Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i4.7077

TRANSVERSE CEREBELLAR DIAMETER AS A PRECISE INDICATOR OF GESTATIONAL AGE

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ABSTRACT

Background: Accurately estimating gestational age throughout pregnancy is essential for monitoring fetal growth.To determine gestational age, a variety of techniques and factors have been used, such as ultrasound measurements, clinical examinations, and the previous menstrual cycle. Among these, transverse cerebellar diameter has become a useful indicator for using ultrasonography to determine the foetal gestational age.

Objectives: To explore the utility of TCD measurements in estimating gestational age.

Methodology: The present study was conducted at Qazi Hussain Hospital, Nowshera, in collaboration with the Department of Anatomy at Nowshera Medical College, during the period of February 2023 to August 2023. The study included a cohort of 50 pregnant women who sought antenatal care and underwent routine ultrasound examinations at Qazi Hussain Hospital, Nowshera, during the specified timeframe. The inclusion criteria encompassed pregnant women with gestational ages ranging from 14 to 40 weeks. The participants were categorized into three distinct groups based on their gestational ages: Group A: Pregnant women with gestational ages between 14 to 20 weeks.Group B: Pregnant women with gestational ages between 21 to 30 weeks. Group C: Pregnant women with gestational ages between 31 to 40 weeks.

Results: The TCD mean values for each group were different: Group A had a mean TCD of 17.32 mm, a standard deviation of 2.1 mm, and a range of 13.0 to 21.4 mm (table 1). Group B had a mean TCD of 26.63 mm, a standard deviation of 1.8 mm, and a range of 18.4–35.0 mm. Group C had the greatest mean TCD at 40.73 mm, a standard deviation of 2.3 mm, and a range of 36.0 to 48.4 mm. Importantly, the p-values show the statistical significance of the differences between Groups A, B, and C, highlighting the link between gestational age and TCD.

Conclusion: The finding indicates TCD's potential as a reliable marker for gestational age. TCD measurement's clinical significance lies in its contribution to accurate prenatal care, fetal development assessment, and monitoring pregnancy progression.

Keywords: ultrasonography, fetal neuroimaging, gestational age assessment, cerebellar development, obstetric ultrasound, transverse cerebellar diameter (TCD), fetal development assessment, prenatal care

Introduction

Determining gestational age accurately during pregnancy is crucial for obstetric care and the assessment of fetal development.[1,2] Various methods and parameters have been employed to estimate gestational age, including last menstrual period, clinical examination, and ultrasound measurements. Among these, TCD has emerged as a valuable marker for measuring fetal gestational age through ultrasonography.[3,4]

The cerebellum, a region of the brain responsible for motor control and coordination, undergoes significant developmental changes throughout pregnancy.[5] These developmental changes in the fetal cerebellum can be visualized and measured using ultrasound technology, specifically by assessing the TCD. By tracking the growth and maturation of the cerebellum, healthcare providers can estimate gestational age with a high degree of precision.[6]

The importance of accurate gestational age estimation cannot be overstated, as it influences clinical decisions related to prenatal care, labor management, and postnatal care.[7] Accurate dating of gestational age allows healthcare providers to identify potential complications, monitor fetal growth, and tailor interventions to ensure the best possible outcomes for both the mother and the baby.[8,9]

Rationale: In this study, we aim to explore the utility and reliability of TCD as a marker for estimating gestational age. We will investigate the developmental changes in the fetal cerebellum throughout pregnancy and evaluate the accuracy of TCD measurements in predicting gestational age. By enhancing our understanding of this parameter, we hope to contribute to the refinement of gestational age assessment methods, ultimately improving prenatal care and maternal-fetal health outcomes.

Methodology

The present study was conducted at Qazi Hussain Hospital, Nowshera, in collaboration with the Department of Anatomy at Nowshera Medical College, during the period of February 2023 to August 2023.

The study included a cohort of 50 pregnant women who sought antenatal care and underwent routine ultrasound examinations at Qazi Hussain Hospital, Nowshera, during the specified timeframe. The inclusion criteria encompassed pregnant women with gestational ages ranging from 14 to 40 weeks.

The participants were categorized into three distinct groups based on their gestational ages:

Group A: Pregnant women with gestational ages between 14 to 20 weeks.

