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Can trans-cerebellar diameter supersede other fetal biometry in measuring gestational age? A prospective study

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Abstract

Background: Estimation of gestational age plays a pivotal role in day to day clinical practice for appropriate management of newborn. The trans-cerebellar diameter can predict gestational age in cases of variations of fetal head shape such as dolichocephaly and brachycephaly or even when fetus is in posterior position. Trans-cerebellar diameter (TCD) may be useful in gestational age estimation.

Aim and methodology: To determine the accuracy of trans-cerebellar diameter in the estimation of gestational age of fetus and comparing the conventional parameters like head circumference, biparietal diameter, abdominal circumference and femur length in the measurement of gestational age. This is a prospective, cross-sectional analytical study done in the Radiology Department in those patients who were referred to the department for a routine antenatal ultra-sonogram checkup.

Results: Comparison of trans-cerebellar diameter with gestational age derived from last menstrual period indicates that there is a linear relationship throughout the gestational ages. There is a strong correlation of trans-cerebellar diameter with other conventional parameters namely biparietal diameter, femur length and abdominal circumference of which Femur length correlates well with the trans-cerebellar diameter. Correlation of transcerebellar diameter with gestational age shows a R^2 of 0.995 (p value < 0.001).

Conclusion: Trans-cerebellar diameter is best in estimation of gestational age when compared to biparietal diameter, femur length and abdominal circumference. The regression formula derived from trans-cerebellar diameter measurement can be applied to determine the gestational age of fetus.

Keywords: Trans-cerebellar diameter, Ultrasonography, Gestational age

Background

Estimation of gestational age plays a pivotal role in day to day clinical practice for appropriate neonatal management [1]. The various ways for estimation of the age of gestation and predicting the date of expected delivery are menstrual history, clinical examination and sonography [2]. Ultrasonography plays an important role in

differentiation of normal fetus from growth restriction [3]. Ultrasound assessment of fetal biometry has become the important and widely available method of reassuring fetal growth and estimation of the age of gestation [4].

The cerebellum is the important part of the hind brain in the posterior cranial fossa [5]. From the second trimester, it starts growing quickly. The Trans-cerebellar diameter can predict gestational age, even in cases of difficult fetal head position or abnormal fetal head shape like dolichocephaly and brachycephaly [6]. Estimation of Biparietal diameter (BPD) and Head circumference (HC)

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becomes unreliable in the third trimester due to excessive molding of fetal head. In those circumstances, TCD has become a reliable marker for the estimation of gestational age [1, 2].

Aim

To determine the accuracy of Trans-cerebellar diameter in the estimation of gestational age of fetus and comparing the conventional parameters like head circumference, abdominal circumference, biparietal diameter and femur length in measurement of gestational age.

Methods

The present study was cleared by the institutional ethics committee (IEC number 92/2017). This is a prospective, cross-sectional analytical study done in the Radiology Department in those patients who were referred to the department for a routine antenatal ultrasoundogram checkup. USG was done by a single radiologist to eliminate the inter observer errors.

Inclusion criteria

Normal singleton pregnancies of 16–36 weeks who clearly knows the first day of the last menstrual period (LMP) and those with complete PCPNDT documentation.

Exclusion criteria

Women who are not sure of LMP or those with congenital malformations or those clinically or radiologically suspected to have IUGR.

Sample size

The sample size was calculated as 130, using nMaster software version 2.0 taking into consideration of the sensitivity of Trans-cerebellar Diameter for the estimation of gestational age as 91.7% from a previous study with 5% absolute precision, 95% confidence interval and 10% non-response rate [7]. Study duration: Total duration of eighteen months from November 2017 to April 2019.

Using simple random sampling, 2 patients out of 10 per day were selected for the study. The machine used in this process was GE Voluson S6 with 3.5 MHz Convex probe. 130 patients who fulfilled the inclusion criteria were included in the study. Biparietal diameter (BPD), Abdominal circumference (AC), Head circumference (HC), Femur length (FL) were measured using standard technique.

Trans-cerebellar diameter (TCD) was measured by placing the transducer in the perfect axial plane to the head and focusing the thalamus and then the probe is mildly posteriorly angulated to see the bilateral cerebellar hemispheres. The view of the cerebellum, cistern

magna and cavum septum pellucidum is obtained by this maneuver. Cerebellum gives the appearance of two lobules which are on both sides of the midline in posterior cranial fossa. The widest diameter of the cerebellum is taken (Fig. 1) as the trans-cerebellar diameter (TCD).

