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Transcerebellar Diameter in Normal and Fetal Growth-Restricted Pregnancies: A Comparative Sonographic Study

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ABSTRACT

Background: Accurate gestational age (GA) assessment is important for antenatal surveillance and obstetric decision-making. Conventional fetal biometric measurements may be affected by altered growth patterns in fetal growth restriction (FGR). Transcerebellar diameter (TCD) has been proposed as an additional sonographic parameter because cerebellar growth may be relatively preserved in some growth-restricted pregnancies. This study compared TCD measurements between normal and intrauterine growth-restricted (IUGR) pregnancies and examined the relationship of TCD with amniotic fluid index (AFI). Methods: A comparative study was conducted over four months at the University Ultrasound Clinic, Green Town, Lahore. A convenience sample of 100 pregnant women in the second trimester was included. Ultrasound examinations were performed using a Toshiba Xario XG system with a 3–5 MHz convex probe. Participants were classified into non-IUGR and IUGR groups (50 in each group). Descriptive statistics, one-way analysis of variance (ANOVA), and correlation analyses were reported. Results: Participants had a mean age of 29.54 years (SD = 2.47) and a mean GA of 21.00 weeks (SD = 1.97). Mean AFI was 10.62 cm (SD = 1.82), and mean TCD was 21.00 mm (SD = 1.97). Mean TCD was higher in the non-IUGR group than in the IUGR group (21.46 ± 1.70 vs. 20.54 ± 2.13 mm; $F(1, 98) = 5.684$, $p = .019$). TCD showed a moderate positive correlation with AFI ($r = .4065$, 95% CI [.2284, .5584], $p < .0001$) and a weak negative correlation with IUGR status ($r = -.2341$, 95% CI [−.4116, −.0395], $p = .019$). Conclusion: TCD measurements differed significantly between the non-IUGR and IUGR groups and were positively associated with AFI in this second-trimester sample. These findings suggest that TCD may provide complementary information during fetal assessment. The study does not, however, establish diagnostic accuracy or independently validate TCD-based gestational dating; larger studies using a clearly defined reference standard and standardized FGR criteria are required.

Introduction

Accurate assessment of gestational age is central to antenatal care because it informs fetal growth surveillance, the timing of investigations, and decisions about obstetric management. Dating may be based on menstrual history and ultrasound biometry; however, menstrual dates may be uncertain, and the interpretation of later-pregnancy biometric measurements can be complicated when fetal growth is abnormal (Mahendru et al., 2016; Damhuis et al., 2021).

Fetal growth restriction refers to failure of a fetus to achieve its expected growth potential and is associated with increased perinatal risk. Conventional sonographic parameters, including biparietal diameter, head circumference, abdominal circumference, and femur length, provide important information about fetal size and development. Nevertheless, asymmetric growth patterns may affect some measurements more than others. In placental insufficiency, redistribution of fetal blood flow may preserve cerebral structures relative to abdominal growth, a phenomenon commonly described as brain sparing (Suhag & Berghella, 2013).

The fetal cerebellum undergoes measurable growth during pregnancy. Transcerebellar diameter is therefore used as an additional biometric parameter for estimating gestational age. Previous studies have reported associations between TCD and gestational age and have explored its potential value in pregnancies complicated by IUGR (Dashottar et al., 2018; Mishra et al., 2020; Eze et al., 2021; Maher et al., 2022). However, reference values and performance may vary across populations and gestational periods, supporting the need for population-specific evidence.

In addition to fetal biometric measurements, amniotic fluid index is routinely considered during obstetric ultrasound assessment. Reduced amniotic fluid may accompany placental dysfunction and fetal growth concerns. Examining the relationship between TCD and AFI may therefore contribute to understanding how these sonographic measures vary within a clinical sample.

The present study compared TCD measurements in normal and IUGR pregnancies attending an ultrasound clinic in Lahore and examined the association of TCD with AFI and IUGR status. The study focused on second-trimester pregnancies.

Objective

To sonographically estimate gestational age in normal versus fetal growth-restricted pregnancies using transcerebellar diameter.

For this manuscript, the available thesis results specifically support comparison of TCD between the two groups and assessment of its correlations with AFI and IUGR status. A direct accuracy analysis against an independently established gestational-age reference standard was not reported in the thesis results.