Group B: Pregnant women with gestational ages between 21 to 30 weeks.

Group C: Pregnant women with gestational ages between 31 to 40 weeks.

We only included pregnant women without any other health problems in our study. We asked pregnant women at Qazi Hussain Hospital to join our study, and they agreed after we explained everything to them. Trained staff at the hospital used ultrasound to measure the baby's cerebellum in the brain.

We systematically recorded data from ultrasound tests, specifically the measurements of the baby's cerebellum. This data was then grouped based on the stage of pregnancy. Statistical analysis was employed to examine the relationship between these cerebellum measurements and the gestational age of the fetus. The results were thoroughly analyzed, leading to conclusions regarding the effectiveness of using cerebellum measurements as a reliable marker for estimating the precise stage of pregnancy.

This study was conducted following ethical guidelines and with the approval of the relevant institutional ethics committee. The privacy and confidentiality of participants were strictly maintained throughout the study.

While every effort was made to ensure the accuracy and validity of the data, it is essential to acknowledge that this study may have limitations inherent to its observational nature. Additionally, the results may be influenced by factors not accounted for in this study.

Results

The study included 50 pregnant women who underwent ultrasound examinations to assess the TCD in relation to their gestational age. The participants were divided into three groups based on gestational age: Group A (14 to 20 weeks), Group B (21 to 30 weeks), and Group C (31 to 40 weeks). We measured the TCD and found distinct mean values for each group: Group A had a mean TCD of 17.32 mm with a standard deviation of 2.1 mm and a range from 13.0 mm to 21.4 mm (table 1). Group B had a mean TCD of 26.63 mm with a standard deviation of 1.8 mm and a range from 18.4 mm to 35.0 mm. Group C displayed the highest mean TCD at 40.73 mm, with a standard deviation of 2.3 mm and a range from 36.0 mm to 48.4 mm. Importantly, the p-values indicate the statistical significance of the differences observed among the groups, with p-values of 0.003, 0.023, and 0.001 for Groups A, B, and C, respectively, emphasizing the relationship between gestational age and TCD.

Table 1: Descriptive Statistics of TCD (TCD) by Gestational Age Groups

Gestational Age Group	Mean TCD (mm)	Standard Deviation (mm)	Minimum TCD (mm)	Maximum TCD (mm)	p-value
Group A (14-20 weeks)	17.32	2.1	13	21.4	0.003
Group B (21-30 weeks)	26.63	1.8	18.4	35	0.023
Group C (31-40 weeks)	40.73	2.3	36	48.4	0.001

The TCD measurement was acquired via electronic calipers, which were positioned at the outer boundaries of the cerebellum. Various anatomical structures, including the thalami, cavum, septum pellucidum, and third ventricle, were successfully recognized, requiring a little adjustment in transducer rotation below the level of the thalamic plane. The use of this approach unveiled the posterior fossa, showcasing the distinctive butterfly-shaped structure of the cerebellum. In every instance, the cerebellum was seen as a pair of lobules situated bilaterally along the midline inside the posterior cerebral fossa.

The study categorized cases into three groups based on gestational age. The mean TCD (TCD) for each group was as follows:

Table 2: Mean TCD during Different Gestational Ages

Gestational Age (Weeks)	No. of Cases	Mean TCD (mm)
14 - 20	18	17.32
21 - 30	23	26.63
31 - 40	9	40.73

A linear relationship was observed between gestational age (in weeks) and TCD, as depicted in the scatter diagram.

For different gestational age ranges, the minimum and maximum TCD measurements were as follows:

Table 3: Cerebellar Measurements during Different Gestation Ages

Gestation Age (Weeks)	TCD (Minimum) (mm)	TCD (Maximum) (mm)
14 – 20	13	21.4
21 – 30	18.4	35
31 – 40	36	48.4

The correlation coefficient between gestational age and TCD was found to be +0.991, indicating a highly statistically significant positive correlation ($p < 0.001$).

Regression analysis revealed a very significant connection between fetal TCD and gestational age. A mathematical model for calculating TCD based on gestational age is provided by the regression equation $y=5.821+0.188x$. These findings demonstrate a clear and statistically significant relationship between gestational age and TCD. The TCD measurements increase as gestational age advances,

reflecting the progressive development of the fetal cerebellum. This relationship has important implications for estimating gestational age accurately using TCD measurements in clinical practice.

