Research Article

Ultrasonographic Evaluation of the Fetal Transverse Cerebellar Diameter (TCD) Measurement for Prediction of Gestational Age in 2nd and 3rd Trimesters of Pregnancy

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Abstract

Prediction of gestational age based on sonographic fetal parameters is perhaps the cornerstone in modern obstetrics. The transverse cerebellar diameter serves as a reliable predictor of GA in the fetus and is a standard against which abnormalities in other fetal parameters can be compared. A variety of sonographic fetal biometric parameters can be used to assess gestational age in the second and third trimesters of pregnancy. The TCD is an additional biometric parameter against which aberrations in other fetal parameters can be compared.

Objective: To assess the predictability of GA calculated by fetal TCD measured in 2nd & 3rd trimester of pregnancy on ultrasound.

Methods: This was an cross-sectional study with a sample size 319 healthy, pregnant females with a normal fetus included aged 18 to 40 years, conducted in Gilani ultrasound center ferozpur road lahore. A standard 2nd and 3rd trimester ultrasound examination was done. In addition to the standard biometric parameters, the transcerebellar diameter was also measured. The collected data was subjected to statistical analysis.

Results: Pearson product-moment correlation coefficient method was applied at a significance level of 1% ($\alpha = 0.01$).using statistical software SPSS version 23.0. It was observed that BPD and TCD had a statistically significant, strong, linear correlation (r=0.976), GA of FL (r=0.978), LMP (r=0.976) P value (0.000) were considered significant.

Conclusion: The TCD is a reliable parameter for the determination of GA in the 2nd & 3rd trimesters of pregnancy.

Keywords: Gestational age; transcerebellar diameter; femur length; Biparietal diameter

Introduction

Prediction of gestational age (GA) based on sonographic fetal parameters is perhaps the cornerstone in modern obstetrics and continues to remain an important component in the management of pregnancies with fetuses who have growth disturbances. The transverse cerebellar diameter (TCD) serves as a reliable predictor of GA in the fetus and is a standard against which abnormalities in other fetal

parameters can be compared, especially when the GA cannot be determined by the date of the last menstrual period or an early pregnancy scan (Chavez *et al.*, 2007).

The predicted gestational age by TCD between 22 – 28 weeks is within 0-2 days, between 29 – 36 weeks is within 05 days and at 37 week is 09 days of actual gestation. TCD norm gram predicts gestational age with accuracy of 94% in the third trimester (Chavez *et al.*, 2007). In addition to traditional biometry including biperietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL), non-traditional sonographic measurements can help to accurately estimate gestational age at late gestation and specific clinical situations, however the accuracy of some of these parameters is affected by growth aberrations. Transverse cerebeller diameter (TCD) is considered as a new non-traditional sonographic parameter and is claimed to be more accurate in certain situations like extremes of growth abnormalities and variations of fetal head shape such as dolicocephaly and brachycephaly (Chavez *et al.*, 2004).

Standard measurements of TCD can also be used in the diagnosis of cerebellar hypoplasia when the GA is known and TCD percentile charts can be used to assess cerebellar growth in preterm infants.Ultrasonography of fetal measurements is very authentic in the first and second trimester of pregnancy but reliability of any ultrasound method greatly reduces as gestation advances. In third trimester, reliability of any single ultrasound parameter is poor. Since the last decade, ultrasound parameter transcerebellar diameter (TCD) is considered a dependable predictor for gestational age in third trimester.[5,6] Another important consideration is that, despite their reliability, the standard parameters also have some pitfalls and limitations. So there is always a need for additional reliable biometric parameters that are relatively easy to visualize and measure. One of these is the transverse cerebellar diameter. According to several studies, the TCD has been found to be a reliable predictor of gestational age even in the third trimester (Hata *et al.*, 2002; Goel *et al.*, 2010). A significant advantage of the transverse cerebellar diameter is that its correlation with gestational age is not effected in IUGR and large fetuses so it can help in accurate prediction of the gestational age and subsequent management to minimize prenatal morbidity and mortality (Naseem *et al.*, 2013).

