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Accuracy of Trans-Cerebellar Diameter and Placental Thickness in Third Trimesteric Pregnant Women for Calculation of Gestational Age: A Cross Sectional Study

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Abstract

Background: Accurate determination of gestational age has become important for deciding the appropriate time for termination of the pregnancy as well as to monitor the fetal growth during the entire period of pregnancy. **Objective:** The aim of the study was to assess whether the trans-cerebellar diameter, placental thickness or combining both of them is more accurate for assessment of gestational age in the 3rd trimester of pregnancy. **Patients and Methods:** This is a cross sectional study conducted at outpatient Clinic and Obstetric ward, Ain Shams University Maternity Hospital, over a period of six months from March 2019 to September 2019. One hundred pregnant women were recruited according to inclusion criteria either from outpatient clinic or were admitted in obstetric ward Ain Shams Maternity Hospital to find out the most accurate fetal biometric measurement in the third trimester either trans-cerebellar diameter placental thickness or both compared to reliable LMP (last menstrual period) dates confirmed by crown rump length (CRL) in the first trimester. **Results:** Trans-cerebellar diameter mean ± SD was 46.0 ± 3.5 with range 38.2 - 51.7. The mean of placental thickness was 39.6 ± 7.1 with range 22.8 - 54.3. Placental thickness had highest determination (0.813) for last menstrual period followed by trans-cerebellar diameter (0.802). Combining trans-cerebellar diameter and placental thickness increased determination (0.902) for last menstrual period. **Conclusion:** Combined use of trans-cerebellar diameter and placental thickness in the third trimester of pregnancy is a reliable indicator for gestational age in women whose last menstrual period is unreliable or unknown, but placental thickness

had higher accuracy than trans-cerebellar diameter.

Keywords

Accuracy of Trans-Cerebellar Diameter, Placental Thickness, Third Trimesteric Pregnant Women, Gestational Age

1. Introduction

Historically, gestational age has been determined by the first day of last menstrual period (LMP). The ultrasound-based method for pregnancy dating is generally more accurate than LMP-based methods in first trimester, especially when there is lack of information on LMP or unreliable dates, in which ultrasound provides crucial dating information [1]. An underestimation of gestational age could also lead to a delay in induction of pregnancies [2].

Miscalculation of gestational age could give two fetuses with similar actual gestational age very unequal opportunities in the case of extreme preterm delivery; might render one to be judged as viable and given intensive life support in advanced units, whereas the other might be judged as not viable and be deprived of any life support [1].

Detection of gestational age by ultrasound using fetal biometric parameters such as biparietal diameter (BPD), Femur length (FL), abdominal circumference (AC) and Head circumference (HC) assumed important role in management of pregnancy. The placenta is a materno-fetal organ which nourishes and protects the fetus. Since it is closely related to the fetus and the mother, it acts like a mirror, reflecting the statuses of both. Kulman and Warsoff stated that a placental thickness of <25 mm at term measured at the level of cord insertion was associated with intra uterine growth retardation (IUGR). A placental thickness of >40 mm at term is associated with gestational diabetes, intra uterine infections and hydrops fetalis [3].

Trans-cerebellar diameter (TCD) a new parameter for determining gestational age was developed. Cerebellum is located in the posterior cranial fossa surrounded by the dense petrous ridges and the occipital bone making it withstand the deformation caused by extrinsic pressure [4].

Fetal cerebellum can be visualized as early as 10 - 11 weeks by ultrasound. From second trimester onwards, it grows with gestational age. TCD is least affected by external factors because it is surrounded by dense petrous bone which allows its use for assessing gestational age (GA) even in third trimester [4].

A prospective pilot study was conducted on 100 pregnant women between 15 - 40 weeks of gestation, TCD showed mean gestational age which was closest to that of LMP especially in the third trimester more than other parameters ($r = 0.982$) [4].

A prospective cross sectional study was done on 211 antenatal women referred to ultrasonography. It was evident that placental thickness has a linear re-

lationship with gestational age yet it was not evident that it can be declared as a reliable predictor of gestational age [3].

The aim of the study was to assess whether the trans-cerebellar diameter, placental thickness or combining both of them is more accurate for assessment of gestational age in the 3rd trimester of pregnancy.

