

Transcerebellar Diameter: an effective tool in estimating gestational age

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ABSTRACT

Background: Estimating correct gestational age is the first and foremost goal of obstetrician and gynaecologist and cannot be underestimated. Commonly the parameters used are BPD, head circumference (HC), Femur length (FL), Abdominal circumference (AC). Recently transverse cerebellar diameter is a new diagnostic tool to measure the gestational age.

Aim: To determine the accuracy of transverse cerebellar diameters in estimating gestational age, taking LMP as the gold standard.

Study design: Descriptive Cross-Sectional Study.

Setting: This study was conducted at Department of Obstetrics & Gynaecology, JPMC, Karachi, Pakistan

Duration: Six months after the approval of synopsis from January 29 2021 to 28 July 2021.

Methods: Ultrasonographic measurement of Transverse Cerebellar Diameter(TCD) was taken. Routine measurements of crown-rump length or bi-parietal diameter were also done. Accuracy was considered if the difference between TCD and LMP was ≤ 2 mm. Correlation of age on LMP with TCD was tested using Kendall's tau-b test and its scatter plot as generated.

All the collected data was entered into a proforma attached at the end and used electronically for research purposes.

Results: A total of 114 patients were inducted after informed consent. Their mean age was 28.18 ± 27.24 years. Maternal age was 28.18 ± 27.24 years, maternal weight was 60.59 ± 9.64 kg and BMI was 23.58 ± 3.63 kg/m². Median (IQR) of gravida was 2.0 (2). Mean of gestational age on LMP was 33.84 ± 5.29 and was significantly more as measured by TCD was 31.51 ± 5.05 ($p < .001$). Age on LPM and TCD showed linear correlation. Accuracy of TCD was documented in 108 (94.7%).

Conclusion: It is to be concluded that transverse cerebellar diameter was found to be equally good and relatively comparable with LMP in predicting gestational age.

Keywords: Gestational Age; Intrauterine Growth Restriction; Last Menstrual Period; Miscarriage; Stillbirth

INTRODUCTION

Estimation of precise gestational age is an imperative obstetrical calculation in pregnancy; as pregnancy management holistically depends on it¹. During first half of pregnancy, nearly all fetuses grow at the same percentage, the deviation in foetal weight increases with advancing gestation depending on intrauterine atmosphere and genes². Ancillary biometric and non-biometric measurements have shown to be beneficial in estimating precise gestational age³.

For assessment of gestational age femur length (FL), abdominal circumference (AC), bi-parietal diameter (BPD) & head circumference (HC) are commonly used biometric parameters. But these parameters are also not reliable in all pregnancies like in diseases altering the shape of skull or in oligohydramnios, in which deformity of the foetal head and abdomen causes inaccurate bi-parietal diameter and abdominal circumference. Even in severe growth restriction, the TCD is not altered significantly give valid measurements leading to accurate estimates of age⁵. So transverse cerebellar diameter (TCD), is established as a substitute indicator of foetal brain growth development and for assessment of exact gestational age at any gestation.

Looking at the anatomy of posterior cranial fossa, will help us understand that, why Trans-cerebellar diameter cerebellum is an excellent tool to calculate the gestational age. Cerebellum is situated in the posterior cranial fossa. It lies posterior to pons and the medulla, separated by the fourth ventricle. Cerebellum is split apart from the cerebrum by duramater called the tentorium cerebelli. The cerebellum consists of central vermis and two lateral hemispheres. It is narrowed in its median zone and flattened; its transverse diameter is largest. In the embryo cerebellum appears at the end of the fifth week as a swelling overriding the fourth ventricle. Cerebellum is well protected by the dense petrous ridges and the occipital bone. The foetal cerebellum can be visualised with ultrasound without any effort therefore imaging by ultrasonography of the posterior cranial fossa may hold great value to become an integral part of routine foetal sonogram.

