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**Original article** 

Accuracy of trans cerebellar diameter in comparison with biparietal diameter, femur length, fetal kidney length in the sonographic assessment of gestational age in the 2nd and 3rd trimester pregnancy

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Article Info	Abstract					
Article history:	Background: When a fetus's age cannot be determined from					
Received 25 October 2023	the mother's last menstrual period or an early ultrasound, the					
Accepted 3 December	cerebellar diameter serves as a reliable predictor of GA and a					
2023	standard against which other fetal measures may be evaluated.					
Corresponding Author:	This study aims to detect an accurate method for assessment of					
Sarah Ahmed Ibrahim	gestational age in second and third trimester of pregnancy					
saritaahmed92@gmail.com	comparing the trans cerebellar diameter, biparietal diameter,					
	femur length and fetal kidney length. Methods: This was an					
Keywords	analytical study performed on 100 pregnant females in second					
BPD	or third trimester pregnancy attending at the Obstetrics and					
FL	Gynecology Outpatient Clinic at Beni-Suef University					
gestational age	Hospital. Fetal biometric measurements were taken using					
TCD.	ultrasound, including TCD, BPD, FL, and fetal kidney length.					
	Result: The TCD and KL both rise with an increase in GA and					
	have excellent correlation coefficients, indicating good					
	measurement agreement and reproducibility that is unaffected					

by the late-trimester variability **Conclusion:** According to the

findings of this research, KL and TCD exhibit a strong correlation with fetal GA in the third trimester, while in the second trimester BPD, FL, AC and TCD are good predictors of gestational age and no role for KL at that time of pregnancy

## 1. Introduction:

Gestational age (GA) is the number of weeks and days from the first day of the last menstrual period (LMP). This is also called as menstrual age <sup>(1)</sup>

Clinical examination, menstrual history, and ultrasonography are the three mainstays for estimating the gestational age (GA), however the first two are very inaccurate and should only be used in the absence of ultrasonography <sup>(2)</sup>

Predicting a fetus's gestational age (GA) using sonographic fetal characteristics has been a cornerstone of contemporary obstetrics specially in fetus with growth disorder <sup>(3)</sup>

The biparietal diameter (BPD) is still used as a reference point for evaluating other GA evaluation metrics. It's one of the most frequent fetal measurements taken. From 12 weeks of gestation until delivery, the BPD may be assessed quickly and reliably by ultrasonography <sup>(4)</sup>

In the second and third trimesters of pregnancy, femur length (FL) is a very helpful biometric measure. The optimal time to take a measurement, based on how linearly it develops, is around week 14 of pregnancy. The length of the bone is measured in a straight line from one end to the other, ignoring any curvature in the underlying osseous structure <sup>(5)</sup>

The trans cerebellar diameter (TCD) is a reliable and independent indicator of gestational age <sup>(6)</sup>. Transcerebellar diameter in millimeters correlates with gestational age in weeks for the fetal cerebellum during the second trimester, but the curve tends to flatten in the third trimester as the growth of the fetal cerebellum in mm exceeds the fetal gestational age, reducing the margin of interobserver error. When fetal head size and shape make it challenging to evaluate BPD, TCD is the method of choice <sup>(7)</sup>

One such non-standard measure for calculating GA is fetal kidney length (FKL). It's a metric with which to easily work. It has been shown on MRI to increase linearly throughout pregnancy, and its association with GA is substantial. After the 24th week of pregnancy, this technique outperforms BPD and FL in estimating GA <sup>(8).</sup> So, our study aims to detect an accurate method for assessment of gestational age in second and third trimester of pregnancy comparing the trans cerebellar diameter, biparietal diameter, femur length and fetal kidney length.

## 2. Patients and Methods:

This is a cross sectional analytical study conducted in Obstetrics and Gynecology department, Beni-Suef University Hospital between July 2021 and October 2022, following approval by the scientific & ethics committee.

#### Methods:

Study design: prospective observational study was conducted at Obstetrics and Gynecology Outpatient Clinic at Beni-Suef University Hospital, September 2021- June 2022. **Study population:** 100 pregnant women in second or third trimester pregnancy were recruited from Outpatients attending Beni-Suef University Hospital.