2. Patients and Methods

This a cross sectional study was conducted at outpatient Clinic and Obstetric ward, Ain Shams University Maternity Hospital, over a period of six months from March 2019 to September 2019. Hundred pregnant women were recruited either from outpatient clinic or were admitted in obstetric ward Ain Shams Maternity Hospital.

2.1. Inclusion Criteria

Sure of dates, have dating ultrasound with crown rump length (CRL) between (9 to 12) weeks, no hormonal contraception 3 months before conception, regular menstrual cycles, medically free, single pregnancy, and gestational age 32 - 36 weeks.

2.2. Exclusion Criteria

Irregular menstrual cycles and not sure of dates, multiple pregnancy, fetal anomalies, placenta previa, placental anomalies and poor visualization of the placenta, fetal growth restriction, and pregnant women with medical disorder e.g. diabetes mellitus, Pre-eclampsia, systemic lupus erythromatosis, hypertension.

All hundred women included were subjected to the following:

An informed consent to participation after explaining the nature, scope and possible consequences of the clinical study in simple form to the patient.

Full history were taken from all participants and included:

- Personal history (Maternal age, weight, height, special habits as smoking).
- Obstetric history Gravidity, Parity, previous pregnancy induced hypertension or preeclampsia or IUGR, antiphospholipid syndrome, accidental hemorrhage. Any associated complication during pregnancy. Menstrual history (Last menstrual period).
- Maternal medical history (hypertension, diabetes mellitus & Coagulopathies).
- Maternal surgical history.

2.3. Examination

- General examination: Vital signs and chest and heart examination.
- Abdominal examination: Fundal level to detect expected gestational age, fetal weight, amount of liquor, fetal lie and presentation, fetal heart sounds, uterine contractions and scar of previous surgeries.

Investigations:

1) CBC.

2) Obstetric ultrasound study: Ultrasound were done by same sonographer in: 1st trimesteric ultrasound: to measure crown rump length between 9 and 12 weeks of gestation. 3rd trimesteric ultrasound: between 32 and 36 weeks of gestation to measure placental thickness and trans-cerebellar diameter.

All ultrasound performed using SAMSUNG H60 convex probe 2 - 8 MHz Machine by same sonographer.

Trans-cerebellar diameter was identified by obtaining an oblique view through posterior fossa that included visualization of midline thalamus, cerebellar hemispheres and cisterna magna [4]. Placental thickness was measured at the level of the umbilical cord insertion excluding the myometrium and sub-placental veins [3]. Crown rump length is the length of the embryo or fetus from the top of its head to the bottom of torso in the largest dimension excluding the yolk sac and extremities [5].

Primary outcome:

Ultrasound measurements of placental thickness and trans-cerbellar diameter compared to LMP (confirmed by crown rump length calculated by early ultrasound between 9 to 12 weeks) and combining both of them to determine gestational age in third trimester of pregnancy.

Secondary outcome:

Other fetal biometric measurements

- Femur length (FL)
- Biparietal diameter (BPD)

Ethical considerations:

The study was approved by ethical committee of Ain Shams University. All patients had an informed consent: their right to self-determination and the right to know understand to make informed decisions, right to privacy and confidentiality.

Statistical methods:

Statistical analysis were done on a personal computer using IBM© SPSS© Statistics version 21 (IBM© Corp., Armonk, NY, USA). Data were collected, tabulated then analyzed using appropriate statistical tests. The D'Agostino-Pearson test was used to test the normality of numerical data distribution. Numerical data was presented as mean and standard deviation (if normally distributed) or as median and interquartile range (if skewed). Categorical data was presented as number and percentage or as ratio. One-way analysis of variance (ANOVA) was used to compare normally distributed numerical data. For skewed data, the Kruskal-Wallis test was used. The chi square test or Fisher's exact test, when appropriate, were used to compare categorical data. $P < 0.05$ was considered statistically significant.

Sample size justification:

Sample size was calculated using G power program, setting the type-1 error (α) at 0.05 and the power ($1 - \beta$) at 0.8. Result from previous study [4] showed that in second and third trimester, TCD had highest correlation with GA with value of ($r = 0.997$) compared to the correlation between placental thickness and

the gestational age, (r = 0.812) [3]. Calculation according to these values with taking in consideration 20% drop out rate, the needed sample is 100 cases (Figures 1-4).