The TCD correlates with the gestational age weeks up to 22-24 weeks. After that, TCD has shown to be able to predict gestational age

with a 1 to 2 weeks difference at 28 to 30 weeks and 4 to 6 weeks difference at >32 weeks. TCD strongly correlates with dating across gestation and complements other biometric measurements. TCD has proven to be a better tool when the transducer is in direct contact with the foetal head in occipito-posterior position or in cases of head shape deformities⁷.

However, despite the strides made in generating supportive evidence, TCD is not used to its fullest potential and seldom recognized as a viable tool to yield better estimates of gestational age. Pakistan has a very low literacy rate, women don't seem to remember their last menstrual period and therefore rely on ultrasonography for estimating their gestational age⁸. Nonetheless, evidence is needed to support the use of this modality and this research may provide the much-needed evidence. The expected sensitivity, specificity, positive predictive value and negative predictive value as reported in literature stands at 73.26%, 80.25%, 79.75%, and 73.86%. Previous studies reveal that accuracy of TCD was 92%¹³ and 14(98.7%)^{7,10}.

The aim of our study is to determine the accuracy of transverse cerebral diameter in predicting gestational age in our population. Gestational age is of prime importance to obstetricians & gynaecologists and thus many methods are employed to obtain an accurate measure. Each method has its own limitations; however, it is believed that TCD holds potential for producing reliable results even under a range of conditions, whereas other parameter prove ineffective. As per author's knowledge no such study has been conducted in Pakistan. Although international studies shows that TCD is more reliable in predicting gestational age beside this in routine practice TCD is not used for predicting gestational age in our health settings, international studies available on this subject but on thorough literature search we couldn't find any study from Pakistan. This will help to reliably assess gestational age.

Operational definitions

Gestational age: Time period (weeks), from the first day of the woman's last menstrual cycle till time of determination.

Foetal transverse cerebellar diameter: Maximal diameter (mm) between the cerebellar hemispheres on an axial scan.

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TCD Gestational Age:

Upto 19mm	16-20 weeks
20-22mm	>20-24 weeks
23-29mm	>24-28 weeks
30-40mm	>28-32 weeks
41-45mm	>32-36 weeks
46-49mm	>36-40 weeks

Accuracy of TCD: Gestational age measured by transverse cerebral diameter was considered accurate if the difference between TCD and LMP was ≤ 2 mm.

METHODOLOGY

This descriptive Cross-Sectional Study was conducted in the Department of Obstetrics & Gynaecology, JPMC, Karachi during six months after the approval of synopsis from Institutional Ethical Review Board from January 29, 2021 to July 28, 2021. Sample size was calculated using WHO sample size calculator. Accuracy of TCD in previous study was 92%¹¹, margin of error was kept at 5% and confidence interval at 95%. Using these parameters, sample size was calculated as 114. Sampling Technique used was non-Probability, Consecutive Sampling.

Inclusion Criteria: Consenting patients (aged 19 to 39) years) with a normal singleton pregnancy and a reliable recall of last menstrual period dates were included into the study. Gestational age >16 weeks.

Exclusion Criteria: Patients with foetal anomalies malformations or patients with chronic maternal diseases such as arterial hypertension, diabetes mellitus, and thyroid disease were excluded from the study sample.

Data collection: Study was started after taking approval from the institutional ethical review committee. Women presenting to the obstetrics and gynaecology department of JPMC for antenatal visits were enrolled as per inclusion criteria. Informed consent was taken from each woman before enrolment in the study. Data was collected using structured interview-based questionnaires containing inquiries about the biodata, basic sociodemographic details and inferences obtained from obstetric examination. Ultrasonographic examinations were performed using 3-5 MHz transducers. The transverse cerebellar, diameter measurement was taken in axial plane at level of lateral ventricles maintaining 30° angle between the transducer and the foetal head plane^{6,10}. All evaluations were done by a senior radiologist with at least three years of experience in ultrasonography in obstetrics. The routine measurements (best suited for respective gestational age) of crown-rump length or bi-parietal diameter were also conducted. All the information such as age, maternal weight (measured through digital weighing scale in light cloths), height (measured through stadiometer in without heel shoes), BMI (kg/m²), gravida, gestational age on LMP and gestational age on TCD were recorded on a predefined proforma. Accuracy was labelled as per operational definition.

