ISSN: 2091-2331 (Print) 2091-234X (Online)

Journal of Nobel Medical College

Volume 13, Number 02, Issue 25, July-December 2024, 55-59.

Original Article

Ultrasonography Guided Gestational Age Estimation Using Transcerebellar Diameter in Third Trimester Pregnancy

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Article Received: 14th August, 2024; Accepted: 8th November, 2024; Published: 31st December, 2024

DOI: https://doi.org/10.3126/jonmc.v13i2.74460

Abstract

Background

The correct estimation of gestational age is of great importance for managing pregnancy. Determining gestational age by the first-trimester scan is considered the gold standard, but classical calculation from the last menstrual period is also useful. Fetal biometry is widely used, but estimation from trans-cerebellar diameter can be very important, especially in low-income countries.

Material and Methods

This was a prospective analytical study carried out in a Tertiary Care Centre from 21stMarch, 2023 to 20th March, 2024. Ethical clearance was taken from the Institutional Review Committee (Ref no:817/2023). Consecutive sampling was done to include 384 pregnant women in the third trimester of pregnancy. Variables collected were demographics, last menstrual period, first-trimester scan, and obstetrical ultrasound including fetal biometry and trans-cerebellar diameter. Analytical analysis for correlation and coefficient of determination was done.

Results

A total of 384 third-trimester pregnancies were studied. A statistically significant correlation was seen between gestational age from transcerebellar diameter and first-trimester scan ($r=0.965$, $R^2=93.12\%$,$p<0.01$) and with last menstrual period ($r=0.941$, $R^2=88.54\%$,$p<0.01$). The correlation of the first-trimester scan was better with trans-cerebellar diameter than with fetal biometry ($r=0.938$, $R^2=87.98\%$, $p<0.01$). The estimation of gestational age from trans-cerebellar diameter was better in the early weeks of the third trimester than in the later weeks.

Conclusion

Trans-cerebellar diameter is an accurate parameter in the determination of gestational age in the third trimester. It is a better parameter to determine gestational age when compared to fetal biometry especially in the third trimester.

Keywords: *Fetus, Gestational age, Ultrasound*

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Citation
Acharya S, Poudel S, Parajuli B, Kaphle P, *Ultrasonography Guided Gestational Age Estimation Using Transcerebellar Diameter in Third Trimester Pregnancy, JoNMC. 13:2 (2024) 55-59.* DOI: https://doi.org/10.3126/jonmc.v13i2.74460.

Introduction

Estimating the correct gestational age (GA) is paramount in managing obstetrical cases in their antenatal care plan, perinatal and postnatal outcomes [1]. The lack of appropriate and accurate methods leads to underestimation and increased burden of IUGR and preterm deliveries [2,3]. Counting from the first day of last menstruation is unreliable and largely influenced by the person's menstrual history, hormonal status, and various other physiological influencers [4,5]. The first-trimester ultrasonography (USG) scan is regarded as the gold-standard method of gestational age estimation [6,7]. However, the reach of ultrasound in resource-limited areas is scarce, and early antenatal ultrasonography may not be available. Fetal biometry is the most common method of estimation of gestational age in the third trimester [8]. This method is accurate within 3-3.5 weeks of the measurement from the first-trimester scan [6]. Trans-cerebellar diameter (TCD) can be used to estimate the gestational age and is less affected by shortcomings of fetal biometry such as IUGR [9].

The reach of USG in first-trimester antenatal checkups is still unsatisfactory in Nepal. As such, there are inaccuracies in the calculation of gestational age. Improvement in third-trimester scan accuracy would have a great impact on overall antenatal care in low-resource areas such as ours.

The study seeks to identify the possibility of third-trimester estimation of gestational age by TCD, in comparison to first-trimester scan and third-trimester biometry scan, and the potential use of TCD as an independent variable for the calculation of gestational age.

Material and Method

This was an analytical study done by collecting data from 21stMarch, 2023 to 20thMarch, 2024. In this research, pregnant women who presented to a tertiary hospital in their third trimester of pregnancy for antenatal USG checkups were studied. Ethical approval was taken from the Institutional Review Committee of Nobel Medical College Teaching Hospital (Ref:817/2023). Data was collected after obtaining written informed consent from the women included in the study, following a thorough explanation of the nature and purpose of the study. All pregnant women in their third trimester of pregnancy, with a singleton pregnancy, who are sure of the first day of their last menstrual period, and with an available first-trimester USG scan that presented for an antenatal checkup at Nobel Medical College Teaching Hospital, Biratnagar, Morang, Nepal were included in the study. Women who were unsure of their first date of last menstrual cycle, twin or higher order pregnancies, pregnancies with congenital malformation, clinically or radiologically suspected intrauterine growth restriction (IUGR), and those without a first-trimester USG scan were excluded from the study.