Figure 1. Placental thickness.

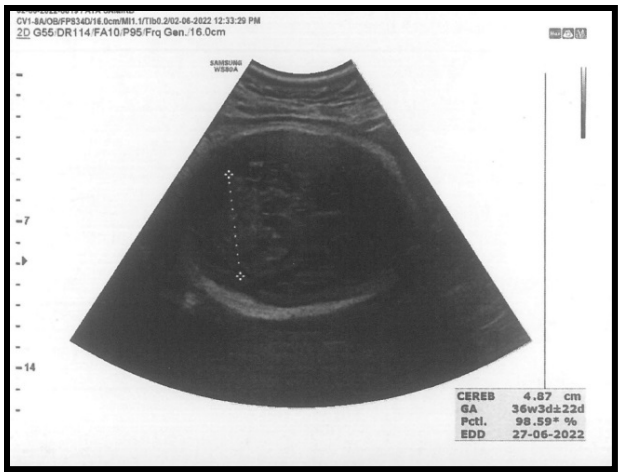

Figure 2. Trans-cerebellar diameter.

Figure 3. Biparietal diameter.

3. Results

Placental thickness had highest determination (0.813) for gestational age followed by trans-cerebellar diameter (0.802). Combining trans-cerebellar diameter and placental thickness increased determination (0.902) for gestational age (Table 1 & Table 2).

Placental thickness had highest agreement (0.945) with gestational age followed by trans-cerebellar diameter (0.941). Combining trans-cerebellar diameter and placental thickness increased agreement (0.974) with gestational age (Table 3).

Placental thickness had highest three days' accuracy 58 (58.0%) followed by trans-cerebellar diameter 56 (56.0%). Combining trans-cerebellar diameter and placental thickness increased three days' accuracy 69 (69.0%) (Table 4 & Table 5).

Figure 4. Femur length.

Table 1. Age, parity, gestational age and anthropometric measures of the studied cases.

Variables		Mean ± SD	Range
Age (years)		28.5 ± 5.9	19.0 - 43.0
LMP (week)		35.0 ± 1.4	32.0 - 36.8
Trans-cerebellar diameter (mm)		46.0 ± 3.5	38.2 - 51.7
Placental thickness (mm)		39.6 ± 7.1	22.8 - 54.3
		N	%
Parity	**Primiparous**	34	34.0
	Multiparous	66	66.0
LMP week	**Week-32**	13	13.0
	Week-33	9	9.0
	Week-34	16	16.0
	Week-35	28	28.0
	Week-36	34	34.0

Total = 100. SD: Standard deviation.

Table 2. Regression analysis for gestational age using different measures.

Measures	Items	β	SE	95% CI	p-value	Adjusted R^2
Trans-cerebellar diameter	**Constant**	18.10	0.85	16.42 - 19.78	**<0.001***	**0.802**
	TCD (mm)	0.37	0.02	0.33 - 0.40	**<0.001***	
Placental thickness	**Constant**	27.75	0.36	27.04 - 28.45	**<0.001***	0.813
	PT (mm)	0.18	0.01	0.17 - 0.20	**<0.001***	
Trans-cerebellar diameter and Placental thickness	**Constant**	21.65	0.69	20.28 - 23.03	**<0.001***	**0.902**
	PT (mm)	0.11	0.01	0.08 - 0.13	**<0.001***	
	TCD (mm)	0.20	0.02	0.16 - 0.24	**<0.001***	

Total = 100. β: Regression coefficicent. SE: Standard error. CI: Confidence interval. *Significant. R^2: Coefficient of determination.

Table 3. Agreement between gestational age and estimated gestational age by regression models.

Method	Chronbach's α	95% CI	p
Trans-cerebellar diameter	0.941	0.913 - 0.960	<0.001*
Placental thickness	0.945	0.919 - 0.963	<0.001*
Trans-cerebellar diameter and Placental thickness	0.974	0.962 - 0.983	<0.001*

Total = 100. Interclass correlations test. *Significant.

Table 4. Three days' accuracy of different measures among the studied cases.