After measurement of the above parameters, the age of the fetal gestation were calculated by the ultrasound machine based on Hadlock tables. The measured parameters such as BPD, AC, HC, FL and TCD were measured in millimeters and duration of pregnancy in weeks was recorded to the nearest menstrual week (Fig. 2a–c).

Statistical analysis

Data was entered in the software Epi info version 7.2.1.0 and analyzed using software SPSS version 24.0. Description of categorical variables was mentioned in percentage. Data related to a continuous variable like age were described in terms of mean and standard deviation. Each parameter i.e. BPD, AC, HC, FL and TCD were correlated with GA using regression analysis. All statistical tests were two-tailed and statistical significance was set at p value < 0.05.

Results

Of 130 patients included in the study, the age range was from 18 to 31 years with mean of 23.47 years and standard deviation of 2.89. The 96 patients were gravida 1, twenty-eight were gravida 2 and six were gravida 3. Similarly with respect to para; twenty-four participants were para 2 and six participants were para 3. The distribution of gestational age in weeks is given in the Table 1, of which majority of them are in 21–28 weeks. Each parameter i.e. BPD, HC, AC, FL and TCD were correlated with GA using regression analysis as given in

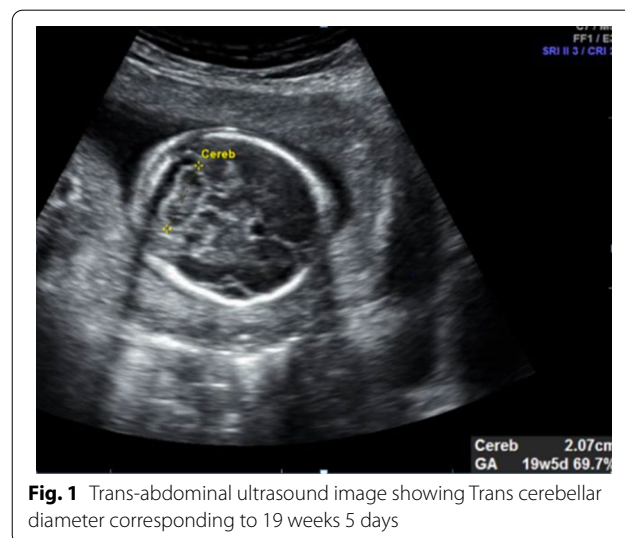


Fig. 1 Trans-abdominal ultrasound image showing Trans cerebellar diameter corresponding to 19 weeks 5 days

