

## Comparison between Trans-cerebellar Diameter, Bi-parietal Diameter and Femur Length for Gestational Age Measurement Accuracy in Third Trimester of Pregnancy

Ahmed Taha Abd El Fattah<sup>1</sup>, Hazem Sayed Shaban<sup>2</sup>,  
Eman Ahmed Abdelsalam Younis<sup>1</sup>

Obstetrics and Gynecology Department, <sup>1</sup> Faculty of Medicine, Al-Azhar University,  
<sup>2</sup> Police Authority Hospital

\* Corresponding author: Eman Ahmed Abdelsalam Younis, E-mail: amr\_pharm1234@yahoo.com

### ABSTRACT

**Background:** the provision of obstetric and neonatal care, as well as the public health monitoring of pregnancy outcomes, relies upon the accurate determination of gestational age. Uncertain gestational age has been associated with adverse pregnancy outcomes including low birth weight, preterm delivery and perinatal mortality, independent of maternal characteristics.

**Aim of the Work:** was fine out an accurate method for assessment of gestational age in third trimester of pregnancy comparing the Transcerebellar diameter, Biparietal diameter and femur length.

**Patients and Methods:** a total of 200 pregnant women in third trimester pregnancy were assessed in this prospective observational study held at Al-Hussein University Hospital and New Cairo Police Hospital using two-dimensional ultrasound technique during the period from January to June 2018 in order to assess an accurate method for assessment of gestational age in third trimester of pregnancy. Examinations were performed after a written consent received from the patients lying in the dorsal supine position. Two-dimensional ultrasound examination was carried out. Fetal biometry and amniotic fluid volume were assessed. These ultrasound parameters were done under the supervision of a certified gynecologist to exclude bias.

**Results:** the majority of the patients in our study belong to the age group 20 to 30 years (65%) with minimum of 15 years and maximum of 35 years. In our study, also 55 patients out of 200 were primigravida and 145 patients were multigravida. Our patients showed that the percentages of accurate assessment of gestational age within 3 days were as follow: Out of 200 patients, TCD gave accurate assessment within 3 days in 118 patients (59%), FL gave accurate assessment within 3 days in 92 patients (46%), while the BPD gave accurate assessment within 3 days in 59 patients (29.5%).

**Conclusion:** we concluded that TCD is the most accurate method for the assessment of gestational age in third trimester followed by FL, and the least accurate is the BPD. Also by combining accuracy of TCD (90%) and that of FL (80%).

**Keywords:** Trans-cerebellar Diameter, Bi-parietal Diameter, Femur Length, Gestational Age, Third Trimester

### INTRODUCTION

The use of ultrasonography has significantly improved the evaluation of fetal growth and development and has permitted prenatal diagnosis of a variety of congenital malformations. Ultrasonographic fetal biometry is highly reliable in first and second trimester of pregnancy but reliability of any ultrasound method greatly diminishes as gestational age advances, in third trimester, reliability of any single ultrasound parameter alone is poor without correlation with other parameters. The biparietal diameter (BPD) remains the standard against which other

parameters of GA assessment are compared. It is one of the most commonly measured parameters in the fetus. The BPD may be rapidly and reproducibly measured by ultrasound examination from 12 weeks' gestation until the end of pregnancy. The BPD is imaged in the transaxial plane of the fetal head at a level depicting thalami in the midline, equidistant from the Temporoparietal bones and usually the cavum septum pellucidum anteriorly. Although several methods have been used to measure BPD, the most commonly accepted method is

measurement from leading edge to leading edge (outer-to-inner) <sup>(1)</sup>.

**Butt and Lim** <sup>(2)</sup> compared the BPD and the frontooccipital diameter. The ratio of these diameters is called the cephalic index (CI), with a mean value of 0.78 and a normal range ( $\pm 2$  SD) of 0.70 to 0.86. In the fetus with an abnormal cephalic index (noted in <2% of fetuses prior to 26 weeks' gestation), dates may be estimated more accurately using other fetal parameters, such as head circumference.

FL is a very useful biometric parameter used in the second and third trimesters of pregnancy. It grows linear throughout and is best measured after 14 weeks of gestation. It is measured along the long axis of the bone; a straight measurement of the osseous portion is taken from one end to the other, disregarding bone curvature. Femur length (FL) measurements may be used to accurately predict gestational age between 14 weeks' gestation and term. The accuracy of gestational age prediction based on FL is greatest in the second trimester and least near term <sup>(2)</sup>.

