Original Article

Comparing the Reliability of Trans-Cerebellar Diameter with Other Fetal Biometrics for Gestational Age Estimation

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Abstract

Background: Accurate estimation of gestational age is critical in obstetric care decision-making, especially when managing high-risk pregnancies. It is indispensable in developing countries where most antenatal care women book late. **Objectives:** To determine the accuracy and reliability of trans-cerebellar diameter as a method of estimating gestational age in the second trimester of pregnancy. **Methods and Materials.** This was a hospital-based cross-sectional study. The respondents were 384 ANC women carrying singleton and uncomplicated pregnancies in the second trimester who presented for booking at the JUTH between 1st January 2020 and 31st March 2020. The respondents were women between 15- 26 weeks of gestation and who were either sure of their last menstrual periods or had an early obstetrics ultrasound scan done on or before 20-22 weeks of gestation. They were recruited using convenience sampling method until the sample size was reached. Interviewer-administered semi-structured questionnaire was used to gather data on socio demographic characteristics, obstetric history, gestational age, LMP, previous history of contraceptive use, menstrual history, and co-morbidities and ultrasound scan results. The estimated gestational age was calculated using the Naegele's rule and the fetal biometric parameters were measured using GE Voluson P8-BT19 ultrasound machine with a RAB6-RS 4-8.5 MHz Real Time 4D Convex Transducer. Fetal biometric parameters including, TCD, BPD, HC, AC and FL were measured in 2D mode. Data was subjected to descriptive and inferential statistical analysis using Statistical Package for Social Sciences (SPSS) version 23 (SPSS Inc, Chicago, IL). **Results**. The mean GA was 21.1 +3.1 weeks, with a bimodal GA distribution of 20.1-21, and 25.1-26 weeks. Two hundred and thirty-nine respondents (62.2%) were sure of their last menstrual period and 145 (37.8%) had a first trimester ultrasound scan. The mean age of the participants was 29.1+5.7 years. There was significant correlation between TCD and menstrual GA (r = 0.963; p<0.05). The correlation between TCD and GA was better than the other four parameters at 95% confidence interval. This correlation was further corroborated by the student t-test. The composite ultrasound GA however had a better correlation than TCD alone-r = 0.969. **Conclusion**. TCD is a reliable method of gestational age estimation. It is superior to BPD, HC, AC and FL in the second trimester of pregnancy, but less accurate than the composite GA.

Key Words: Trans-cerebellar diameter, Gestational age, Ultrasound, Second trimester, Nigeria

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Introduction

In the field of Obstetrics, everything revolves around the gestational age. In the absence of a reliable GA, features such as intrauterine growth restriction and macrosomia may be misdiagnosed or missed.[1,2] What is even worrisome is the increasing incidence of iatrogenic preterm birth.[3] In addition, accurate estimation of gestational age is critical in the neonatal care unit. The prognosis of preterm neonates relies heavily on the gestational age (GA) at birth.[4,5] National health indices in sub-Saharan Africa Countries are alarming; with WHO reports revealing 1 in 36 neonates dying in their first month of life, while prematurity

accounts for about 28.5% of perinatal deaths.[6,7] In Nigeria, neonatal mortality is 34 per 1000 live births from 2015 data compared with global indices of 19 per 1000 live births.[7] The alarming indices alluded to above may not be unrelated to poor obstetrics challenges in the region. Report from north central Nigeria showed that most women present late (19.1 weeks ±7.8 days) for ANC for multitude of reasons including not being sick (26.1%), ignorance about the importance of early booking (22.8%), having booked elsewhere (14.1%), financial constraints (9.2%), fear of too many follow-up visits (4.9%), spouse's unco-operative attitude (3.9%), lack of transport to the health care facility (2.2%), and other minor reasons. In addition to late booking, most women scan late even when USS is available either because of lack of finance or ignorance.[8]

Hence, a reliable method of dating in late pregnancy is crucial. Current methods of GA estimation face a lot of challenges. Indirect methods of dating like physiologic changes in pregnancy including early morning vomiting and breast changes are flawed as they are time-bound events in pregnancy. Historically, quickening is an issue of maternal perception and therefore highly subjective. In addition, while the use of last menstrual period (LMP) is inexpensive, requires no equipment only a keen memory, there is vast variance because of recall bias especially where the use of menstrual calendar is not the norm. Also, this routine practice is based on the assumptions that the menstrual cycle is regular, ovulation occurs mid-cycle and fertilization began on day 14 of the menstrual cycle.[9,10]

Irregular menstruation, prior use of contraceptive devices/ pills, variation in the awareness of women about their internal bodily functions and breastfeeding can affect the accuracy of LMP for GA estimation. In addition, most of the women in our environment do not keep a menstrual calendar and illiteracy that make women to refer to certain event are not reliable methods of dating. Furthermore, even when a woman is accurate with her self-knowledge of ovulatory cycles, the precise moments when ovulation, fertilization and implantation occur cannot be known since sperm can survive for up to 5-7 days within the female reproductive tract. Also, there is no accurate knowledge on the length of time between ovulation and implantation, as it varies from woman to woman.[7,9] The only objective way is by recording precisely when ovulation, fertilization, implantation happen as practiced in Assisted Reproductive Technology.[9] Serial symphysio-fundal height measurement to estimate GA is indirect and can be affected by maternal obesity, uterine masses and fetal factors.