**Inclusion criteria**: All women carrying a single, viably developing baby in a vertex presentation in their second or third trimester of pregnancy. Reliable menstruation periods throughout history. Calculated from the first day of the last menstrual cycle or an ultrasound taken during the first trimester, the

gestational age at the end of the second or third trimester.

**Exclusion criteria:** women unsure of their dates or non-reliable dates, obstetric or medical disorders with pregnancy as diabetes , hypertension, Rh iso-immunization, women with polyhydramnios, preterm rupture of membranes, women with congenital fetal anomalies, multiple pregnancy, fetal malpresentation, antepartum hemorrhage, patients with placenta previa, macrosomia and IUGR were excluded from the study.

Information about the pregnant women who participated in the research was gathered as follows: All women's menstrual cycles and first trimester ultrasounds were used to validate their obstetric histories and gestational ages. The medical history of the mother during her pregnancy was also documented. Ultrasound examination for, gestational age determination as femur length, biparietal diameter, trans-cerebellar diameter, abdominal circumference, and fetal kidney length.

#### The examination technique:

The sonographer verified the examination's rationale for the patient. It is important to keep track of when the woman's last menstruation was (or when she is expected to give birth).

In gynecology and obstetrics, a semirecumbent posture is the norm. For extra coziness, a cushioned table and pillow are employed. Some pregnant women, particularly those in their late trimesters, have trouble lying flat and may benefit from having the head of their bed raised. Concerning the transcerebellar diameter measurement, gaining the trans thalamic perspective of BPD. The biparietal diameter was measured in the lateral ventricles view of the skull, which has a rugby-football-shaped profile with a rounded rear (occiput) and a more pointed front.

The kidneys were seen slightly below the stomach after the fetus had been examined in the transverse plane. The FL is imaged ideally for measuring femur length with both ends of the ossified metaphysis being easily visible. The ossified diaphysis' longest axis is measured.

#### Statistical analysis of the data

We used the SPSS program version 27 for data analysis. Numeric data was expressed as mean and standard deviation. Pearson correlation was done between the gestational age and the measured parameters. Simple linear regression analysis was done to predict the gestational age from specific formula. Multiple linear regression was done to assess the significant parameters to assess the gestational age. P-value less than 0.05 was considered significant.

#### **Ethical considerations:**

Our study was conducted in line with the declaration of Helsinki. Our study protocol was approved by the local ethics committee of Faculty of Medicine of Beni-Suef University taken number; FMBSUREC/05122021/Ibrahim.

# 3. Results :

The study included 100 pregnant women in the second and the third trimester with mean age 27.8±5.7 years and mean gestational age 26.8±5.5 weeks. There were 36% para 0, 28% para 1, 16% para 2, 11% para 3, 8% para 4, and 9% para 5.

The mean biparietal diameter was  $67.3\pm15.7$  mm and gestational age by biparietal diameter was  $27.4\pm5.9$  weeks with a strong correlation between GA by BPD and by date (r=, P-value<0.001).

**Table 1** showed that there was a significant role of BPD in prediction of the gestational age by date. The predictive value of the BPD in prediction of gestational age by date can be used as follows:

Gestational age by date= 3.95+0.340 (BPD)

# Table (1) Prediction of gestational age by date from Biparietal diameter among the studied pregnant women:

Model	Unstandardized Coefficients		Standardized Coefficients	Τ	P-value	95.0% Confidence Interval for B	
	В	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	3.956	.602		6.574	< 0.001*	2.762	5.150
Biparietal diameter	.340	.009	.969	38.999	<0.001*	.323	.357

Dependent Variable: Gestational age by date

The mean Femur length was  $47.2\pm13.1$ mm, the mean gestational age by FL was  $26.7\pm5.7$  weeks by FL with a strong positive correlation between GA by FL and by date (r=0.956, P-value<0.001). There was a significant role of FL in prediction of the gestational age by date. The predictive value of the FL in prediction of gestational age by date can be used as follows as shown in **Table 2:** Gestational age by date= 7.98+0.399 (FL)