Data analysis: Data was analysed using SPSS version 21.0. Qualitative data such as place of residence, history of previous IUGR, history of previous still birth, history of previous miscarriage and accuracy were expressed as number and percentage. Quantitative data such as age, maternal weight, height, BMI, parity, gravida, gestational age on LMP and TCD were expressed as Mean \pm SD for normally distributed data and Median (Mdn) IQR for non-normally distributed data. Normality of distribution was checked using Kolmogorov-Smirnov (KS) Test. Bi-variate linear correlation was tested between gestational age by LMP & TCD using Kendall's tau-b test as both were non-normally distributed. Scatter plot of both variables was also generated. Significance level was set at ≤ 0.05 .

RESULTS

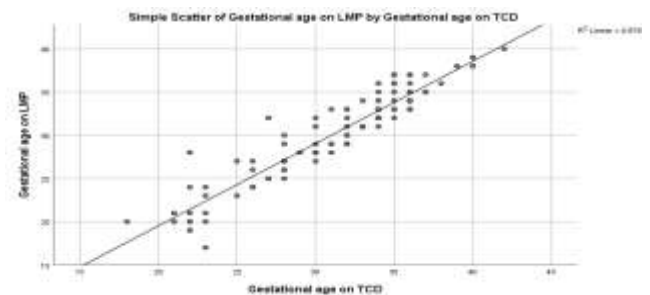
In this study 114 patients were included to assess the accuracy of transverse cerebellar diameters in predicting gestational age using LMP as the gold standard. Mean \pm SD of maternal age was 28.18 \pm 27.24, maternal weight was 60.59 \pm 9.64 kg, height was 162.13 \pm 4.19 cm and BMI was 23.58 \pm 3.63 kg/m². Median (IQR) of gravida was 2.0 (2). Mean of gestational age on LMP was 33.84 \pm 5.29 on TCD was 31.51 \pm 5.05. Details of maternal demographics and pregnancy parameters are given in Table 1. TCD assessment of age was significantly lower as compared to assessment on LMP by paired

sample t-test $t(113) = -6.125, p < .001$. TCD was found to be accurate in 108(94.7%) of patients. Values of both (LMP & TCD) showed significant linear correlation using Kendall's tau-b test $r(112) = .813, p < .001$. Scatter plot of correlation is given in Figure 1.

Table 1: Maternal demographics and pregnancy parameters

Parameter	Value	%age
Maternal Age (years)	28.18 \pm 27.24	Mean \pm SD ^[1]
Maternal Weight (kg)	60.59 \pm 9.64	Mean \pm SD
Maternal Height (cm)	162.13 \pm 4.19	Mean \pm SD
Maternal BMI (kg/m ²)	23.58 \pm 3.63	Mean \pm SD
Gravida	2.0 (2)	Mdn ^[2] (IQR) ^[3]
IUGR	0 (0%)	n ^[4] (%)
Still Birth	110 (96.5%)	n (%)
Previous Miscarriage	106 (93.0%)	n (%)
GA on LMP (weeks)	33.84 \pm 5.29	Mean \pm SD
GA on TCD	31.51 \pm 5.05	Mean \pm SD
Accuracy of TCD	108 (94.7%)	n (%)

Figure 1: Scatter Plot of Gestational Age on last menstrual period by Trans cerebellum diameter

**DISCUSSION**

In pregnancy, it is crucial to calculate the gestational age of a foetus by ultrasonography. It assists in accurate pregnancy dating, appraisal of foetal growth, and management accordingly. Mean Sac Diameter (MSD), Crown Rump Length (CRL), Bi-Parietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and Femoral Length (FL) are the most frequently employed biometric parameters for estimation of foetal gestational age. Additional parameter, trans-cerebellar diameter TCD has proven to be precise for foetal gestational age approximation which is vital in obstetric management. Multiple tools are used for the surveillance of foetal growth and gestational age including USG throughout the antenatal period. USG parameters are especially beneficial in gestational age assessment, where accurate LMP is not known or early pregnancy scan is not available.