Transcerebellar diameter is an independent unique parameter for assessment of gestational age. The fetal cerebellum is visualized as early as 10-20 weeks post menstrual, it grows in a linear pattern in the second trimester where the transcerebellar diameter in millimeters correlates with the gestational age in weeks, but the curve tend to flatten in the third trimester where the growth of the fetal cerebellum in mm exceeds the fetal gestational age which in return also decreases the margin of inter observer error. TCD is better used when it is difficult to measure BPD due to change in size and shape of fetal head <sup>(3)</sup>.

**Reddy et al.** <sup>(4)</sup> evaluated accuracy of predicting GA using foetal Transcerebellar Diameter (TCD) and to compare between TCD and other existing parameters in evaluating GA in 15 to 40 weeks of gestation. They 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.

## AIM OF THE WORK

The aim of this study was to examine an accurate method for the assessment of the gestational age in third trimester of pregnancy comparing the Transcerebellar diameter, Biparietal diameter and femur length.

## PATIENTS AND METHODS

A total of 200 pregnant women in third trimester pregnancy were assessed in this prospective observational study carried out at Al-Hussein University Hospital and New Cairo Police Hospital using two-dimensional ultrasound technique during the period from January to June 2018 to explore an accurate method for the assessment of gestational age in third trimester of pregnancy. Examinations were performed after a written consent from the patient with the patient lying in the dorsal supine position. Two-dimensional ultrasound was carried out. Fetal biometry and amniotic fluid volume were estimated. These ultrasound parameters were done under the supervision of a certified gynecologist to be unbiased during the determination.

### Inclusion criteria:

1. Singleton, viable fetus in the vertex presentation.
2. History of reliable menstrual cycles.
3. Gestational age in third trimester calculated from the first day of last menstrual period or by first-trimester ultrasound examination.
4. No obstetric or medical complications of pregnancy.

### Exclusion criteria:

1. Patients unsure of their dates or Non reliable dates.
2. Medical disorders with pregnancy as hypertension, diabetes mellitus and Rh iso-immunization.
3. Prelabor rupture of membranes.
4. Polyhydramnios.
5. Women with multiple pregnancy.
6. Congenital fetal anomalies.
7. Antepartum hemorrhage.
8. Fetal mal-presentation.

### Methods:

*All women included in the study were subjected to the following:*

### History taking:

- Gestational age of all women was confirmed by menstrual period and first trimester ultrasonography.

- Maternal medical history during pregnancy.

**Clinical examination:**

- General Examination: Vital signs (Blood pressure, Temperature, pulse rate).
- Abdominal Examination: Physical examination.
- Local Examination: Fundal level.

**Laboratory investigations:**

- Complete blood count.
- Blood grouping and Rh.
- Liver and kidney functions.

**Ultrasound examination and Doppler studies for:**

- i. Gestational age determination
- ii. Biparietal Diameter
- iii. Femur Length
- iv. Trans-Cerebellar Diameter

**Procedure:**

Transabdominal ultrasound was performed to all patients while in a slightly tilted position with the head of the bed raised 30 degrees and with a small pillow under the right loin. The apparatus which used was the Voluson 730 ProV ultrasound machine with Doppler unit and convex linear transducer 3.5 MHz. Regarding the measurement of the transcerebellar diameter, obtaining the trans thalamic view of BPD then rotation of the probe slightly downwards, toward the fetal neck, the posterior horns of the lateral ventricles would be disappeared from the view to be replaced by the cerebellum. The TCD measured at 90 degree to the long axis of the cerebellum across its widest point, by the use of the outer to outer method <sup>(5)</sup>.

Measurement of the Biparietal diameter was taken in the lateral ventricles view, a rugby-football-shaped skull, rounded at the back (occiput) and more pointed at the front (synciput). Along midline equidistant from the proximal and distal scale echoes. The cavum septum pellucidum bisected the midline one-third of the distance from the synciput to the occiput. The two anterior horns of the lateral ventricles symmetrically placed about the midline. All or part of the posterior horns of the lateral ventricles symmetrically placed about the midline. The BPD included the thickness of only the upper parietal bone (outer to outer measurement) <sup>(6)</sup>. Regarding the measurement of the femur length, the FDL was imaged optimally with both ends of the ossified metaphysis clearly visible. The longest axis of the ossified diaphysis was measured. The same technique as that used to establish the reference chart was used with regard to the angle between the femur and the insonating ultrasound beams. An angle of insonation between 45° and 90° is typical. Regarding the Caliper placement, each caliper was placed at the ends of the ossified diaphysis without including the distal femoral epiphysis if it is visible. This measurement excluded triangular spur artifacts that can falsely extend the diaphysis length <sup>(7)</sup>. The percentages of accurate assessment of gestational age by the three measurements (TCD, BPD and FL) within 3 days and within 1 week from the actual gestational age measured by LMP or first trimester ultrasound were calculated.

**Statistical analysis**

Data were entered checked and analyzed using Epi-Info version 6 and SPP for Windows version 8.

