study the mean TCD/AC was 13.866% (SD: 0.55). There was a strong linear relationship between TCD and AC.

TCD/AC ratio was 13.6 \pm 0.95% in study done by Campbell et al. in 1991. [22] Meyer and his colleagues described that TCD/AC ratio is 13.69 \pm 0.94% in their study in 1991¹⁸. According to Meyer et al [19] TCD/AC ratio greater than the cut off value would be antenatally diagnosed as IUGR. So it was concluded that fetal TCD/AC ratio can be used as an independent method for antenatal diagnosis of IUGR especially in pregnancy with uncertain gestational age.

The results of present study and previously published studies on TCD show that additional small improvements in accurate gestational dating can be achieved by incorporating the results of TCD with some combination of other fetal biometric parameters, including biparietal diameter, head circumference, abdominal circumference, and femur length. Nevertheless, the best combination of biometric measurements remains to be determined. We recommend that TCD be used as an important sonographic biometric parameter for accurate prediction of GA. The potential importance of TCD in predicting gestational age in normal as well as in IUGR pregnancies has thus been stated.

Conclusion:

The present study suggests that, there is good correlation between TCD and other parameters in normal pregnancies at 15 to 40 weeks of gestation. TCD is a better parameter for gestational age assessment compared to BPD and FL. TCD measurements are not affected by conditions which affect BPD for e.g. molding and dolicocephaly. FL measurements can be faulty due to inclusion of unossified epiphyses. Such problems are not encountered during TCD measurement. The Nomograms and quadratic equation derived from the measured TCD data can be used to predict the gestational age of fetus.

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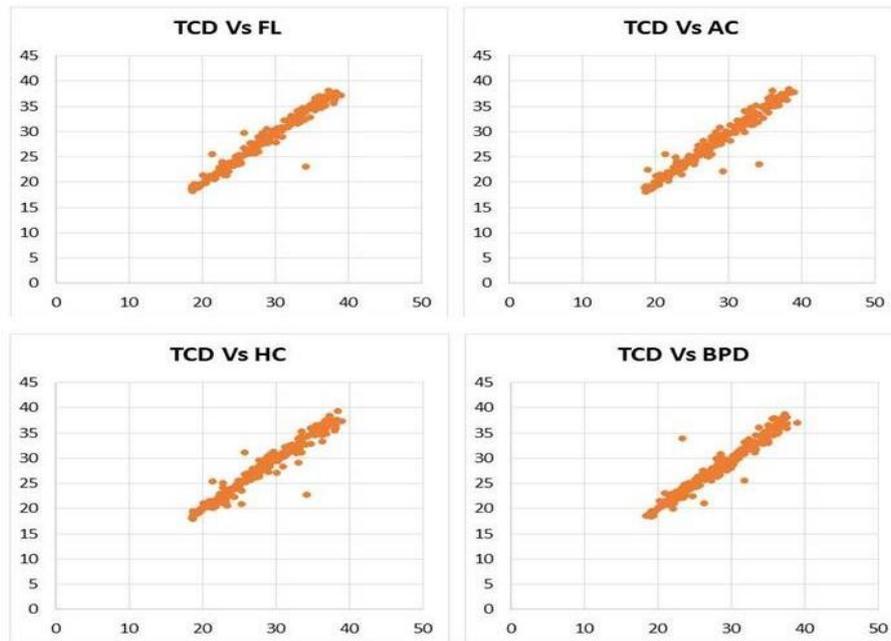
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Table 1: Correlation of TCD with BPD, HC, AC and FL

Parameters compared	R ²	P Value
TCD Vs BPD	0.952	< 0.001
TCD Vs HC	0.948	< 0.001
TCD Vs AC	0.953	< 0.001
TCD Vs FL	0.958	< 0.001

Graph 1: Scatter diagrams showing correlation between TCD gestational age and gestational age through femur length, abdominal & head circumference and bi parietal diameter**Table 2: Table showing correlation of GA with BPD, HC, AC, FL AND TCD**

Parameters compared	R ²	P Value
GA Vs BPD	0.970	< 0.001
GA Vs HC	0.964	< 0.001
GA Vs AC	0.954	< 0.001
GA Vs FL	0.973	< 0.001
GA Vs TCD	0.978	< 0.001

Table 3: Polynomial equations describing the relationship between Gestational Age, BPD, HC, AC, FL and TCD respectively