The mean age found in our study was 28.18 \pm 27.24 years. Ali OE, et al noted age as 31.20 \pm 5.77 years¹². 26.7 \pm 7.7 mean age was noted in the findings of Júnior EA¹³. Another study reported as 30.4 years¹⁴. The mean gestational age on LMP was 33.84 \pm 5.29 weeks and mean gestational age on TCD was 31.51 \pm 5.05 weeks. Ali OE, et al further noted the gestational age on LMP as 33.97 \pm 1.52 and on TCD as 33.41 \pm 1.32 weeks¹². Verburg BO, et al noted as 40 \pm 1¹⁴ whereas Nagesh R et al found gestational age as 27.64 \pm 7.3 weeks¹⁵.

In our study, history of previous IUGR was not found in 114(100%) patients, previous still birth was found in 110 (96.5%) and whereas previous miscarriage was found in 106(93%) patients. In present study, accuracy was found in 108 (94.7%) patients which is very close to Ali OE et al 490 (98%) patients¹².

Patients with unknown expected date of delivery (EDD) have worse foetal or neonatal outcomes¹. If gestational age is miscalculated, it will lead to either pre-maturity or post maturity in the new born; resulting in overall enhanced perinatal and infant morbidity or mortality⁶. Thus it can be concluded that authentic evidence on gestational age is imperative for appraisal of foetal

size and foetal growth. If foetal growth disorders are recognized timely, it will essentially reduce foetal morbidity and mortality^{16,17}. Moreover, exact gestational age is likewise significant to circumvent redundant obstetric interventions during the pregnancy and delivery¹⁸. Gestational age is calculated from the first day of the last menstrual period (LMP) according to Naegele's rule¹⁹. Nevertheless, in nearly 40% of pregnancies the LMP is either not recognized or is not dependable. It is well-known that embryos nearly have the same growth rate initially in pregnancy²⁰. Therefore, USG gives the more precise data on gestational age estimation and is considered as the gold standard²¹. Gestational age is calculated by scan with crown-rump length (CRL) or biparietal diameter (BPD)²². Disagreement still exists about the measurement of choice and the optimal gestational age for estimation²³.

Literature searches show various methods to attain the reference charts for foetal size. Nevertheless, with sub-standard design, due to utilising either hospital-based population or having small sample size. Moreover, variation occurs in reference charts due to population or the technique of pregnancy dating²⁴. Exact data of gestational age is a prime requisite for an obstetrician to plan proper antenatal care of a patient, carrying out antenatal tests, making antenatal diagnosis or for provision of suitable therapy or intervention. Every effort should be made to avoid iatrogenic prematurity which is associated with increased perinatal morbidity and mortality.

In Pakistan, a large number of women do not report for antenatal examinations and report for their first antenatal examination in third trimester at some times near term.³ Management in conditions like foetal growth restriction, growth acceleration or pre-eclampsia etc becomes challenging⁸. TCD is established as an authentic predictor for gestational age assessment in 3rd trimester^{1,10}. As size of cerebellum is not significantly affected by foetal growth deviations, thus TCD is a reliable measurement¹⁵. Prediction of gestational age by TCD has accuracy of 0-2 days at 22-28 weeks, and is within 05 days 29-36 weeks.

CONCLUSION

It is concluded that transverse cerebellar diameter was found to be equally good and relatively comparable with LMP in predicting gestational age. More clinical trials are necessary to evaluate the accuracy of TCD with a larger sample size in multiple study centres in Pakistan to validate the findings of the present study.

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Authors' contribution: **VF:** Collected Data & entered in SPSS. Accountable for data accuracy or integrity, **MR:** Conception, design, acquisition of data, analysis and interpretation of data, **EM:** Drafting & critical revision of manuscript, **BFZ:** Did statistical analysis and manuscript draft writing, **Sara Nazeer:** Did critical review of the article, **Saba Khan:** Final proofreading

All authors approve the final version of the manuscript.

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