Several studies have reported the use of TCD and the TCD/AC ratio in an attempt to find a method to determine the gestational age (Naseem *et al.*, 2014). A study conducted in Nepal in 2007 by Joshi BR concluded that their TCD measurements had a similar relationship with GA across previously published nomograms before 28 weeks but significant differences occurred after 33 weeks and that the nomogram of Chavez significantly overestimated GA in the latter part of the third trimester (Lee *et al.*, 1991). In another study conducted in Pakistan in 2010, Khokhar

(2012) compared the TCD values of 850 patients in the 2nd and 3rd trimesters of pregnancy with Chavez, Hill and Goldstein and concluded that there were no significant differences up to 28 weeks of gestation but values were significantly different in the latter part of the third trimester. Assess the use of transvers cerebellar as an independent parameter for GA assessment in 2nd and 3rd trimester of pregnancy (Smith and Smith , 2006).

The rationale of my study was helpful in assessing the predictability of G.A calculated by fetal transverse cerebellar diameter measure in 2nd & 3rd trimester of pregnancy.

Materials and Methodology

Research Method
This was a prospective cross sectional study. 319 pregnant females in 2nd and 3rd trimester were observed in this study.

Facilities Available
Honda Electronics HS-2000

Probe: TA Curvilinear 3-5 MHz

Population Sample
The target population for this research study was female with a history of regular menstrual cycles, known date of last menstrual period and previous live normal neonates in multipara and having singleton pregnancy without any maternal complications or fetal anomalies were included in the study.

All pregnant women with any maternal complication e.g. hypertension, pre-eclampsia, maternal diabetes, central placenta previa, cases of oligohydramnios or polyhydramnios were excluded from study. Fetal Complications such as twins pregnancy, severe IUGR, chromosomal, congenital abnormalities, dilated renal pelvis (>4mm) were also excluded from study.

Method of Collecting Data
Data recorded on pre designed questionnaire forms and data collection sheets. These were then transferred to EXCEL. SPSS version 23.0 then used to apply relevant tests for statistical analysis Correlation coefficients calculated between values of TCD with gestational age (aggregated calculated by ultrasound machine). A normogram of these values made using the available data and it compared with the previous studies using correlation coefficient test. P value of 0.5 considered as significant.

Data Collection Procedure
Trans-abdominal scan was performed on every included woman whose gestational age was confirmed by early ultrasound scan and by her LMP.

Examination Method Procedure
An informed consent was taken from all patients. The a traumatic nature and the significance for the procedure was

explained detail to the patient referring doctor was also taken into account..Biometric parameters were obtained. These included the bi-parietal diameter (BPD), the transcerebellar diameter (TCD), femur length (FL)Procedure was explained to the patient and it was performed in supine position with hips and knees in extension. The probe was held with right hand and the same observer was perform all the measured by transverse view of fetal intracranial anatomy through the posterior fossa that was include visualization of midline thalamus, cerebeller hemisphere and cistern magna.Measurements was obtained by placing on screen calipers of ultrasound machines at the outer margins of cerebellum.

Data Storage Method

All data collected during the study was kept confidential and stored on computer protected by password. All paper format data was stored in a locked cabinet.

Data Analysis Method

After, taking informed written consent the data was collected through Questionnaire. Data was tabulated and analyzed by SPSS version 23.0 The quantitative data (TCD, BPD, FL) was presented in form of mean ± S.D and person correlation coefficient was applied to compare the means of the two groups.

Ethical Issues

After Approval from Ethical Committee (IRB). Written informed consent was taken from all the patients. All information and collected data was kept confidential. Participants remained anonymous throughout the study. The subject was informed that there are no disadvantages or risk on the procedure of the study. They were also informed that they were free to withdraw at any time during the process of the study.

Variables:

Bi-parietal Diameter (BPD)

Femur Length (FL)

Last menstrual period (LMP)

Transverse cerebellar diameter (TCD)

Results

A nomogram is showing the observed TCD in mm of 319 Patients according to gestational age in weeks. This has been derived from the data recorded during this research mean TCD measurement in 109 patients of gestational age 14 weeks to 20 weeks is 12.9mm to 20.4mm, 82 patients of gestational age in between 21weeks to 26 weeks have mean TCD measurement 21.4mm to 27.6mm,88 patients of gestational (Table 1)

Age in between 27weeks to 31weeks have mean TCD measurement 28.2mm to 33.4mm,78patients of gestational age in between 32weeks to 36 weeks have mean TCD measurement 34.2mm to 38.0mm, and 14 patients of gestational age in between 37weeks to 38 weeks have mean TCD measurement 38.9mm to 39.4mm.