Model	Unstandardized Coefficients		Standardized Coefficients	Т	P-value	95.0% Interval for	Confidence B
	В	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	7.987	.607		13.167	< 0.001*	6.783	9.190
FL	.399	.012	.956	32.220	< 0.001*	.375	.424

Table (	2)	Prediction	of	gestational	age	by	date	from	femur	length	among	the	studied
pregnar	nt v	vomen:											

Dependent Variable: Gestational age by date\*P-value is significant

The mean abdominal circumference was  $222.1\pm58.1$  mm, the mean gestational age by AC was  $27\pm5.6$  weeks by AC with a strong correlation between GA by AC and by date (r=0.963, P-value<0.001). There was a significant role of AC in prediction of the gestational age by date as shown in **Table 3**. The predictive value of the AC in prediction of gestational age by date can be used as follows: Gestational age by date= 6.52+0.091 (AC)

 Table (3) Prediction of gestational age by date from Abdominal circumference (AC) among

 the studied pregnant women:

Model	Unstandardized Coefficients		UnstandardizedStandardizedTCoefficientsCoefficients		Т	P-value	95.0% Confidence Interval for B	
	В	Std. Beta Error				Lower Bound	Upper Bound	
(Constant)	6.527	.594		10.983	< 0.001*	5.347	7.706	
AC	.091	.003	.963	35.277	< 0.001*	.086	.096	

Dependent Variable: Gestational age by date\*P-value is significant

The mean TCD was  $29.9\pm8.5$  mm, the mean gestational age by TCD was  $26.9\pm5.6$  weeks by TCD with a strong positive correlation between GA by TCD and by date (r=0.965, P-value<0.001). **Table 4** showed that there was a significant role of TCD in prediction of the gestational age by date. The predictive value of the TCD in prediction of gestational age by date can be used as follows: Gestational age by date= 8.22+0.623 (TCD)

Table (4) Prediction of gestational age by date from trans cerebellar diameter (TCD) amorphic	ng
the studied pregnant women:	

Model	Unstandardized Coefficients		Standardized Coefficients	Т	P-value	95.0% Confidence Interval for B	
	B Std. Beta		Beta			Lower	Upper
		Error				Bound	Bound
(Constant)	8.221	.531		15.485	< 0.001*	7.167	9.274
TCD	.623	.017	.965	36.417	< 0.001*	.589	.657

Dependent Variable: Gestational age by date \*P-value is significant

The mean KL was  $30.1\pm9.6$  mm, the mean gestational age by KL was  $30.1\pm9.6$  weeks by KL with a strong positive correlation between GA by KL and by date (r=0.911, P-value<0.001). Table 5 showed that there was a significant role of KL in prediction of the gestational age by date. The predictive value of the KL in prediction of gestational age by date can be used as follows:

Gestational age by date= 9.004+0.672 (KL)

Table (5) Prediction of gestational age by date from kidney length (KL) among the studied pregnant women:

Model	Unstandardized Coefficients		Standardized Coefficients	Т	P-value	95.0% Confidence Interval for B	
	B Std. H		Beta			Lower	Upper
		Error				Bound	Bound
(Constant)	9.004	1.135		7.930	< 0.001*	6.739	11.270
KL	.672	.037	.911	18.173	< 0.001*	.598	.746

Dependent Variable: Gestational age by date \*P-value is significant

A multiple regression was run in **Table 6** to predict gestational age from Biparietal diameter. Femur length, Trans-cerebellar diameter, and Kidney length. These variables statistically significantly predicted the gestational age, F(5, 64) = 209, P-value < 0.05, R2 = 0.935. All four variables added statistically significantly to the prediction, P-value <0.05. The predictive value of all parameters in prediction of gestational age by date can be used as follows:

Gestational age by date= 5.15+0.121 (BPD)+0.111(FL)+0.218 (TCD)+0.131(KL).