Method	≤±3 days	>±3 days
Trans-cerebellar diameter	56 (56.0%)	44 (44.0%)
Placental thickness	58 (58.0%)	42 (42.0%)
Trans-cerebellar diameter and Placental thickness	69 (69.0%)	31 (31.0%)

Total = 100.

Table 5. One-week accuracy of different measures among the studied cases.

Method	≤±1 week	>±1 week
Trans-cerebellar diameter	90 (90.0%)	10 (10.0%)
Placental thickness	91 (91.0%)	9 (9.0%)
Trans-cerebellar diameter and Placental thickness	97 (97.0%)	3 (3.0%)

Total = 100.

Placental thickness had the highest ≤ ±1.96 SD 94 (94.0%) followed by Trans-cerebellar diameter 91 (91.0%). Combining Trans-cerebellar diameter and Placental thickness increased ≤ ±1.96 SD 97 (97.0%) (Table 6).

Table 7 and Figure 4 show that: Biparietal and femur length had agreement (0.886 and 0.935) respectively.

Table 6. Bland Altman deviation (1.96 SD) grades of different measures from gestational age.

Method	≤±1.96 SD	>±1.96 SD
Trans-cerebellar diameter	91 (91.0%)	9 (9.0%)
Placental thickness	94 (94.0%)	6 (6.0%)
Trans-cerebellar diameter and Placental thickness	97 (97.0%)	3 (3.0%)

Total = 100.

Table 7. Agreement between gestational age and estimated gestational age by regression models.

Method	Chronbach's α	95% CI	p
Biparietal	0.886	0.851 - 0.923	**<0.001***
Femur length	0.935	0.898 - 0.957	**<0.001***

Total = 100. Interclass correlations test. *Significant.

Table 8. Agreement between gestational age and estimated gestational age by regression models.

Method	Chronbach's α	95% CI	p
Biparietal	0.886	0.851 - 0.923	**<0.001***
Femur length	0.935	0.898 - 0.957	**<0.001***
Trans-cerebellar diameter	0.941	0.913 - 0.960	**<0.001***
Placental thickness	0.945	0.919 - 0.963	**<0.001***
Trans-cerebellar diameter and Placental thickness	0.974	0.962 - 0.983	**<0.001***

Total = 100. Interclass correlations test. *Significant.

Table 8 and Figure 1 show that: Placental thickness had highest agreement (0.941) with gestational age followed by trans-cerebellar diameter (0.921). Combining trans-cerebellar diameter and placental thickness increased agreement (0.974) with gestational age; while Biparietal and femur length had agreement (0.886 and 0.935) respectively.

4. Discussion

The use of ultrasound for pregnancy dating led to a reduction of post-term births and fewer inductions for post-maturity. Other benefits of routine ultrasound examinations are early detection of multiple pregnancies and increased possibilities to assess placental localization and to detect fetal malformations [1].

Accurate determination of gestational age has become important for deciding the appropriate time for termination of the pregnancy as well as to monitor the fetal growth during the entire period of pregnancy [6].

Several parameters can be considered for estimation of gestational age such as

crown rump length (CRL), bi parietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC) [4].

The measurement of placental thickness at the site of umbilical cord insertion site is relatively simple. Placental thickness normo-grams have been published and there is literature available about the use of placental thickness as a new parameter in the assessment of gestational age [6].

The present study is a cross sectional study that was done to assess whether the trans-cerebellar diameter, placental thickness or combining both of them is more accurate for assessment of gestational age in the 3rd trimester of pregnancy.

The study was conducted at outpatient clinic or obstetric ward, Ain Shams University Maternity Hospital, over a period of six months from March 2019 to September 2019. Hundred pregnant women were recruited either from outpatient clinic or were admitted in obstetric ward Ain Shams Maternity Hospital.

The current study revealed the range of values for TCD was 38.2 - 51.7 mm (mean = 46.0 ± 3.5 mm).

The mean of Placental thickness was 39.6 ± 7.1 with range 22.8 - 54.3, while in a study done by Noor *et al.* [7], the mean placental thickness (Mean ± SD) between the ranges of 18 - 40 mm was 31.63 ± 4.79 mm.

In the current study placental thickness had the highest determination (0.813) for last menstrual period followed by trans-cerebellar diameter (0.802).