Discussion

The results of this research emphasize the effectiveness of TCD as a dependable indicator for measuring the gestational age of the fetus. Ultrasound technology has been used to assess TCD with notable findings of a robust positive association with gestational age, hence suggesting an increment in TCD values as gestation advances. The observed correlation aligns with the anticipated progression and maturation of the embryonic cerebellum.

Numerous prior researches have examined the correlation between TCD and gestational age, and our findings are consistent with their respective outcomes.[13,14,15] A research done by Smith et al[13] on a broad sample of pregnant women found a similar positive association between TCD measurements and gestational age. The findings of our research align with the outcomes seen by Smith et al hence substantiating the applicability of the association across diverse groups.[13]

In addition, the range of TCD measures obtained in our investigation across various gestational ages exhibits a notable similarity to the results reported in a meta-analysis done by Johnson et al[16]. That analysis effectively integrated data from many studies. The findings of this study indicate that TCD displays a consistent pattern of development during pregnancy, showing little variation across different groups.

The present results align with the current body of research on the association between gestational age and TCD measurements. Multiple studies have shown evidence indicating a positive linear relationship between TCD measurements and gestational age, with a robust correlation value of about 0.99. This implies that TCD may serve as a dependable indicator for estimating gestational age, especially in the latter stages of the second and third trimesters. As an example, a research conducted by Prabhat et al[17] revealed that TCD had a correlation coefficient of 0.92 with gestational age among a population of pregnant women who were in good health.15 In a cohort of pregnant women from the Netherlands, Vinkesteijn et al[18] discovered that TCD had a correlation coefficient of 0.97 with gestational age.[18]

The regression equation ($y=5.821+0.188x$) has similarities to the regression equations documented in previous investigations. This observation implies that the association between TCD and gestational age exhibits a certain degree of uniformity across diverse groups. The robust association between TCD measurements and gestational age has significant therapeutic ramifications.[19,20,21] The precise determination of gestational age is of utmost importance in ensuring adequate prenatal care, evaluating fetal growth, and tracking the progress of pregnancy.[19,20] The use of TCD readings may be a beneficial supplement to current approaches for estimating gestational age, including the use of the last menstrual period and early ultrasound dating.

The TCD might be especially advantageous in situations when last menstrual period date lacks reliability or when continuous monitoring of fetal development is required.[22,23] The aforementioned technique offers a non-intrusive and conveniently attainable approach to evaluating the progression of fetal growth and guaranteeing that necessary actions are implemented promptly and suitably.[24,25]

Although our research provides evidence of a robust correlation between TCD and gestational age, it is important to acknowledge the presence of some limitations. The study's sample size was rather small, and the research was carried out at a solitary institution, which may restrict the applicability of the results. Subsequent investigations should strive to reproduce these findings among broader and more heterogeneous cohorts.

Furthermore, our investigation centered on the use of TCD as an indicator for approximating gestational age. Additional research might be conducted to examine the potential of this method in predicting negative pregnancy outcomes and evaluating the health of the fetus, thereby broadening its range of therapeutic uses.

Conclusion

In conclusion, our study provides further evidence supporting the reliability of transverse cerebellar diameter (TCD) as a valuable marker for estimating fetal gestational age. The robust correlation observed between TCD measurements and gestational age, which aligns with previous research findings, highlights the clinical significance of TCD in prenatal care and monitoring. By demonstrating the consistency of TCD measurements in predicting gestational age across various stages of pregnancy, our study underscores the utility of TCD as a reliable tool for obstetricians and sonographers. This consistency suggests that TCD can serve as a dependable adjunct to existing methods of gestational age estimation, potentially improving the accuracy of prenatal assessments.

Furthermore, the strong association between TCD and gestational age underscores the importance of ongoing research in refining our understanding of fetal development. As our knowledge expands, TCD measurement offers a valuable means of tracking fetal growth and assessing developmental milestones with greater precision. In practical terms, integrating TCD measurements into routine obstetric practice has the potential to enhance prenatal care by enabling clinicians to more accurately assess fetal well-being and identify any potential deviations from expected developmental trajectories. This, in turn, may facilitate timely interventions and personalized management strategies to optimize outcomes for both mother and baby.

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