Where equipment and trained personnel are available, ultrasonography is the safest and most accurate method of estimating fetal GA in pregnancy. This is especially true for first and second trimester dating of pregnancy.[9,11] Routinely assessed parameters for the estimation of GA include FL, BPD, HC and AC. These biometric methods have their limitations. Ultrasound determination of gestational age using these biometric components is based on the assumption that there is consistency between the size and age of the fetus. In addition, their reliability is affected significantly by genetic influence after 20 weeks of gestation, especially for the femur length. Furthermore, extrinsic factors such as alteration in the shape of the fetal head (as it occurs in brachycephaly and hydrocephalus) and abnormalities of the long bones such as achondroplasia also affect biometry. Transcerebellar diameter (TCD) is an emerging parameter has been found to be more accurate in predicting GA than the routine parameters. In addition, there tends to be less biologic variation in size of the cerebellum.[12] Importantly, the cerebellum which appears at the end of 5th week of pregnancy in the embryo can be reliably measured from 12th or 14th week of gestation till delivery. In addition, studies of TCD shows that the cerebellum is the least organ affected by fetal growth abnormalities and biologic variations. Furthermore, the anatomical location of the cerebellum in the posterior cranial fossa at the same level for BPD measurement makes it easily assessable for measurement.[13]

The gestational age also plays a most vital role on the date of delivery; as interventions such as caesarean section or induction of labour largely depend on it. It is therefore essential that a study be done in this environment to determine if the TCD will be reliable in estimating gestational age in the 2nd trimester, and therefore help obstetricians accurately calculate GA in the 2nd trimester when most pregnant women commence antenatal care in Nigeria; thereby improving healthcare indices.

We therefore sought to determine the reliability of transcerebellar diameter measurements as a method of estimating gestational age in the second trimester of pregnancy and evaluate its correlation with routinely used biometric parameters.

Methods and Materials

It was a hospital-based cross-sectional study. The study participants were 340 ANC women carrying singleton and uncomplicated pregnancies in the second trimester who presented for booking at the JUTH between 1st January 2020 and 31st March 2020. These were women who were between 15- 26 weeks of gestation. The 15 weeks' gestation was used and not below because of the limitation in the machine. These respondents were either sure of their last menstrual periods, had regular menstrual cycles in the preceding 3 months, have not been on contraceptives for 6 months prior and were not breastfeeding and who keep a menstrual calendar or had an early obstetrics ultrasound scan done on or before 20-22 weeks of gestation. They were recruited using convenience sampling method until the sample size was reached. Interviewer-administered semi-structured questionnaire.[14,15] was used to gather data on socio demographic characteristics, obstetric history, gestational age, LMP, previous history of contraceptive use, menstrual history, and co-morbidities and ultrasound scan results. Women who had hypertension, diabetes, sickle cell anaemia, renal disease, multiple gestation or other conditions that may affect fetal growth, fetuses with congenital anomalies and women who declined were excluded.

Interviewer-administered semi-structured questionnaires from previous similar studies 32,33, was adapted and administered to the participants.

The estimated GA at examination was calculated using the Naegele's rule.[16] GE Voluson P8-BT19

ultrasound machine serial number VP8801825, with Convex Transducer RAB6-RS 4-8.5 MHz and 4D capabilities was used. The fetal biometric parameters including, transcerebellar diameter (TCD), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femoral length (FL) were measured in 2D mode making use of the freeze frame capacity, cine-loop and 3D TUI (Tomographic Ultrasound Imaging). The choice of the transducer frequency was to ensure adequate penetration and provide excellent resolution of the cerebellum measured. Ultrasound examinations were carried out according to the International Society of Ultrasound in Obstetrics and Gynaecology (ISUOG) guidelines for gestational age assessment.[17] The procedure was performed by a single examiner (principal investigator) to ensure consistency. Data was subjected to descriptive and inferential statistical analysis using Statistical Package for Social Sciences (SPSS) version 23 (SPSS Inc, Chicago, IL). Ethical clearance was obtained from the Ethical and Research Committee of the Jos University Teaching Hospital.