Table (6) Multiple linear regression analysis for prediction of gestational age by date from Biparietal diameter, Femur length, Abdominal circumference diameter, Trans cerebellar diameter, and Kidney length among the studied pregnant women (no=70):

Model	Unstanda	rdized	Standardized	Т	P-value	95.0%	Confidence
	Coefficie	nts	Coefficients			Interval for B	
	В	Std. Error	Beta			Lower	Upper
						Bound	Bound
(Constant)	5.152	.996		5.175	< 0.001*	3.163	7.141
Biparietal	.121	.048	.321	2.535	0.014*	.026	.217
diameter							
Femur length	.111	.041	.265	2.739	0.008*	.030	.192
Abdominal	008	.013	088	632	0.529	035	.018
circumference							
diameter							
Trans cerebellar	.218	.057	.335	3.847	< 0.001*	.105	.331
diameter							
Kidney length	.131	.055	.178	2.361	0.021*	.020	.242

Dependent Variable: Gestational age by date\*P-value is significant.

Table 7 showed that the highest difference was seen between the gestational age by date and the gestational age by BPD and this difference was statistically significant.

Table (7) Absolute difference between the gestational age by date and gestational age by Biparietal diameter, Femur length, abdominal circumference diameter, Trans-cerebellar diameter, Kidney length:

Meas	ures	Mean	Mean	Ν	Std. Deviation	P-value
			Difference			
1	Gestational age by date	26.8150	58400	100	5.51128	< 0.001*
	GA by biparietal	27.3990		100	5.96699	
	diameter					
2	Gestational age by date	26.8150	.10800	100	5.51128	0.407
	GA by femur length	26.7070		100	5.66940	
3	Gestational age by date	26.8150	19900	100	5.51128	0.151
	GA by abdominal	27.0140		100	5.60626	
	circumference diameter					
4	Gestational age by date	26.8150	10800	100	5.51128	0.209
	GA by trans cerebellar	26.92		100	5.634	
	diameter					
5	Gestational age by date	29.2129	01571	70	4.37675	0.897
	GA by kidney length	29.2286		70	4.37288	

\*P-value is significant

To stop on the real role of the studied parameters we stratified the studied women to  $2^{nd}$  and  $3^{rd}$  trimesters, there were 50% in the  $2^{nd}$  trimester and 50% in the  $3^{rd}$  trimester.

A multiple regression was run in **Table 8** to predict gestational age from Biparietal diameter, Femur length, Trans cerebellar diameter, and Kidney length. These variables statistically significantly predicted the gestational age in the  $2^{nd}$  trimester except for the kidney length. On the other hand, the same variables can't except the trans cerebellar diameter and kidney length were the only predictors when the other parameters are constant.

The predictive value of the studied parameters in prediction of gestational age by date in the second trimester can be used as follows:

Gestational age by date= 8.947+.144 (BPD)+0.124 (FL)-0.038 (AC)+ .324 (TCD).

The predictive value of the studied parameters in prediction of gestational age by date in the third trimester can be used as follows:

Gestational age by date= 4.456+0.152 (TCD)+0.132(KL).

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New	Independent	Unstand	lardized	Т	P-value	95.0% C	Confidence Interval for B
	variables	Coeffic	ients				
		В	Std.			Lower	Upper Bound
			Error			Bound	
2 <sup>nd</sup>	(Constant)	8.947	.889	10.062	< 0.001*	7.062	10.832
trimester	Biparietal	.144	.038	3.743	.002*	.062	.225
	diameter						
Adjusted	Femur length	.124	.040	3.087	.007*	.039	.209
$R^2 = .944$	Abdominal	038	.011	-3.538	.003*	061	015
.865	circumference						
	diameter						
	Trans cerebellar	.324	.063	5.108	< 0.001*	.190	.458
	diameter						
	Kidney length	.017	.078	.211	.836	150	.183
3 <sup>rd</sup>	(Constant)	4.456	2.727	1.634	.110	-1.047	9.959
trimester	Biparietal	.117	.090	1.306	.199	064	.299
	diameter						
	Femur length	.102	.050	2.018	.049*	.000	.203
Adjusted	Abdominal	.006	.020	.286	.776	035	.047
$R^2=0.865$	circumference						
	diameter						
	Trans cerebellar	.152	.070	2.181	0.035*	.011	.292
	diameter						
	Kidney length	.138	.064	2.151	0.037*	.009	.268

 Table (8) Multiple linear regression analysis for prediction of gestational age by date from

 Biparietal diameter, Femur length, Abdominal circumference diameter, Trans cerebellar

 diameter, and Kidney length among the studied pregnant women in each trimester:

Dependent Variable: Gestational age by date\*P-value is significant.