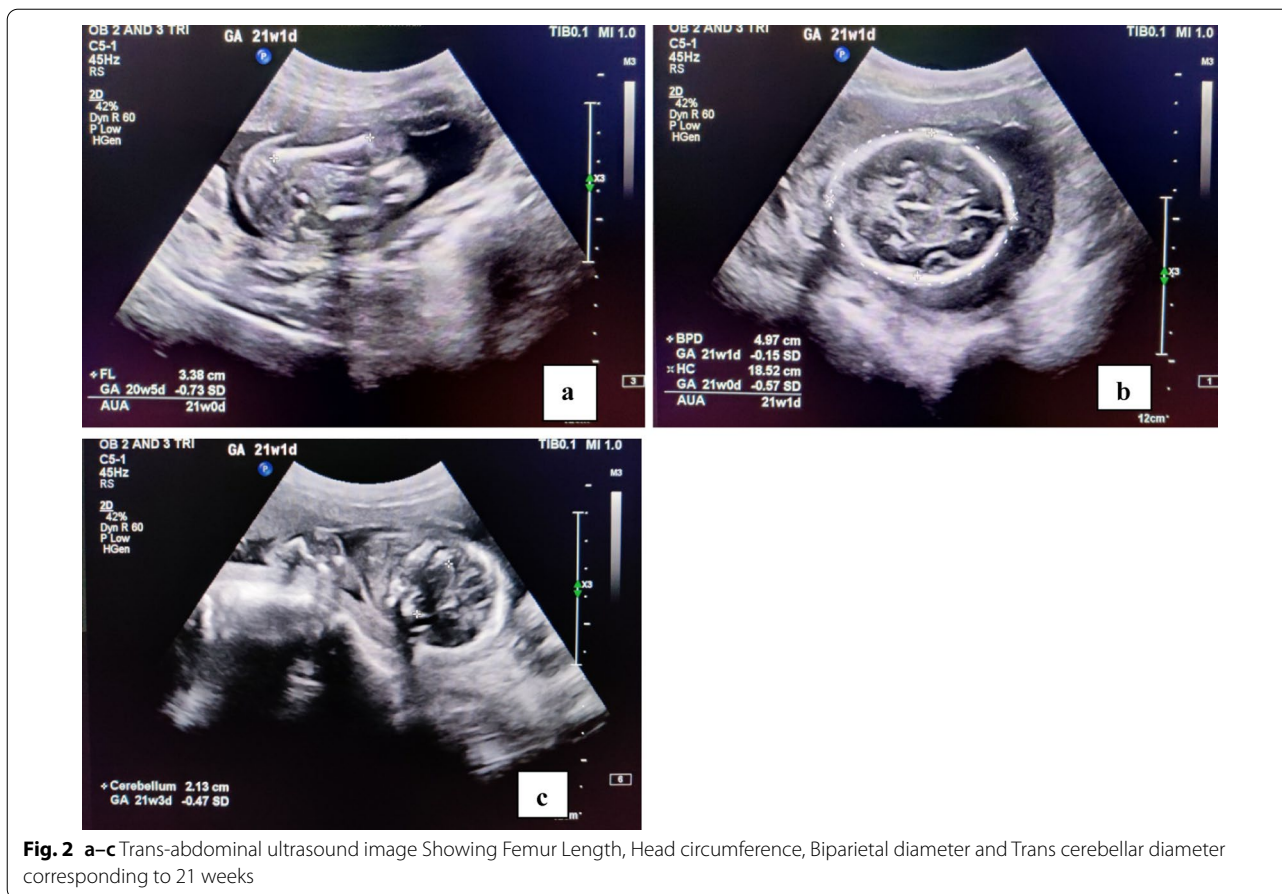


Fig. 2 a–c Trans-abdominal ultrasound image Showing Femur Length, Head circumference, Biparietal diameter and Trans cerebellar diameter corresponding to 21 weeks

Table 1 Distribution of gestational age in weeks, in which 37.7% of the patient belong to the gestational age of 21–28 weeks

S. no	Gestational age	Frequency	Percentage
1	16–20 w 6 d	31	23.8
2	21 w–28 w 6 d	49	37.7
3	29 w–32 w 6 d	28	21.5
4	33 w–36 w 6 d	22	16.9
	Total	130	100.0

Table 2 Correlation of BPD, HC, AC, FL and TCD with GA using regression analysis

S. no	Parameters compared	R ²	p value
1	GA vs BPD	0.992	<0.001
2	GA vs HC	0.992	<0.001
3	GA vs AC	0.991	<0.001
4	GA vs FL	0.991	<0.001
5	GA vs TCD	0.995	<0.001

Table 2, of which TCD shows better regression values. BPD, HC, AC and FL was correlated with TCD using regression analysis as given in Table 3, of which FL shows good correlation with TCD.

Multiple linear regression equation to predict gestational age based upon various parameters are $GA = 0.134 + 0.997 \times BPD$ in cm, $GA = 0.001 + 1.00 \times HC$ in cm, $GA = -0.385 + 1.02 \times AC$ in cm, $GA = 0.441 + 0.985 \times FL$ in cm and $GA = 0.414 + 0.986 \times TCD$ in cm.

The scatter diagram showing correlation between the gestational age and BPD, AC, HC, and FL is given in Table 4. The scatter diagrams showing correlation between the gestational age and TCD is given in Table 5.

Discussion

Precise gestational age measurement is of more important and key elements for the management of pregnancies especially for those fetuses with disturbances of normal growth. In the assorted clinical criteria, the Last

Table 3 Correlation of TCD with BPD, HC, AC and FL

S. no	Parameters compared	R ²	p value
1	TCD vs BPD	0.992	<0.001
2	TCD vs HC	0.991	<0.001
3	TCD vs AC	0.993	<0.001
4	TCD vs FL	0.996	<0.001

menstrual period (LMP) anteceded by normal menstrual cycle is thought to correlate well with the gestational age of the fetus, but it is not corroborative when the pregnant woman is not sure about her LMP. Ultrasonography is habitually used for the dating of pregnancy since many decades. The biometric parameters utilized

for gestational age estimation are BPD, HC, FL, and AC [8]. Nevertheless, each of these parameters has its own advantages and restrictions. Trans-cerebellar Diameter is a distinct growth parameter for estimating the gestational age of fetus. It was found that there is a good correlation between Trans-cerebellar diameter and other parameters. Further equations were derived to seek out the relation between each measured parameter and gestational age.