Results

Three hundred and eighty-four pregnant women fulfilled the inclusion criteria and were studied. The mean age of the participants was 29.1+5.7 years, and greater than 92.9% had at least secondary level of education. Details of occupation and ethnicity are presented in table 1.

The parity of participants ranged from 0 to 9, with a mean of 1.64+1.65. Distribution of mothers according to parity is presented in Table 2.

Prevalence of First Trimester Ultrasound Scan Among Respondents
Of the 384 women studied, 145 women (37.8%) had a first trimester ultrasound scans, while 239 (62.2%) did not have any. Figure 2 represents this finding.

Distribution Based on Gestational Age.

Table 3 shows the gestational age ranges at which the scans were done. The mean GA was 21.1 +3.1 weeks, with a bimodal GA distribution of 20.1-21, and 25.1-26 weeks (14.1%).

Mean TCD Values for GA
The TCD reference values according to GA obtained are represented in Table 4. The mean TCD at 15 weeks was 15.8+1.1mm, and that at the 26th week was 25.5+0.6mm.

Correlation of various parameters
There was significant correlation between TCD and menstrual GA (r = 0.963; p<0.05). Similarly, BPD, HC, AC and FL showed good correlation with menstrual GA: r =0.942, 0.949, 0.949, 0.948 respectively. TCD however

correlated with the GA better than the other four parameters at 95% confidence interval. The composite ultrasound GA however had a better correlation than TCD alone: r = 0.969. This is shown in Table 5. The coefficient of determination (r2) was also calculated, as illustrated in Table 6.

The findings of the TCD having a better correlation with GA; in comparison with the other individual parameters were also corroborated by the

Table 1: Demographic characteristics of study participants

Demographic characteristics	Frequency	Percentage
Age group(years)		
≤20	26	6.8
21-30	203	52.9
31-40	148	38.5
>40	7	1.8
Educational level		
Nonformal	2	0.5
Primary	25	6.5
Secondary	128	33.3
Tertiary	229	59.6
Occupation		
Civil servant	116	30.2
Business	55	14.3
Housewife	89	23.2
Tailor	37	9.6
Students	50	13.0
Others	37	9.6
Ethnicity		
Hausa/Fulani	170	44.3
Yoruba	23	6.0
Igbo	18	4.7
Plateau indigene	111	28.9
Others	62	16.1
BMI (Kg/m2)		
<18.5	11	2.9
18.5-24.9	160	41.7
25-29.9	137	35.7
≥30	76	19.8

Table 2: Parity Distribution

Parity	Frequency	Percentage
Nulliparous	116	30.2
1	97	25.3
2	76	19.8
3	46	12.0
4	28	7.3
≥5	21	5.5

Table 3: Distribution of number of scans according to gestational age

Estimated gestational age (weeks)	Frequency(n=384)	Percentage
15.1-18	76	19.8
18.1-21	120	31.3
21.1-24	99	25.9
24.1-26	89	23.2

student t-test, as shown in Table 7. No statistically significant difference was noted when comparing the means of the GA based on the LMP, and that from the TCD. Other parameters (BPD, HC, AC and FL) had statistically significant difference when their means were compared individually with the GA.

Table 4: Mean Trans-Cerebellar Diameter at Specific Estimated Gestational Age.

Specific EGA in weeks	TCD Mean ± SD	Frequency(n=384)	Percentage
15.1-16	15.87±1.19	18	4.7
16.1-17	16.18±0.45	28	7.3
17.1-18	17.60±1.09	30	7.8
18.1-19	18.73±1.21	28	7.3
19.1-20	19.54±0.96	38	9.9
20.1-21	20.49±1.13	54	14.1
21.1-22	21.19±0.63	36	9.4
22.1-23	21.89±1.25	29	7.6
23.1-24	23.20±1.04	34	8.9
24.1-25	24.45±0.67	35	9.1
25.1-26	25.51±0.69	54	14.1