Combining trans-cerebellar diameter and placental thickness increased determination (0.902) for last menstrual period.

The current study showed that placental thickness had highest three days accuracy 58 (58.0%) followed by trans-cerebellar diameter 56 (56.0%). Combining trans-cerebellar diameter and placental thickness increased three days accuracy 69 (69.0%).

A study was done by Kaushal *et al.* [6], 199 pregnant women at 11 to 37 weeks of gestation were recruited to measure placental thickness at the level of insertion of the umbilical cord and correlated to gestational age of the fetus in normal singleton pregnancy and found a linear increase in placental thickness with gestational age, so it can be used as a predictor of the gestational age, in women in whom the last menstrual period is unreliable or is not known.

In contrast to Adeyekun and Orji [8], 450 pregnant women were recruited and was found that TCD has strong predictive accuracy for gestational age compared to other routinely measured fetal biometry($r = 0.984$, $p = 0.000$). They also followed pregnant women throughout second and third trimesters.

On the contrary, Bansal and Bansal [9] study, it was done on total of 200 consecutive pregnant women with gestational age ranging from 15 to 38 weeks measuring trans-cerebellar diameter. They concluded that the transverse cerebellar diameter (TCD) has the highest statistical significance in comparison to other diameters hence could be used in the third trimester (Correlation coefficient—0.97305, p-value—0.001). The points of difference with our study are that they enrolled women with IUGR, different sample size and inclusion criteria; they also followed pregnant women throughout second and third trimesters.

Coinciding with our study, Noor *et al.* [7] study on 152 pregnant women, With Gestational ages among the studied cases were between 32 to 36 weeks. It was found that the placental thickness measured at the level of umbilical cord insertion is an accurate sonographic indicator in the assessment of gestational age due to its linear correlation. But they didn't address TCD and other biometrics in the study.

In a study done by Uikey *et al.* [10] and his colleagues to assess the role of fetal trans-cerebellar diameter in estimating the gestational age in second and third trimester of pregnancy and its correlation with gestational age, BPD, HC, AC and FL. It was found that normative cerebellar measurements throughout pregnancy permit estimation of gestational age independent of the shape of fetal head. There is a strong correlation of GA and TCD (r = 0.972). The correlation of TCD with BPD was (r = 0.960), with HC (r = 0.979), with AC (r = 0.980) and with FL (r = 0.976).

While Karthikeyan *et al.* [3] used multiple correlation between GA, USG (ultrasonographic) BPD, FL, AC, HC, FW and PT by using the Fishers' Z—transformation with a 5% confidence interval in the matrix form. It was found that the correlation between the gestational age and the placental thickness was r = 0.968, which was significant at a 5% confidence interval. This shows a very high positive correlation between the GA and the placental thickness but didn't assess TCD. But they didn't study TCD and other biometrics in the study.

The results of the current study are similar to observations of others but some studies didn't compare between various fetal biometrics, also they recruited pregnant women and followed them throughout the whole pregnancy.

Throughout our study, different parameters were measured as a secondary outcome which were femur length and biparietal diameter.

Yet, the agreement between the 4 parameters of our study compared to our gold standard was as follows; placental thickness had the highest agreement (0.941), followed by trans-cerebellar diameter (0.921). Combining trans-cerebellar diameter and placental thickness showed the highest agreement (0.974). While femur length and biparietal diameter had agreement (0.935) and (0.886) respectively.

Points of strength: Compare different fetal biometric with reliable LMP dates confirmed by first trimesteric ultrasound to have the most accurate one as a predictor for gestational age in 3rd trimester; involving the same sonographer in all ultrasounds.

Limitations of the study: Pregnant women with medical disorders were excluded. No regular follow up from 1st till 3rd trimester for fetal biometrics.

Covid-19 pandemic made limitations to recruitment of pregnant women.

5. Conclusion

Use of trans-cerebellar diameter and placental thickness in the third trimester of pregnancy is a reliable indicator for gestational age in women whose last men-

strual period is unreliable or unknown, but placental thickness had higher accuracy than TCD.

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Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with ethical standards of the ethical committee of the department of obstetrics and gynaecology faculty of medicine, Ain Shams University.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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