Section: Obstetrics and Gynecology

Original Research Article

DETERMINATION OF THE ACCURACY OF TRANS-CEREBELLAR DIAMETER IN ESTIMATING GESTATIONAL AGE IN THE SECOND AND THIRD TRIMESTER OF PREGNANCY

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ABSTRACT

Background: Estimating gestational age accurately is highly important in taking clinical decisions in pregnant women, identifying high risk pregnancies and deciding the clinical outcomes of the pregnancies and avoiding certain newborn complications. In Indian setup, where majority of the pregnant women belonging to rural areas, due to lack of awareness or knowledge, tend to forget the exact date of their last menstrual periods which leads to inaccurate estimation of gestation age and further issues in taking decisions. That is why certain sonological parameters can help in estimating the gestation age of such women. Sonological parameter includes TCD, BPD, AC, FL which can be used accurately for gestational age estimation. TCD has been used very accurately for estimation compared to the other sonological parameters. Present study tries to show the importance of TCD measurement in estimation of gestational age.
Aims and objectives: Aim of the present study was to evaluate the accuracy of trans cerebellar diameter in singleton gestation in estimating gestational age in foetuses in second and third trimester. Objectives of the study was to determine the TCD and its correlation with GA obtained from the patients LMP and first trimester scan.
Materials and Methods: Total 304 participants were included in the study which was conducted at a tertiary care center based in urban area in Maharashtra. Participants were included after taking written informed consent and who fulfilled the eligibility criteria, mainly the participants belonging to second and third trimester based on the LMP. Data collection included their demographic details, parity and blood investigation. USG was done to estimate various sonological parameters such as TCD, BPD, AC, HC and FL. All the sonographies were done by single radiologist to avoid the inter assessor bias.
Results: In the study population of 304, most of the pregnant women were in the age group of 20-25 years (71.7%). 82.56% (n=251) participants were in their first pregnancy showing increasing awareness in the antenatal care services. There was a very strong positive correlation between Trans cerebellar diameter, Biparietal diameter, Head circumference, abdominal circumference, femur length and last menstrual period which were used to estimate the gestational period. Compared to other sonological parameters, TCD showed strongest correlation with respect to the gestational age. Linear regression also showed a strong predictive relationship between TCD measurement and gestational age. (Equation: GA = -5.34 + 1.07 (TCD)) with p value < 0.001 showing very high statistical significance.
Discussion: Present study findings could be corroborated with other similar studies suggesting that TCD as one of the sonological parameters could be accurately used to estimate the gestational age, linear regression analysis was

applied to derive the equation which showed strong predictive accuracy similar to other studies.

Conclusion: From the study it could be concluded that the Trans cerebellar diameter could be used to estimate the gestational age accurately with strong positive correlation which is statistically significant and with less variability.

Keywords: Trans cerebellar diameter, Gestational age, Biparietal diameter, Head circumference, Abdominal circumference, Femur length, correlation, linear regression analysis.

INTRODUCTION

Gestational age (GA) is usually assessed through maternal recollection of the last menstrual period (LMP) in combination with clinical evaluation. In Indian setup, many a times women do not remember their LMP or seek ante natal care (ANC) late in pregnancy making it difficult to estimate gestational age accurately. This can lead to complications such as differentiating between small for age babies and babies growing appropriately.[1-4]

Due to this limitation of clinical evaluation and unclear LMP, prenatal ultrasonography (USG) has emerged as a more dependable approach for assessing fetal growth. USG helps in identifying the fetus with growth restriction, offering a non-invasive, reliable and widely accessible tool for estimating fetal growth parameters and gestational age.[2]

Commonly used sonological parameters included biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL). Accurate interpretation of these parameters is again contingent upon knowing the precise GA. When GA is uncertain, differentiating appropriately grown fetuses from small for gestational age (SGA) fetuses becomes more complex.