Table 5: Pearson correlation analysis between TCD, BPD, HC, AC and FL and EGA

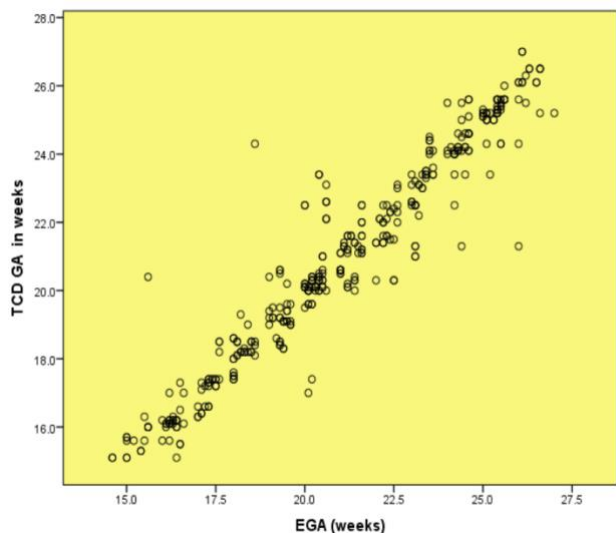| Parameters	EGA	TCD	BPD	HC	AC	FL	Composite
EGA	1	0.963**	0.942**	0.949**	0.949**	0.948**	0.969**
TCD	0.963**	1	0.953**	0.962**	0.962**	0.955**	0.980**
BPD	0.942**	0.953**	1	0.974**	0.960**	0.952**	0.980**
HC	0.949**	0.962**	0.974**	1	0.967**	0.958**	0.985**
AC	0.949**	0.962**	0.960**	0.967**	1	0.951**	0.981**
FL	0.948**	0.955**	0.952**	0.958**	0.951**	1	0.977**
Composite	0.969**	0.980**	0.980**	0.985**	0.981**	0.977**	1

Figure 1: Linear graph showing the correlation of EGA and TCD

Discussion

Our study shows that the mean TCD has a positive linear correlation with GA. This is similar to previous studies.[12,18,19,13] The superiority of TCD over routinely used parameters as demonstrated in this study also tallies with previous studies.[20,21] Gupta *et al,* also studied TCD in singleton pregnancies and observed that the gestational age of pregnant women not sure of their LMP can be reliably estimated by measuring the TCD which showed good correlation (r=+0.946, r2=89.6% and p<0.001).[22] The TCD showed better correlation with menstrual GA at 95% confidence interval compared to the conventional parameters like BPD, HC, AC and FL, individually. This was corroborated by Chavez et al who also reported a TCD predictive accuracy of 98.7%+5days.[23] Our finding was at variance with that of Chervenak who found HC to be the best single predictor of gestational age in second trimester.[24] He also showed FL as deemed the least accurate, while we found FL had better predictive accuracy than the BPD, but however corroborated with our study showing that the combination of HC, AC, and FL was better than the HC alone in the prediction of gestational age.[24] Hoanda-Filho in addition showed that TCD those not differ between genders.[18]

Even though this study aimed to assess the suitability of TCD measurement in the second trimester, other studies have also showed TCD measurements remains a reliable aid in gestational age assessment during other periods in pregnancy. Reddy in his investigation of the fetal posterior cranial fossa using ultrasound, also reported that the trans-cerebellar diameter as a useful indicator of accurate gestational age between 17 and 40 weeks of gestation.[25] Furthermore, our study showed TCD to be the most reliable predictor of gestational age followed by HC, AC, FL, and BPD in that order. This is similar to other findings.[23,26,27] Goldstein *et al.* evaluated accuracy of predicting GA using Fetal Trans-Cerebellar Diameter (TCD) and to compare between TCD and other existing parameters in evaluating GA from 15 to 40 weeks of gestation. He showed that TCD is an accurate parameter in estimation of gestational age in second and third trimesters as its values are in close relation with that of GA by LMP. It is also better predictor of the gestational age when compared to other parameters especially in third trimester.[21] Other studies in the region showed similar pattern.[15]

Some incidental findings from this study are twofold. The average gestational age at presentation for antenatal booking was 21.1+3.1weeks. This mid-trimester booking agrees with previous reports from the region.[8] The other worrying discovery during this study was that about two-thirds of the respondents did not have a first trimester ultrasound scan. This falls short of the ACOG standard, which states that pregnancies without an ultrasound examination before 22 weeks of gestational age should be considered suboptimally dated**Error! Bookmark not defined.**. This cut-off by ACOG is based on the fact that early ultrasound imaging is extremely useful for accurate diagnosis of first trimester complications like ectopic pregnancy, abortion, and gestational trophoblastic diseases (GTDs) which can contribute to maternal mortality ratio.[28] Furthermore, apart from confirming viability, first trimester ultrasound scan provides an opportunity for accurate determination of the number of viable fetuses in multiple gestation.[29]

Our study was not without some limitations. This was a single centre study and therefore cannot be generalized to the entire population. Also, being a sampling of convenience, the study population may be skewed and therefore not a true representation of the general population of pregnant women.

This study has showed the reliability of TCD for GA estimation, that TCD has a better correlation with menstrual GA at 95% confidence interval compared to the conventional parameters like BPD, HC, AC and FL, individually, but less than the composite. TCD as a more reliable method for GA estimation, remains stable throughout gestation, not affected by genetics and does not vary between gender. It is critical for optimal obstetric care. This will aid the diagnosis and management of conditions such as intrauterine growth restriction and macrosomia can easily be achieve, and iatrogenic prematurity, post-datism and unexplained intrauterine fetal death can be prevented in view of dwindling resources to manage these in our setting.

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