#### 4. Discussion:

Many women in developing nations lack access to routine antenatal care. As a result, many pregnant patients who are in their second or third trimester of pregnancy visit hospitals without any documents that could be used to calculate their gestational age, moreover, the best obstetric management of pregnancies depends on accurate gestational dating, which is of utmost significance and the cornerstone of pregnancy management. Clinically significant gestational dating parameters for sonography include reproducible fetal biometric measurements. This is particularly true when determining the best time to perform various gestational tests, gauge the baby's development, and schedule the delivery <sup>(7)</sup>

Accordingly, unnecessary induction, dysfunctional labor, surgical birth, and iatrogenic prematurity or post maturity can all result from inaccurately estimating GA, so the most popular technique for determining GA is ultrasonographic prenatal biometry. Crown Lump Length (CRL), Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), and Femur length are some of the prevalent sonographic biometric parameters. (FL). CRL measurements can only be used for cases that present in the first trimester, but they can reliably predict GA to within 5-7 days <sup>(9)</sup>

Additionally, in the early second trimester, FL, HC, and AC can reasonably forecast GA  $(\pm 10-11 \text{ days}, \pm 10-20 \text{ days}, \pm 10-14 \text{ days and}$  $\pm 10-14$  days respectively). These parameters could be off in late pregnancy, particularly if the expectant mother is unable to remember her LMP. Furthermore, there is strong evidence that the standard derivation for these indices widens as pregnancy continues. If the head is too low or an obvious plane cannot be obtained, this will be even worse, which will all together lead to inaccurate measurement of BPD and HC<sup>(10).</sup> Therefore, it is still difficult to provide an exact estimate of GA in the third trimester. Third-trimester calculation of gestational age relies on a number of different measurements, none of which are universally accepted <sup>(11)</sup>

On the other hand, depending on the GA at which the study is conducted, fetal kidneys in

the second and third trimesters usually have the same configurations as in postnatal life. It was discovered that estimating the length of the fetal kidney had a strong correlation with gestational age, so it was recommended for determining the fetal maturity <sup>(9)</sup>

Consequently, TCD has been investigated over the past few years, and the findings were very encouraging, demonstrating a very strong correlation with GA, particularly in the third trimester of pregnancy <sup>(12)</sup>. Between the occipital and petrous bones in the posterior fossa is where the embryonic cerebellum is situated. Its development exhibits a linear relationship with advancing GA, does not alter in response to fetal skull changes, and is unaffected by fetal growth even in IUGR <sup>(13)</sup>, because of these characteristics, many writers now regard TCD as one of the most trustworthy sonographic parameters for estimating GA. Some of them observed that in IUGR cases, it was even more dependable than other parameters (14).

In this study the BPD, FL, AC TCD and KL measurements showed a significant role in prediction of gestational age by date where the mean of measurement length and mean of gestational age was as follows ( $27.8\pm5.7$ mm &  $27.4\pm5.9$  weeks), ( $47.2\pm13.1$ mm &  $26.7\pm5.7$  weeks), ( $222.1\pm58.1$  mm &

 $27\pm5.6$ weeks), ( $29.9\pm8.5$  mm &  $26.9\pm5.6$ weeks) & ( $30.1\pm9.6$  mm &  $30.1\pm9.6$  weeks) respectively. These results go with different studies that recommend the above biometric parameters in determination of gestational (15,16,17)

Additionally on doing multiple linear analysis for prediction regression of gestational age by date from Biparietal diameter. Femur length, Abdominal circumference diameter, Trans cerebellar diameter, and Kidney length among the studied pregnant women, we found that ( BPD, FL, TCD & FL) variables statistically significantly predicted the gestational age with P-value < 0.05, R2 = 0.935 where the equation was: Gestational age by date=  $5.15 \pm 0.121$ (BPD)+0.111(FL)+0.218 (TCD)+0.131(KL), while AC although it is one of the documented biometric parameters for gestational age but in this equation it has no significant value, Žaliūnas B et al<sup>(18)</sup> agreed with this data and concluded that Although AC should not be used to estimate a pregnancy's progress, it is an important parameter for gauging IUGR and fetal macrosomia.(18)