Variables like age, occupation, religion,last menstrual period (LMP), gravidity, parity, placental localization, fetal presentation, gestational age based on LMP, gestational age based on first-trimester scan, gestational age based on AC/FL/BPD/HC, average gestational age based on those 4 parameters, TCD measurement in millimeters, gestational age based on TCD, and average gestational weight were studied during the study. A consecutive sampling technique was used for data collection. The sample size was calculated using the following formula:

$N = (Z^2 \times p \times q) / e^2$

$= (1.96^2 \times 0.5 \times 0.5) / 0.05^2$

~ 384

To increase the maximum sampled population, the incidence was taken at 50%, at 95% confidence interval and 5% margin of error.The sample size was calculated to be 384. Hence, 384 cases were included in the study.

All USGs were done by a single radiologist to reduce inter-observer errors. The division of trimesters was done according to the time from the first day of LMP. The early third trimester was considered to be between 28 and 31^{+6} weeks of pregnancy, the middle was considered to be between 32 and 35^{+6} weeks, and the late third trimester was considered to be anything above 36 weeks of pregnancy. The USG scan was done using GE Voluson with the convex probe, in a supine position. First-trimester gestational age used the measurement of crown-rump length (CRL) and its conversion to the time of examination in the third trimester by adding the additional time from the date of the previous scan to the present one. The third-trimester scan included the measurement of regular obstetric ultrasound parameters including FL, AC, HC, BPD, fetal weight, fetal presentation, placental localization along with TCD, and gestational age according to TCD.

The data were entered in a Microsoft Excel Sheet and statistical analysis was done with IBM SPSS Statistics for Windows, version 29 (IBM Corp., Armonk, N.Y., USA). Pearson's coefficient was calculated for the correlation between the variables.

Results

Over the period of 1 year, 384 pregnant women in their third trimester of pregnancy, with an available documented first-trimester CRL assessed scan and fulfilling other inclusion and exclusion criteria, were studied by a single radiologist. The cases were sampled using a consecutive sampling method until all 384 cases were analyzed.

The mean age of pregnant women was 26.25 ± 5.77 years. The majority were primigravida, 166 (43.23%) with an average gravidity of 1.76 ± 0.75. Other demographic findings are tabulated in Table 1.

Table 1: Demographic characteristics of the study population (N=384)

Variables		N (%)
Mean Age		26.25 ± 5.77 years
Occupation		
	Homemaker	302 (78.65%)
	Corporate Job	57 (14.84%)
	Farming	25 (6.51%)
Religion		
	Hinduism	240 (62.5%)
	Islam	88 (22.92%)
	Christianity	31 (8.07%)
	Buddhism	25 (6.51%)
Gravida		
	1	166 (43.23%)
	2	144 (37.5%)
	3	74 (19.27%)
Parity		
	1	202 (52.6%)
	2	144 (37.5%)
	3	38 (9.9%)

The Pearson's correlation coefficient was calculated among the gestational age according to fetal biometry (FC, AC, BPD, HC), gestational age according to TCD, and gestational age according to LMP in comparison to the gestational age calculated by the first-trimester scan as gold standard during our study. The findings according to the overall third trimester are tabulated in Table 2 and according to subdivisions of the third trimester are done in Table 3.

Table 2: Correlation between TCD, LMP and fetal biometry

Parameters	Pearson's correlation coefficient (r)	Coefficient of determination (R^2) %	P value
Gestational age from first trimester and scan TCD	0.965	93.12%	<0.01
Gestational age from first trimester scan and LMP	0.944	89.11%	<0.01
Gestational age from first trimester scan and fetal biometry	0.938	87.98%	<0.01
Gestational age from LMP and TCD	0.941	88.54%	<0.01
Gestational age from LMP and fetal biometry	0.927	85.93%	<0.01

Table 3: Correlation between the parameters in early, middle and late third-trimester.

Parameters	Pearson's correlation coefficient (r)	Coefficient of determination (R^2) %	P value
Early Third Trimester (28-31^{+6} weeks)			
First Trimester Scan and TCD	0.930	86.41%	<0.05
First Trimester Scan and LMP	0.926	85.74%	<0.05
First Trimester Scan and Fetal biometry	0.919	84.45%	<0.05
Middle Third Trimester (32-35^{+6} weeks)			
First Trimester Scan and TCD	0.929	86.30%	<0.05
First Trimester Scan and LMP	0.901	81.18%	<0.05
First Trimester Scan and Fetal biometry	0.861	74.13%	<0.05
Late Third Trimester (≥36 weeks)			
First Trimester Scan and TCD	0.906	82.08%	<0.05
First Trimester Scan and LMP	0.961	92.35%	<0.05
First Trimester Scan and Fetal biometry	0.785	61.62%	<0.05

The correlation between gestational age among first-trimester scans and TCD was better than from LMP or fetal biometry. A similar finding was seen in subdivisions of the third trimester, with the highest correlation seen during the late third trimester. The table shows that gestational age correlates more to the first-trimester scan as the gestational age advances.