Patil et al. [9] had described that there is evidence of strong direct relationship between the age of the gestation and trans-cerebellar Diameter and it can be new parameter estimating the gestational age. Ravinder Nath et al. [10] shows similar results like our study, which shows good correlation of transverse cerebellar

Table 4 Scatter diagram showing correlation between GA and BPD, HC, AC and FL

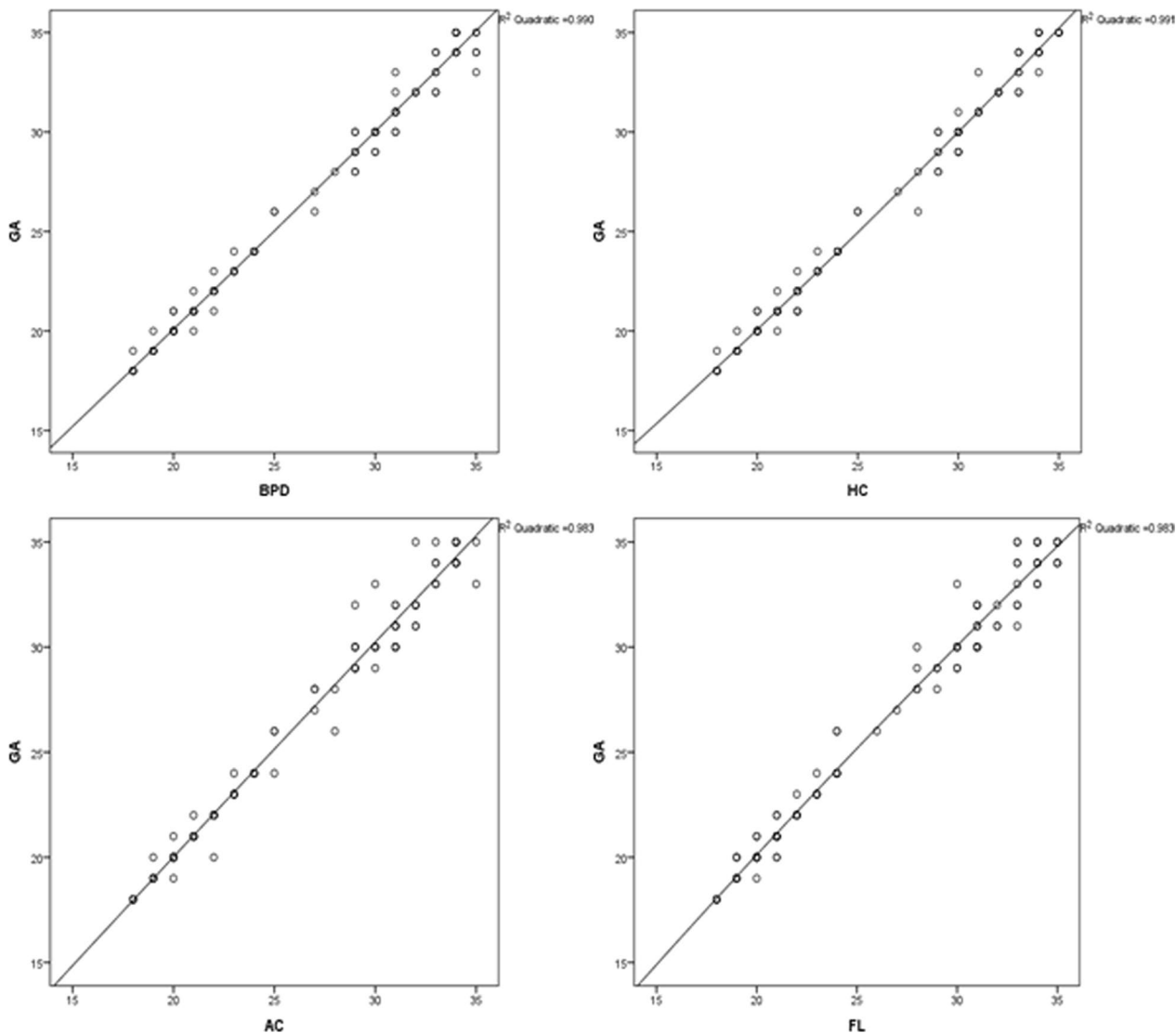
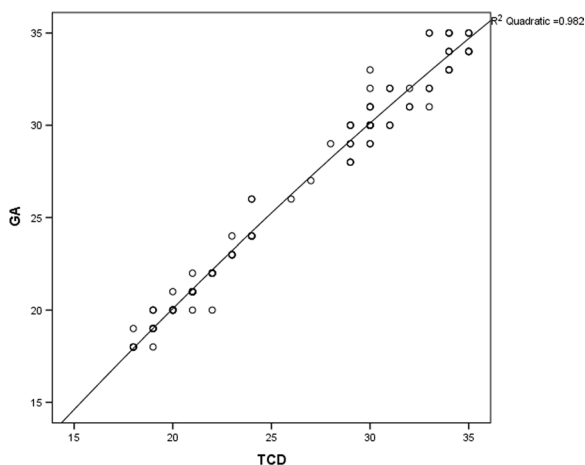