Table 1: Nomo gram transverse cerebellar diameter

Average weeks	Mean TCD (mm)	Total
14 to 20	12.9 to 20.4	57
21to 26	21.4 to 27.6	82
27to 31	28.2 to 33.4	88
32 to 36	34.2 to 38.0	78
37 to 38	38.9 to39.4	14

Present study has showed a strong relationship of gestational age of transverse cerebellar diameter with the gestational age of bi-parietal diameter, gestational age of femur length gestational age of last menstrual periods (LMP)

The mean gestational age of transverse cerebellar diameter was 223 ± 33.908. Mean gestational age of last menstrual periods was 223.85 ± 34.278. Mean gestational age of femur length 223.71± 33.643. Mean gestational age of bi-parietal diameter is 223.85 ± 34.278. These results are highly significant. There was no association between gestationl age, maternal weight, height, parity or socioeconomic status (Table 2). Table 2 shows Gestational age estimated from FL, BPD and TCD, range, mean and standard deviation.

Table 2: Demographic data of the fetal biometry given.

Variable	Mean. ± Std. Deviation
TCD	223.00±33.908
LMP	223.85±34.274
FL	223.71±33.643
BPD	223.85±34.274

In this cross sectional study gestational age of fetus is determined by different parameters e.g. transcerebellar diameter, last menstrual period, biparietal diameter and femur length. Gestational age of transcerebellar diameter is compared with other parameters. A verage gestational age of fetus by different parameters is given in table 1. Present study has shown a strong relationship of gestational age of transverse cerebellar diameter with the gestational age of biparietal diameter (r=0.976), gestational age of femer length (r=0.978), gestational age of last menstrual periods(LMP) (r=0.976). These results are highly significant. P value (0.05) was considered significant.