Furthermore, multiple linear regression analysis for prediction of gestational age by the studied gestational parameters in 2nd and 3rd trimesters (50 % in 2nd & 50 % in 3rd

trimesters) was done to stop on the real role of the studied parameters and if their predictive value is affected according to each trimester or not. These variables statistically significantly predicted the gestational age in the 2nd trimester except for the kidney length, and the predictive value was: Gestational age by date= 8.947+.144 (BPD)+0.124 (FL)-0.038 (AC)+.324 (TCD). TariQ et al <sup>(19)</sup> in their study disagreed with us as they found a significant role of fetal kidney length in gestational age determination during second trimester where the mean kidneys length for 18-24 weeks gestational age by FKL was 21.557+2.0476 (P<0.001) (19)

On the other hand, regarding 3<sup>rd</sup> trimester the trans cerebellar diameter and kidney length were the only significantly predictors for gestational age as follows: Gestational age by date= 4.456+0.152 (TCD)+0.132(KL). A study done by Reddy et al agreed with the significant effect of TCD over (BPD, FL, AC) on prediction of gestational age in third trimester, they found in their study that TCD revealed highest correlation with r value of 0.997. Significant variation in r-values was seen between the ages of 29 and 40 weeks. When comparing GA by TCD and LMP, an r-value of 0.982 was found, which is higher than the r-values of the other parameters.

BPD had the weakest association (r=0.951). The r-value for the FL was 0.981, making it the second most reliable correlation.<sup>(14)</sup>. The rise in TCD seen during pregnancy provided a useful metric for estimating cerebellar maturation. Research by Mikovic et al. on the development of the fetal cerebellum between weeks 20 and 40 of pregnancy suggested that TCD might be used in practice when BPD is either hard to quantify or undesirable due to the apparent shaping of the head.<sup>(20).</sup>

Another study done by Mahale et al  $^{(21)}$  agreed with us where comparison of linear coefficient of MKL (Mean Kidney Length) with gestational age revealed a strong correlation (r=0.890) which was higher than the other parameters taken individually. [AC (r=0.856) then BPD (r=0.832), FL (r=0.828) and HC (r=0.827). MKL was statistically highly significant with a p value of 0.0001] (21)

The utility of measuring fetal kidney length from 24 to 38 weeks of gestation was assessed by Konje et al. They found that the average fetal kidney length had the highest correlation with the estimated gestational age at the end of the third trimester (r=0.94) of pregnancy. If BPD and HC measurements are challenging because of fetal head engagement or because accurate planes cannot be acquired, the researchers discovered that fetal kidney length was simple to integrate in dating pregnancies beyond 24 weeks. When other growth measures are trailing behind in late pregnancy, it has been proposed as a predictor of gestational age.<sup>(22)</sup>

In our study we found that both KL and TCD had a significant predictive value in gestational age determination and Singh et al in their study concluded the same where they found that KL and TCD show a strong correlation with fetal GA, with a steady growth rate throughout pregnancy <sup>(23)</sup>on the other hand a study by Ahmed El Saeed et al with a different result than ours, they found mean fetal kidney length is more accurate in determination of gestational age than trans cerebellar diameter (96.3% VS 89.8%) <sup>(24)</sup>.

**5.** Conclusion and recommendations: In conclusion, the TCD and KL both rise with an increase in GA and have excellent correlation coefficients, indicating good measurement agreement and reproducibility that is unaffected by the late-trimester variability. According to the findings of this research, KL and TCD exhibit a strong correlation with fetal GA in the third trimester, while in the second trimester BPD, FL, AC and TCD are good predictors of gestational age and no role for KL at that time of pregnancy. This study recommends a large-scale future study to generate an equation for Egyptian population for assessment of the gestational age by ultrasound parameters and programming a software to be introduced to the available ultrasound for more accurate gestational age calculation. In addition, we recommend using the trans cerebellar diameter and kidney length in the 3rd trimester.

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