Table 5 Scatter diagram showing correlation between GA and TCD**Table 6** Accuracy of TCD with GA-A comparison

Study	Pearson correlation	P value
Reece et al. [9]	0.948	0.0001
Chavez et al. [13]	0.950	0.001
This study	0.995	< 0.001

diameter (TCD) with other parameters and also states the TCD play vital role in GA estimation in case of excessive skull molding or other abnormal skull shape.

Reece et al. [11] in a prospective ultrasonography study conducted on 371 pregnant women, with gestational ages between 13 and 40 weeks found strong relationships between the trans-cerebellar diameter and the gestational age ($R^2 = 0.948$; $P = 0.001$), the biparietal diameter ($R^2 = 0.956$; $P = 0.0001$), and the head circumference ($R^2 = 0.969$; $P = 0.0001$). Throughout the pregnancy, normative cerebellar measurements will be very helpful in calculating the age of the gestational which is independent of fetal head shape.

Hanna et al. [12] concluded that TCD is a precise fetal growth parameter in estimation of gestational age as its values are in good correlation with that of GA by LMP. They added that TCD is a better predictor of the gestational age when compared to other parameters particularly between 14 and 22 weeks.

Reddy et al. [13] concluded that TCD is a perfect predictor of gestational age in the third and second trimester. Among all the other fetal biometry parameters, TCD is least affected in case of IUGR, hence it can be used as a single parameter for the estimation of gestational age.

A comparison of the accuracy of TCD with GA with other studies is shown in Table 6 [9, 13].

Table 7 Correlation between mean predicted GA by TCD with the Gestational age by LMP in both second and third trimester

Gestational age	Present study	Chavez et al. [13]
16–20 weeks	No change	6 days
21–38 weeks	1–2 days	3 days
29–32 weeks	No change	2 days
> 32 weeks	1–2 days	3 days

Our study shows a good correlation between mean predicted GA by TCD with the Gestational age by LMP in both second and third trimester with a difference of 1–2 days as described in Table 7, which was comparable with the study done by Chavez et al. [14].

Conclusion

A comparison of trans-cerebellar gestational age with gestational age derived from the last menstrual period indicates that there is a linear relationship throughout the gestational ages. There is a good connections of Trans-cerebellar diameter with other conventional parameters namely biparietal diameter, femur length and abdominal circumference. Trans-cerebellar diameter is best in the estimation of gestational age when compared to biparietal diameter, femur length and abdominal circumference. The regression formula derived from Trans-cerebellar diameter measurement maybe applied to determine the gestational age of the fetus.

Limitations

Limited sample size and selected sample profile in this geographical area is the impediment of the study. The study was restricted to second and third trimester patients because of difficulty in the evaluation of cerebellum in the first trimester. The inter-observer variation is eliminated because the ultrasonography was done by single radiologist.

Abbreviations

BPD: Bi-parietal diameter; HC: Head circumference; AC: Abdominal circumference; FL: Femur length; TCD: Trans-cerebellar diameter; USG: Ultra sonogram; PCPNDT: Pre-conception and pre-natal diagnostic techniques; IUGR: Intrauterine growth retardation; LMP: Last menstrual period.

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None.

Authors' contributions

Dr RG had involved in collection of data and writing the article. Dr UA had involved in planning the protocol and providing support in executing the study. Dr MRKH had involved in editing the manuscript. Dr VA had involved in writing the manuscript, Dr AM had involved in the grammatical support to the manuscript. Dr EP has involved in providing the technical support to the study and Dr KN had involved in the overall smooth completion of the study. All authors read and approved the final manuscript.

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Availability of data and materials

Available.

Declarations**Ethical approval and Consent to participate**

This study was approved by the Sri Manakula Vinayagar Medical College and Hospital ethics committee Hospital with approval number [SMVMCH-EC/DO/AL/1279/2017]. The patient provided written consent.

Consent for publication

Written consent had been obtained from the participant for publication.

Competing interests

The authors declare that they have no competing interests.

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