Materials and Methods

Study design and setting

A comparative study was conducted over a four-month period at the University Ultrasound Clinic, Green Town, Lahore, Pakistan.

Participants and sampling

A total of 100 pregnant women were recruited using a convenience sampling technique. The thesis describes eligibility as married pregnant women aged 22–35 years who were in the second trimester. Women in the first or third trimester, those carrying multiple fetuses, and those with an underlying disease were excluded. The observed participant ages in the results ranged from 25 to 34 years.

Ultrasound equipment and assessment

Ultrasound data were collected using a Toshiba Xario XG ultrasound machine equipped with a convex probe operating at 3–5 MHz. The thesis describes a standardized abdominal ultrasound examination in the supine position, with ultrasound gel applied to the abdomen. Fetal biometry, including biparietal diameter, abdominal circumference, and femur length, was assessed, fetal heart rate was evaluated, and transverse images of the fetal cerebellum were obtained to measure TCD using ultrasound calipers. AFI was also recorded.

The thesis states that participants were classified into normal and IUGR groups using clinical criteria that could include fetal biometric measurements, Doppler studies, and customized growth charts. However, the specific operational diagnostic threshold or reference chart used to define IUGR is not reported in the methods provided.

Ethical considerations

The thesis reports that the study followed the ethical rules and regulations of the University of Lahore. Written informed consent was obtained, participant information was kept confidential, and participants were informed of their right to withdraw. The thesis does not provide an ethics committee approval number; this should be added to the final manuscript if available.

Statistical analysis

Data were analyzed using MedCalc version 20.215. Descriptive statistics were used to summarize participant characteristics and sonographic measurements. One-way ANOVA was used to compare TCD between the non-IUGR and IUGR groups. Correlation analyses were used to examine relationships between TCD and AFI and between TCD and IUGR status. Statistical significance was set at $p < .05$. Levene's test and the Shapiro–Wilk test were reported for assessment of ANOVA assumptions.

Results

Participant characteristics

The study included 100 participants. Mean maternal age was 29.54 years (SD = 2.47; range, 25–34 years). Mean gestational age was 21.00 weeks (SD = 1.97; range, 16–24 weeks). Mean AFI was 10.62 cm (SD = 1.82; range, 7–15 cm), while mean TCD was 21.00 mm (SD = 1.97; range, 16–24 mm). The sample comprised 50 non-IUGR and 50 IUGR pregnancies.

Table 1: Demographic Characteristics

Variable	N	Minimum	Maximum	Mean	SD
Maternal age (years)	100	25	34	29.54	2.47
Gestational age (weeks)	100	16	24	21.00	1.97
Amniotic fluid index (cm)	100	7.0	15.0	10.62	1.82
Transcerebellar diameter (mm)	100	16.0	24.0	21.00	1.97

The mean TCD was 21.46 mm (SD = 1.70) in the non-IUGR group and 20.54 mm (SD = 2.13) in the IUGR group. One-way ANOVA identified a statistically significant between-group difference, $F(1, 98) = 5.684$, $p = .019$. Levene's test did not indicate unequal variances ($p = .165$). However, the Shapiro–Wilk test indicated non-normality of the residuals ($W = .9631$, $p = .0068$), which should be considered when interpreting the ANOVA result.

Table 2: Comparison of transcerebellar diameter by IUGR status

Group	n	Mean TCD (mm)	SD
Non-IUGR	50	21.46	1.70
IUGR	50	20.54	2.13

A moderate positive correlation was observed between TCD and AFI ($r = .4065$, 95% CI [.2284, .5584], $p < .0001$), indicating that higher AFI values were associated with larger TCD measurements in this sample. A weak but statistically significant negative correlation was reported between TCD and IUGR status ($r = −.2341$, 95% CI [−.4116, −.0395], $p = .019$). The thesis coded IUGR status as 0 = no and 1 = yes; the negative coefficient therefore indicates lower TCD values in the IUGR group.

Table 3: Correlations involving transcerebellar diameter

Association	Correlation coefficient	95% CI	p value
TCD and AFI	0.4065	0.2284 to 0.5584	< .0001
TCD and IUGR status	−0.2341	−0.4116 to −0.0395	.019

Discussion

In this sample of 100 second-trimester pregnancies, TCD was significantly lower in the IUGR group than in the non-IUGR group. The mean difference was approximately 0.92 mm. TCD was also moderately and positively correlated with AFI and weakly and negatively correlated with IUGR status. Taken together, these findings indicate that TCD varied according to growth-restriction status in the study population and was associated with amniotic fluid volume.