$GA = 0.003(BPD)^2 - 0.063(BPD) + 16.626$
$GA = 0.038(HC) + 19.221$
$GA = 0.021(AC) + 14.56$
$GA = 0.003(FL)^2 + 0.099(FL) + 14.78$
$GA = -0.008(TCD)^2 + 1.172(TCD) - 0.756$

Graph 2: Representation of TCD/AC Ratio

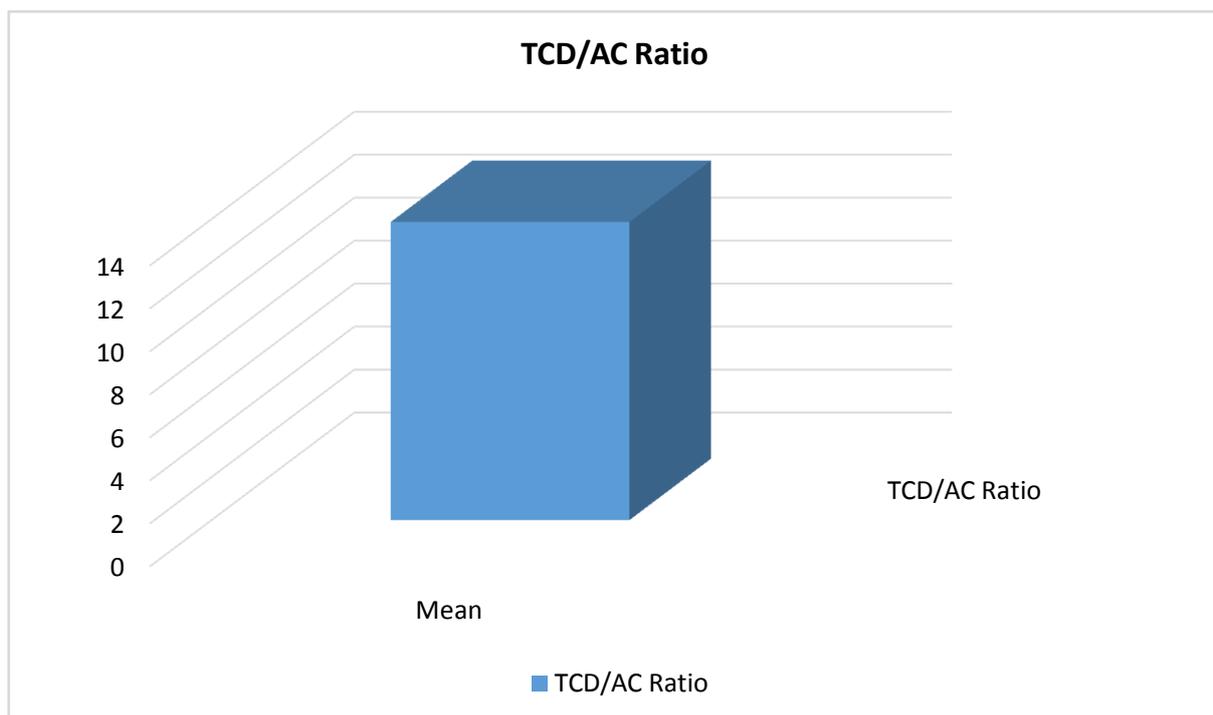


Fig 1: Trans-cerebellar US view at 21 weeks gestation. Cerebellar hemispheres are cystic and show “a pair of eyeglasses” appearance between the crosshairs. It is grade 1 cerebellum.