**RESULTS**

**Table (1):** Percentages of correct assessment within 3 days

Type of measurement	Number of patients positive	Number of patients negative	Positive percentage
TCD	118	82	58%
BPD	59	141	29.5%
FL	92	108	46%

**Table (2):** P value comparing TCD with BPD within 3 days

		BPD		TCD		P value
		Count	%	Count	%	
Accuracy	Yes	59	29.5	118	59	< 0.001
	No	141	70.5	82	41	

**Table (3):** p value comparing TCD with FL within 3 days

		TCD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	118	59	92	46	< 0.05
	No	82	41	108	54	

**Table (4):** p value comparing FL with BPD within 3 days

		BPD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	59	29.5	92	46	< 0.001
	No	141	70.5	108	54	

**Table (5):** Percentages of correct assessment within one week

Type of measurement	Number of patients positive	Number of patients negative	Positive percentage
TCD	180	20	90%
BPD	120	80	60%
FL	160	40	80%

**Table (6):** p value comparing TCD with BPD within one week

		BPD		TCD		P value
		Count	%	Count	%	
Accuracy	Yes	120	60	180	90	< 0.001
	No	80	40	20	10	

**Table (7):** p value comparing TCD with FL within one week

		TCD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	180	90	160	80	> 0.05
	No	20	10	40	20	

**Table (8):** p value comparing FL with BPD within one week

		BPD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	120	60	160	80	< 0.001
	No	80	40	40	20	

## DISCUSSION

Many patients in Egypt due to socio-economic reasons come for their first antenatal visit in third trimester. Most of them are uneducated and come from remote areas. Also many being lactating mothers are unsure of their LMP or having irregular cycles. Because of non-availability of any dating scans or earlier ultrasound and uncertainty in LMP, it becomes very difficult to calculate their due dates, so many pregnancies considered to be preterm or postterm are wrongly classified.

In third trimester, various ultrasound parameters including BPD, which is one of the most commonly used parameters shows margin of error of 3 – 4 weeks from actual gestation. This is because of large biological variations in fetal skull shape and size. Management decisions become particularly difficult in conditions where there is growth

restriction or growth acceleration and in planning induction for postdate pregnancy<sup>(8)</sup>.

The femur length (FL) can be measured as early as 10 weeks gestational age because of its size and echogenicity. Correlation with true gestational age is within one week prior to 20 weeks gestational age, but falls to within 2.1 to 3.5 weeks in the third trimester. Including non-ossified portions of the femur and not visualizing the full femur (femoral head/greater trochanter to femoral condyle) were the major sources of error in gestational age assessment by FL. The former over estimates and the latter underestimates gestational age<sup>(9)</sup>.

Transcerebellar diameter (TCD) represents an independent biometric parameter as shown in this study. The fetal cerebellum visualized as early as 10 – 20 postmenstrual weeks. It grows in a linear pattern in the

second trimester but the curve flattens in third trimester<sup>(3)</sup>.

Cerebellum is not liable to change in form and size because of dense surrounding petrous ridges and occipital bone<sup>(10)</sup>. Due to this, TCD can be used where it is difficult to measure BPD or in cases where there are variations in size and shape of head. Normograms have been established for TCD and gestational age throughout pregnancy<sup>(11)</sup>.

*Naseem et al.*<sup>(9)</sup> reported the better correlation of TCD with gestational age in 2nd and 3rd trimester, its usefulness as growth assessing parameter in comparison with other routine ultrasound parameters. In our study, TCD was compared with FL and BPD in accuracy of assessment of gestational age in third trimester of pregnancy.

In our investigations, we did correlation between the three parameters, Transcerebellar (TCD) and Biparietal diameter (BPD) and Femur length (FL), for accurate determination of gestational age in third trimester of pregnancy.

A total of 200 pregnant women in third trimester pregnancy were assessed in this prospective observational study in Al-Hussein University Hospital and New Cairo Police Hospital by two-dimensional ultrasound method during the period from January to June 2018 to explore and examine an accurate method for estimating gestational age in third trimester of pregnancy. Examinations were performed after a verbal consent from the patient with the patient lying in the dorsal supine position. Two-dimensional ultrasound technique was carried out. Fetal biometry and amniotic fluid volume were assessed.

All women included in the study were subjected to history taking, clinical examination, laboratory investigations (complete blood count, blood group and Rh and liver and kidney functions).

We found that out of the 200 patients, the TCD gave correct measurement of gestational age within 3 days in 118 patients (59%) and within 1 week in 180 patients (90%). While the FL gave correct assessment of gestational age within 3 days in 92 patients (46%) and within 1 week in 160 patients (80%). The least accurate was the BPD that gave correct calculation of gestational age

within 3 days in 59 patients (29.5%) and within 1 week in 120 patients (60%).