One sonological parameter is trans cerebellar diameter (TCD) which is referred to as, widest transverse dimension in the fetal cerebellum, which can be visualized through USG as early as 10-11 weeks of gestation. From the second trimester onward, TCD has demonstrated a strong positive correlation with GA. Cerebellum located in the posterior cranial fossa benefits from relative protection against external pressures.[5,6]

Intra uterine growth restriction (IUGR) caused due to compromised uteroplacental insufficiency, can lead to compensatory redistribution of blood flow – prioritizing vital organs such as the brain, heart and adrenal glands during episodes of acute hypoxia. Due to this brain sparing effect, cerebellar growth and hence TCD remains preserved even in growth restricted fetuses. Therefore TCD can be used as a dependable sonographic measure for estimating GA, especially in those cases where LMP is not known or can not be calculated or first trimester scans are not available, fetal cranial morphology is atypical (such as in brachycephaly or dolicocephaly) or where IUGR is suspected.[6-8]

Keeping this in mind, present study aims to evaluate the usefulness of the TCD in estimating the GA during the second and third trimester.

Aims and objectives

Aim: To evaluate the accuracy of trans-cerebellar diameter in singleton gestation in estimating gestational age in foetuses in the second and third trimester.

Objectives

1. To determine foetal Trans cerebellar diameter and its correlation with gestational age obtained from patients LMP and first trimester scan.
2. To determine accuracy of Trans cerebellar diameter for calculation of gestational age.

MATERIALS AND METHODS

It is an observation study conducted in the department of Obstetrics and Gynecology in a tertiary care hospital in Karad, Maharashtra.

Study population included were all ANC women from the 14-40 weeks of GA after taking written consent for participation in the study.

Study design: Observational study

Sample size calculation

According to El-Ebeisy et al,[9] accuracies of TCD for gestational age was 98.7%. Using the sample size formulae:

n= (Zα/2) 2 * (PQ) / L2

n- Sample size

Zα/2 – Z value at 5% error (1.96)

P – Taken as 98.7% 97

Q- 1-P (1-0.987 = 0.13)

E = Precision (taken as 1.3%)

n = (1.96)2 * (0.987*0.0.13)

(0.013)2

n= 304

Inclusion Criteria

1. Live singleton pregnancy
2. Known LMP with regular cycles
3. No use of Oral contraceptive pills
4. GA between 14-40 weeks
5. No congenital anomalies

Exclusion Criteria

1. Multiple pregnancies
2. Irregular cycles
3. Use of Oral contraceptive pills
4. IUGR
5. Congenital malformations

Study was conducted after taking prior approval from the IEC. Participant, who fulfilled the inclusion criteria, were included in the study after taking a written informed consent.

Demographic details were collected of the participants along with age, LMP, GA and other important prior surgical or medical history.

General and abdominal examination was done. Transabdominal ultrasound was done to assess the fetal viability, BPD, FL, EFW and TCD from 14-40 weeks. All the USGs were done by single radiologist to avoid inter assessor bias.

USG technique: TCD was measured in mm using widest anteroposterior diameter of the cerebellum. The trans-thalamic view will be obtained first; then the probe is slightly rotated below the thalamic plane, towards the fetal neck. The posterior horns of the lateral ventricles disappeared from view and will be replaced by the normal dumbbell-shaped cerebellum. The intersection of the cross of the calipers will be positioned on the outer edge of each hemisphere to obtain an outer-to-outer measurement at 90 degrees to the midline. Single measurement was used for each pregnancy.

RESULTS

The participants included in the study belonged predominantly to the age group of 20-25 year (71.7%, n=218) and 26-30 years (17.1%, n=52) whereas age groups <20 years, 31-35 and 36-40 years were 8.9%, 1.6% and 0.7% respectively. The mean age of all the study participants was found to be 23.66 (Std dev= 2.7) years.

Of the total 304 participants 82.56% (n=251) were prima gravida and only 17.43% (n=53) were multigravida. There was a predominance of primigravida mothers in the study.