Fig 2: USG showing BPD and HC

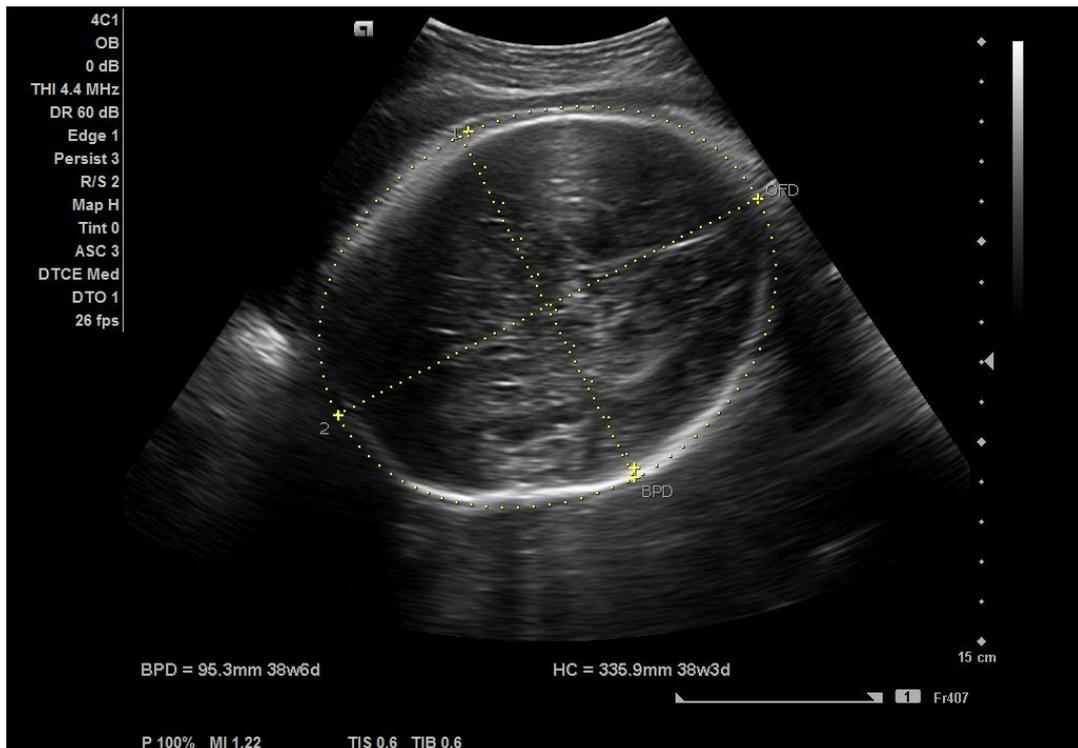
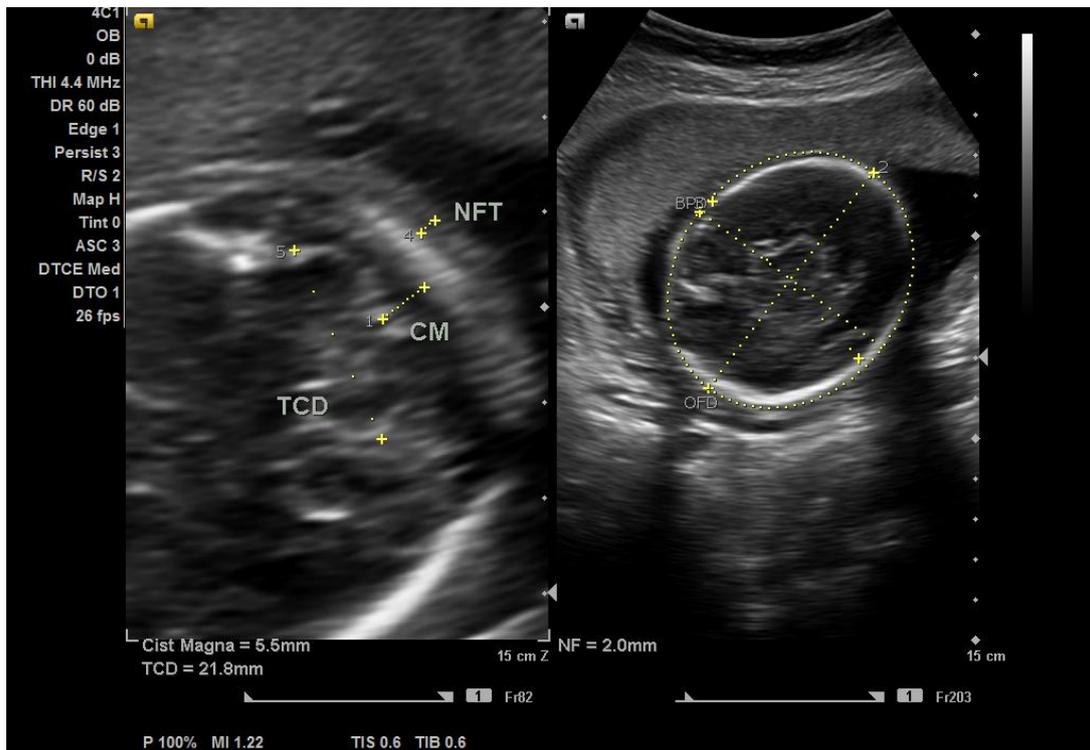


Fig 3: USG showing Cerebellum



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