Table 3: Average gestational age of fetus by different parameters

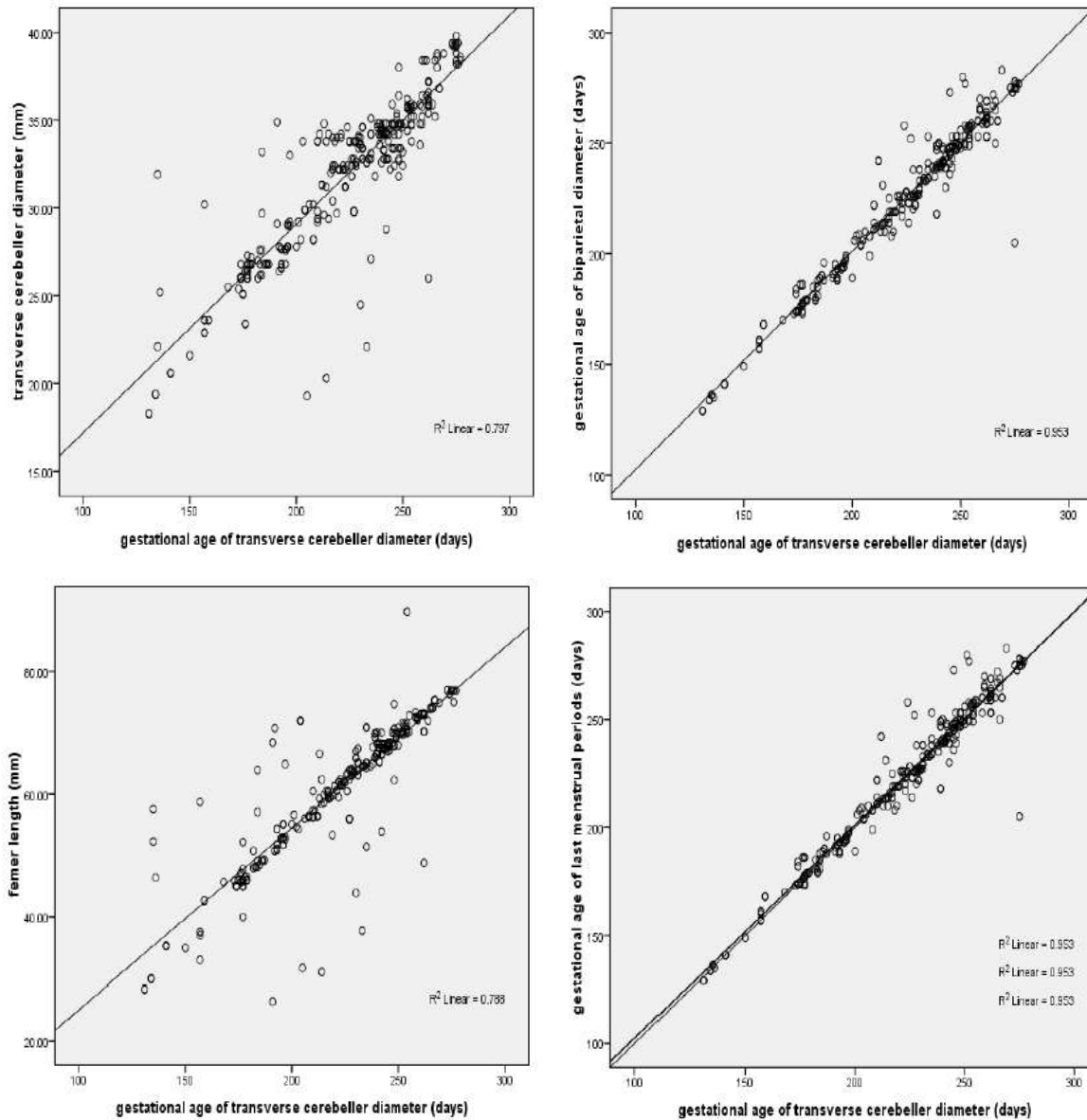|	Mean	Std. Deviation	N
gestational age of transverse cerebellar diameter (days)	223.00	33.908	319
gestational age of last menstrual periods (days)	223.85	34.278	319
gestational age of biparietal diameter (days)	223.85	34.278	319
gestational age of femer length (days)	223.71	33.643	319
biparietal diameter (mm)	78.8505	11.61068	319
femer length (mm)	61.2674	11.25950	319
transverse cerebellar diameter (mm)	31.8188	4.51632	319

Fig.1: The scatter plot showing the positive direct relationship between gestational age of transverse cerebellar diameter and TCD (mm).

The scatter plot (Fig.1) has shown the positive direct relationship between gestational age of transverse cerebellar diameter and TCD (mm). Gestational age of transverse cerebellar diameter (GA.TCD) has positive relation with Femer length (mm), biparietal diameter (mm), gestational age of Femer length and gestational age of biparietal diameter respectively. The overall relationship is (r=95.7). The coefficient of determination (R2) has shown that(r=91.5) of the variability in gestational age is explained by its relationship with GA-BPD, GALMP,GA-FL, GA-TCD, BPD and FL.

Pearson product moment correlation coefficient "r" has shown a strong relationship of gestational age of transverse cerebellar diameter with the gestational age of bi-parietal diameter (r=0.976), gestational age of femur length (r=0.978), gestational age of last menstrual periods (LMP) (r=0.976), bi-parietal diameter (r=0.894), femur length (r=0.888) and transverse cerebellar diameter (0.892) as the p value is 0.000 which is much smaller than the level of significance (α=0.01). The results are highly significant (Table 4).

Table 4: Correlation

Variable	TCD Correlation	P-Value
LMP	0.976	0.000
FL	0.987	0.000
BPD	0.976	0.000

**. Correlation is significant at the 0.01 level

Table:4 shows Pearson product moment correlation coefficient r has shown a strong relationship of gestational age of transverse cerebellar diameter with the GA, TCD, BPD, and FL.