The observed between-group difference is consistent with the broader use of fetal cerebellar measurements as an additional component of sonographic assessment. Dashottar et al. (2018) examined TCD in normal and IUGR pregnancies, while Mishra et al. (2020) and Eze et al. (2021) reported relationships between TCD and gestational age in other populations. Maher et al.

(2022) also investigated TCD in normal and growth-restricted fetuses. Differences in gestational-age range, population characteristics, case definitions, and ultrasound protocols may contribute to variation between studies.

The positive association between TCD and AFI suggests that these two measurements tended to increase together in this sample. This association should not be interpreted as evidence that AFI directly determines cerebellar growth or that either measure independently diagnoses IUGR. The negative correlation between TCD and IUGR status is consistent with the lower mean TCD observed in the IUGR group, although the magnitude of the association was weak.

An important interpretive consideration is that the thesis does not report a direct correlation or regression analysis between TCD and gestational age, nor does it report comparison of TCD-derived gestational age with a reference dating standard. Consequently, the present findings cannot establish the diagnostic accuracy of TCD for gestational-age estimation. Similarly, sensitivity, specificity, predictive values, receiver-operating-characteristic analysis, and a diagnostic cut-off for IUGR were not provided. The conclusions should therefore be restricted to the observed group difference and associations.

The ANOVA assumptions also warrant attention. Although Levene's test supported homogeneity of variances, the Shapiro–Wilk test indicated non-normal residuals. A reanalysis using an appropriate robust or non-parametric method would strengthen confidence in the between-group comparison, particularly before journal submission. In addition, the study used a single-center convenience sample, included only second-trimester pregnancies, and did not report the precise criteria used to classify IUGR. These factors limit generalizability and make it difficult to compare the sample with studies using standardized fetal growth restriction definitions.

Clinical implications

TCD may be considered as a complementary biometric measurement during second-trimester ultrasound assessment, particularly when fetal growth is a concern. The current study does not justify using TCD alone to date a pregnancy or diagnose FGR. Clinical interpretation should continue to incorporate established dating information, fetal biometry, Doppler findings where indicated, and the overall obstetric assessment.

Strengths and limitations

A strength of the study is the inclusion of equal-sized non-IUGR and IUGR groups and the assessment of both group differences and associations with AFI. Limitations include the single-center design, convenience sampling, modest sample size, restriction to the second trimester, cross-sectional assessment, lack of a clearly documented IUGR case definition, and absence of a reported independent reference standard for gestational age. The thesis also does not report inter-observer or intra-observer measurement reliability.

Conclusion

Among 100 second-trimester pregnancies examined at a single ultrasound clinic in Lahore, mean TCD was significantly higher in the non-IUGR group than in the IUGR group. TCD showed a moderate positive correlation with AFI and a weak negative correlation with IUGR status. These findings support further investigation of TCD as a complementary sonographic parameter in pregnancies with suspected growth restriction. Larger, multicenter studies using standardized FGR criteria, reliable gestational dating, reproducibility assessment, and diagnostic-accuracy analyses are needed before firm conclusions can be drawn about its accuracy for gestational-age estimation or diagnosis of IUGR.

Declaration of Interest

The authors declare that they have no competing interests related to this study.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical approval, institutional policies, and participant confidentiality requirements.

Generative AI Disclosure

During the preparation of this manuscript, generative artificial intelligence was used to assist with language editing, drafting, and manuscript organization. The authors reviewed and revised the content and take full responsibility for the accuracy, interpretation, and final content of the manuscript.

Ethics Statement

The study was conducted in accordance with the ethical principles and regulations of the University of Lahore, Pakistan. Ethical requirements established by the university were followed throughout the research process. The study involved pregnant women undergoing ultrasound examinations at the University Ultrasound Clinic, Green Town, Lahore. Formal ethics committee approval details should be provided in the manuscript, including the committee name, reference number, and approval date, where available.

Informed Consent

Written informed consent was obtained from all participants before their inclusion in the study. Participants were informed about the study procedures, confidentiality of their information, and their right to withdraw from the study at any stage without any consequences.

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