The TCD value ranged from a minimum of 30. 80mm to a maximum of 53.30mm. The average TCD was 43.66 ± 5.53mm. The most common presentation of the fetus was cephalic in 275 (71.61%) cases, while the upper anterior placental type was the most common placental location in 183 (47.66%). The average gestational weight was 1954.45 ± 643.6 grams, ranging between 1100 grams to 3700 grams. The findings are tabulated in Table 4.

Table 4: Additional demographic findings in the ultrasound examination.

Variables	N(%)
TCD measurement in mm	
Maximum	53.3mm
Minimum	30.8mm
Average	43.66 ± 5.53mm
Presentation of fetus	
Cephalic	275 (71.61%)
Breech	96 (25.00%)
Transverse	13 (3.39%)
Placenta position	
Upper Anterior	183 (47.65%)
Upper Posterior	133 (34.63%)
Upper Right Lateral	40 (10.42%)
Upper Left Lateral	15 (3.91%)
Low Lying	13 (3.39%)
Average gestational weight	1954.45 ± 643.6 grams

Discussion

Visualizing the fetal cerebellum in ultrasonographic scans starts as early as the 12th week of gestation [10]. It is usually seen as a butterfly-shaped structure joined together in the middle by the more echogenic vermis [11]. The growth trajectory of the cerebellum is relatively linear throughout the gestational period [12].The cerebellum of the fetuses with intrauterine growth restriction (IUGR) observes a decreased growth [13]. This however is lesser to the extent of other fetal biometry parameters which observe a significant limitation in growth, due to the brain-sparing effect in IUGR [9].

The gestational age from the fetal biometry in the third trimester shows a discrepancy of up to 3 weeks in USG [6,14]. To reduce the error in gestational age estimation, TCD has been studied in correlation with GA especially during the third trimester, with various studies showing a strong positive correlation between the two [14-17]. With the brain-sparing effect of IUGR, multiple studies have concluded that it is a better GA predictor than fetal biometry in cases of growth restriction [9,17,18].

In our study, the first-trimester scan was considered to be the gold standard for gestational age, hence the majority of the analysis was done in comparison to the first-trimester scan. In our study, we found that the highest correlation among all parameters for the third trimester was between the gestational age from the first-trimester scan and TCD. With a correlation coefficient (r) of 0.965 and predictive accuracy (R^2) of 93.12%, it was the most accurate parameter to determine GA in the third trimester of our study. This high predictive value of TCD for the determination of GA was also evidenced by the studies of Prasad et al., from Nepal, and Bavini et al. from India where they found the predictive accuracy to be 97.8% and 95.84% respectively [14,19].Similarly, studies by Guan from China and Adeyekun et al., from Nigeria also found a similar high predictive value of TCD for the estimation of GA with the predictive value of 99.62% and 96.9% respectively [20, 21].

The average TCD in our study was 43.66 ± 5.53mm. The TCD showed a better positive curvilinear relationship with both first-trimester scan (r=0.965, R^2=93.12%) and LMP (r=0.944, R=89.11%) when compared to fetal biometry, which has a lower correlation with both first-trimester scan (r=0.938, R^2=87.98%) and LMP (r=0.927, R^2=85.93%). This better correlation showed that the TCD was superior as a single variable in comparison to fetal biometry in determining GA in the third trimester. Similar findings are recorded by Prasad et al., Bavini et al., and Bekele et al [14,19,22].

We stratified the third trimester into three subdivisions of 28-31^{+6} weeks, 32-35^{+6} weeks, and more than 36 weeks of gestation. In our study, we found that the correlation of TCD with GA was better in the early weeks of the third trimester than in later weeks. Several authors reported similar findings from their respective studies. Chavez et al. and Bavini et al. found the correlation to be better in the early weeks of the third trimester than in later weeks [14,18]. The WHO alliance group also noted that the GA with TCD was better in the earlier weeks of pregnancy than in the later weeks. They also noticed that TCD calculated GA was better than fetal biometry in the second trimester and in cases of IUGR, which our study didn't study [6].

Our study has several limitations. It was done in a study pool of 384 cases which is still a poor predictor for the general population. It was a single-center study and used a single observer so we could not understand the differences inter-observer bias may create. Our study studied normal fetuses, while congenital malformations and IUGR were excluded, thus their effect on TCD and calculation of GA was not studied. Our study showed that the benefit of TCD calculation was better in the early stages of the third trimester, so a study on the accuracy of TCD to calculate GA in the second trimester can also be done to compare the benefits.

Conclusion

The correlation between the calculation of gestational age from TCD and the first-trimester scan was better than the calculation from fetal

biometry. TCD can be used as a single parameter for the calculation of gestational age in the third trimester, especially in areas where the population may lack the facility of first-trimester antenatal scan or are unsure of their LMP. TCD may be useful in cases of IUGR pregnancies but further studies are warranted.

Acknowledgement
We would like to acknowledge our study participants and colleagues of the Department of Radiology, Obstetrics and Gynaecology, Nobel Medical College involved in patient care.

Conflict of interest: None

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