Table 1: Table of TCD as per GA

Gestational age (In weeks)	N (Sample size)	Mean	Std deviation	Percentiles		
				5th	50th	95th
18	7	21.78	0.04	21.72	21.77	
19	18	22.72	0.05	22.65	22.71	
20	21	23.65	0.04	23.58	23.64	23.72
21	6	24.58	0.06	24.51	24.56	
22	4	25.56	0.03	25.53	25.56	
23	13	26.43	0.05	26.37	26.44	
24	21	27.38	0.06	27.30	27.39	27.46
25	9	28.31	0.06	28.23	28.30	
26	5	29.28	0.04	29.23	29.28	
27	5	30.14	0.04	30.08	30.14	
28	20	31.12	0.07	31.01	31.12	31.21
29	20	32.04	0.06	31.94	32.03	32.14
30	11	33.00	0.07	32.87	33.02	
31	12	33.89	0.07	33.80	33.88	
32	17	34.84	0.07	34.73	34.86	
33	25	35.77	0.08	35.66	35.79	35.89
34	6	36.69	0.09	36.59	36.67	
35	10	37.64	0.08	37.52	37.66	
36	19	38.57	0.09	38.44	38.59	
37	6	39.50	0.07	39.41	39.50	
38	21	40.43	0.09	40.30	40.42	40.57
39	16	41.37	0.09	41.23	41.37	
40	12	42.33	0.09	42.16	42.34	

The table clearly indicates that as there advancement in the gestational age the TCD also shows positive correlation suggestive of TCD as an anatomical marker for gestational estimation.

Table 2: Correlation between LMP and other sonographic parameters

Pearson correlation: GA by LMP and other sonographic parameters		
Parameters	**r-value**	**p-value**
BPD	0.964	<0.01
HC	0.947	<0.01
AC	0.925	<0.01
FL	0.912	<0.01

Given correlation table between last menstrual period and other sonological parameters indicates that there is a strong positive correlation which is statistically significant. BPD showed highest correlation with LMP (r value = 0.964) followed by head circumference (r value = 0.947), abdominal circumference (r value = 0.925) and femur length (r = 0.912) at a statistically significant p value < 0.05. which suggest that the sonological parameters can be effectively used to estimate the gestational age with almost certain accuracy.

Table 3: Correlation between TCD with GA as measured by LMP and other sonological parameters

Pearson correlation: TCD		
Parameters	**r- value**	**p- value**
LMP	0.997	**<0.01**
BPD	0.949	**<0.01**
HC	0.939	**<0.01**
AC	0.921	**<0.01**
FL	0.910	**<0.01**

Above table also indicates that there is a strong correlation between TCD and other sonological parameters and GA calculated according to LMP. LMP showed the strongest correlation with TCD with r value = 0.997 at a statistically significant p value < 0.01 followed by BPD (r = 0.949), HC (0.939), AC (r = 0.921) and FL (r = 0.910); all showing statistically significant correlation with p value < 0.01.

Table 4: Linear regression analysis for prediction of GA by TCD

Linear Regression Analysis (Gestational Age)							
Variables	**Unstandardized Coefficient (B)**	**S.E.**	**Stand. Beta**	**t value**	**p- value**	**95% CI**	
						Lower	**Upper**
Constant (Length)	-5.348	0.023		-233.034	0	-5.393	-5.303
TCD	1.072	0.001	**1**	1545.53	0	1.071	1.073

Regression equation:
GA = -5.34 + 1.07 (TCD)
Regression analysis showed a predictive relationship between TCD measurement and GA. The derived equation (**GA = -5.34 + 1.07 (TCD)**) demonstrates a very high statistical significance ($p<0.001$) with an extremely high t-value (1545.53). The coefficient indicates a precise predictive capability of TCD, reinforcing its utility as a single parameter in reliably estimating fetal GA.

DISCUSSION

The current study was done to estimate the gestational age based on the trans cerebellar diameter measurement. As gestational age estimation can help in taking clinical decisions, timing of delivery and management strategies for high risk pregnancies. The participants included in the study were in the second and third trimesters only. (14-40 weeks).
Age distribution in the study showed majority of the women were in the age group of 20-25 years which corresponded with typical reproductive pattern observed in India. Which also correlated with results from other studies done previously. Other studies similar to the current one conducted by Dashottar et al and Mishra et al also showed similar age pattern with respect to the demographic details.[10,11] Also, in the study there was predominance of the primigravidae participants (82.6%), which suggested that there is rising knowledge and awareness about the importance of institutional health care services such as antenatal care among the first time mothers. This could be corroborated with the patterns found in the urban health care settings in India.
The main purpose of this study was to see if TCD could be used as a biometric marker to estimate the gestational age accurately. Research showed that there is a strong positive linear correlation between the TCD and advancing gestational age. Study also showed very less variation in the standard deviation and percentile variation suggesting minimal variability in cerebellar growth among foetuses of same gestational age. The results were statistically significant with p value < 0.01.
Correlation between TCD and GA was strongly supported by correlation analysis (r=0.997) indicating that TCD could be strongly used as USG marker to estimate the GA estimation. Similar results were also observed in other studies who reported very high correlation coefficients (r>0.95) when TCD was compared with GA derived from LMP and other USG parameters.[12,13]