Fig. 2 shows that biparietal diameter and transveres cerebellar diameter shown in this ultrasound image 27 weeks of gestational age and transveres cerebellar diameterMeasurement 27.0mm

Fig. 2: 27 weeks of gestational age and transverse cerebellar diameter Measurement 27.0mm.

Biparietal diameter and Transverse cerebellar diameter shown in this ultrasound image (Fig. 2) 30 weeks of gestational age and Transverse cerebellar diameter, Measurement 31.9mm.

Fig. 3: 30 weeks of gestational age and Transveres cerebellar diameter Measurement 31.9mm

Table 5: Linear Regression Equation: association between TCD and gestational age

Parameters	Intercept		Slope		P value	R²	SE
	Estimate	SE	Estimate	SE			
GA-BPD	5.857	0.795	0.116	0.004	0.000	0.775	2.14610
GA-FL	5.185	0.788	0.119	0.003	0.000	0.787	2.08997
GA-TCD	5.311	0.761	0.119	0.003	0.000	0.797	2.04052
Biparietal diameter (mm)	2.666	0.541	0.370	0.007	0.000	0.903	1.40549
FL (mm)	8.961	0.515	0.373	0.008	0.000	0.865	1.66134

The Table: 5 shows the equations derived from the linear regression analysis considering individual variables separately. The most accurate was the biparietal diameter of the foetus with standard error of 1.40549 mm while the less accurate was gestational age of biparietal diameter with standard error of 2.14610 mm respectively.

Discussion

In our study, we found that TCD is the most reliable parameter for the determination of GA in 2nd and 3rd trimesters and it has strong association with biparietal diameter and femur length. Hertzberg and Middleton (2016) studied that biparietal diameter is a reliable parameter for estimation of GA in the early 2nd trimester upto 24 weeks and measurement of the femur length is more accurate in the 3rd trimester. Some researchers observed that abdominal circumference assess the fetal growth and wellbeing but it is not a reliable predictor of GA in 2nd and 3rd trimesters. In present study, we observed that measurements of some parameters (femoral and skeletal diaphysis) have some pitfalls. For example, acquiring technically correct images of the femoral diaphysis is difficult and requires great skill and expertise. Correct measurement of the diaphysis while excluding the epiphysis also poses a challenge. FL measurement is also compromised in cases of IUGR and skeletal dysplasias. So, in our study we concluded that TCD reliably predict gestational age but its reliability does not surpass that of the BPD. Previous studies have also found the TCD to be a reliable predictor of gestational age in the second and third trimesters of pregnancy (Smith and Malik, 2006; Malik *et al.*, 2006; Hertzberg and Middleton, 2016; Naseem *et al.*, 2014).

In present study, we compared the nomogram of TCD with previous established nomograms provided by Chavez, Goldstein and Altman through statistical analysis. We found that our measurements were most concordant with those of Altman (p = 0.8984) and had the least similarity with those of Chavez (p = 0.1289). (Goldstein: p = 0.2946). As it could obviously be seen that the diversion between our measurements and established measurements was the most in the third trimester.

Some differences seen in our nomogram values from that of established ones in the third trimester may be due to the size of sample. Our study sample was not large enough and therefore does not adequately represent our total population's TCD values. Moreover, racial and ethnic differences could also have a role in these differences. A study conducted in Nepal in 2007 by Joshi BR concluded that their TCD measurements had a similar relationship with GA across previously published nomograms before 28 weeks but significant differences occurred after 33 weeks and that the nomogram of Chavez significantly overestimated GA in the latter part of the third trimester (Goel *et al.*, 2010). In another study conducted in Pakistan in 2010, Khokhar (2012) compared the TCD values of 850 patients in the 2nd and 3rd trimesters of pregnancy with Chavez, Hill and Goldstein and concluded that there were no significant differences up to 28 weeks of gestation but values were significantly different in the latter part of the third trimester (Prasad and Likhita, 2014; Vinkestejin *et al.*, 2001).

Conclusion

The TCD is a reliable parameter for the determination of gestational age in the second and third trimesters of pregnancy as it has a strong association with BPD and FL. Our TCD measurements have a similar relationship with gestational age as previously published nomograms in the second trimester of pregnancy. It is a most valuable tool in cases where other established biometric indices are difficult to obtain.

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