Table 5: Comparative analysis of correlation (r values) between TCD and GA in different studies

Author (Year)	Correlation (r- value)
Gupta et al. 12	0.946
George et al. 13	0.995
Sersam et al. 14	0.955
Dashottar et al. 10	0.950
Mishra et al. 15	0.920
Kummari et al. 16	0.986
Present Study	0.997

Regression analysis done in the present study also validated the predictive capacity of TCD for estimating GA which yielded a statistically significant equation:
Gestational Age = -5.34 + 1.07 (TCD).

High t value (1545.53) and p value < 0.05 also strongly indicated the high specificity and predictive accuracy of TCD in estimating GA. The equation generated also shows similarity with other studies done at national and internation level, Joshi et al and Bekele et al, where regression equation were developed showing its accuracy and reliability across diverse population.[17,18]

Table 6: Comparative table of linear regression equation in different studies and present study

Author (Year)	Regression Equation
Joshi et al. 17	GA = 8.44 + 0.56 × TCD
Gupta et al. 12	GA = 9.87 + 0.47 × TCD
Present Study	GA = -5.34 + 1.07 × TCD

In comparison with traditional biometric parameters such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), TCD demonstrated superior correlation with gestational age. Although parameters such as BPD and HC have historically been used as primary measures for gestational age estimation, they are susceptible to variations in fetal head shape, such as dolichocephaly or brachycephaly, potentially leading to inaccuracies. In contrast, TCD remains unaffected by alterations in head shape or fetal growth restrictions, highlighting its unique advantage as an independent biometric parameter. This finding resonates with previous studies by Dashottar et al. and Megahed Bakr Marzouk et al., who similarly reported greater reliability of TCD compared to other biometric parameters, especially in pregnancies complicated by fetal growth abnormalities.[10,19]

The exceptional reliability of TCD observed in our study can be attributed to the anatomical and physiological characteristics of cerebellar development. Unlike other biometric parameters, cerebellar growth appears relatively protected from variations in fetal growth conditions due to the preferential redistribution of blood flow to central organs (brain-sparing effect). This physiological adaptation ensures consistent cerebellar growth, making TCD a reliable marker throughout gestation, even in compromised fetal conditions such as intrauterine growth restriction (IUGR).[83,96]

A key strength of this study is its robust methodological design, encompassing a prospective observational framework with meticulous sample size calculation and rigorous statistical analysis. Moreover, the use of standardized ultrasound equipment and detailed procedural guidelines ensured consistency and reproducibility of TCD measurements across the study population. Such methodological rigor bolsters the reliability and external validity of our findings, supporting wider clinical implementation.

However, the study is not without limitations. The exclusion of multiple pregnancies and cases with congenital anomalies limits generalizability to these groups. Further research, particularly multi-center studies with larger sample sizes and inclusion of complicated pregnancies, could enhance our understanding of TCD's applicability across diverse clinical scenarios.

CONCLUSION

Study demonstrates that fetal trans-cerebellar diameter (TCD) is an accurate, reliable, and superior biometric parameter for estimating gestational age in singleton pregnancies during the second and third trimesters. TCD exhibits minimal variability, high predictive accuracy, and remains unaffected by common fetal growth and head shape abnormalities that compromise other traditional biometric parameters. The strong linear correlation between TCD and gestational age and the robust regression equation derived from our analysis underscore TCD's potential as an indispensable clinical tool for accurate gestational dating. Incorporating TCD into routine prenatal ultrasound protocols could significantly improve clinical decision-making, particularly in settings with limited or unreliable menstrual history data. Continued research and standardized training in TCD measurement techniques are recommended to optimize the clinical utility and reliability of this valuable diagnostic tool.

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