*Rotmensch et al.*<sup>(12)</sup> did a study measuring the cerebellar diameter in cases of Down syndrome and found that cerebellar diameters in Down syndrome fetuses were lesser than normal controls at all gestational age, by an average of 0.67-0.87 mm. A ratio of 0.92 for observed/expected cerebellar diameter gave a sensitivity of 21%, specificity of 95% and PPV 1.66% and 0.50% in a population with risk of having Down syndrome of 1 in 250 and 1 in 750 respectively. However, this difference in cerebellar size was too small to be used clinically.

In a study done by *Chavez et al.*<sup>(13)</sup>, the concordance between the actual and predicted gestational age by TCD was high. The agreement was superior in the second trimester ( $r=0.93$ ) compared to the third trimester.

*Chavez et al.*<sup>(14)</sup> studied TCD in twin pregnancies and concluded that the agreement between the actual gestational age and the predicted gestational age by TCD was comparable to that of singleton pregnancy.

In another study carried by *Chavez et al.*<sup>(15)</sup>, they found that the concordance between the actual gestational age and the predicted gestational age by TCD was high for both IUGR and large fetus. *Joshi*<sup>(16)</sup> did a study measuring TCD in 594 singleton pregnancies in Nepalese population. They showed that the gestational age and TCD (50th percentile in mm) coincided well till 20th week of gestation. They observed no significant clinical difference between the nomogram created by them and the previously published nomogram in gestational age between 21st and 28th weeks. But, they observed significant differences between their nomogram and the previously published nomograms in third trimester.

*Goel et al.*<sup>(17)</sup> evaluated the fetal cerebellar development ultrasonographically which in turn is helpful in assessing the fetal gestational age. They showed that TCD was well correlated with gestational age. So, transverse cerebellar diameter is a good marker for gestational age estimation and can be used in cases that are not sure about their LMP. They offered the normal range of the

cerebellar measurements throughout gestation. These values may allow intrauterine assessment of the development of the cerebellum as well as the posterior fossa.

*Gupta et al.* <sup>(18)</sup>, from India, studied TCD in singleton pregnancies and observed that the gestational age of pregnant women was not sure of their LMP can be reliably estimated by measuring the TCD which showed good correlation. The increase in TCD throughout gestation helped in assessing the development of the cerebellum.

*Naseem et al.* <sup>(19)</sup> investigated the posterior cranial fossa of the fetus and confirmed the capability of the ultrasound to demonstrate the anatomy of the fetal posterior cranial fossa. The vermis and cisterna magna as well as the cerebellar hemispheres could be demonstrated easily. They also proposed a systematic approach to prenatal ultrasound examination of the posterior fossa. They suggested that the use of fetal transcerebellar diameter in utero between 17 and 40 weeks of gestation is a useful indicator of accurate gestational age. In the present work, TCD is also shown as a useful indicator of accurate gestational age in third trimester of pregnancy.

*Naseem et al.* <sup>(19)</sup> performed a study on 228 patients comparing TCD and BPD accuracy in third trimester. They found that there was a good correlation between the multiple growth parameters and TCD and concluded that TCD is more reliable method of gestational age determination in third trimester than BPD.

*Prssad and Likhitha* <sup>(20)</sup> studied an equation that correlates between the GA and the TCD and detected a good correlation between the GA and TCD throughout the third trimester and even in the case of intra uterine growth retardation (IUGR).

In another study done by *Naseem et al.* <sup>(9)</sup> on 327 patients pregnant in their third trimester comparing TCD with FL showed that TCD is more reliable method of gestational age determination in third trimester than FL.

*Akl et al.* <sup>(5)</sup> performed a study in Egypt on 150 pregnant women in their third trimester to determine the accuracy of the TCD in assessment of gestational age and they concluded that the TCD is a reliable method

for assessment of gestational age in third trimester of pregnancy.

*Prssad and Likhitha* <sup>(20)</sup> studied an equation that correlates between the GA and the TCD and detected a good correlation between the GA and TCD throughout the third trimester and even in the case of intra uterine growth restriction. That equation was as follow:  $GA = -0.007(TCD)^2 + 1.1032(TCD) + 0.2463$ .

*Reddy al.* <sup>(4)</sup> evaluated accuracy of predicting GA using Foetal Transcerebellar Diameter (TCD) and to compare between TCD and other existing parameters in evaluating GA in 15 to 40 weeks of gestation. They 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.

## CONCLUSION

From the study, concluded that TCD is the most accurate method for assessment of gestational age in third trimester followed by FL, and the least accurate is the BPD. Also by combining accuracy of TCD (90%) and that of FL (80%), we can be approximately certain of the gestational age in most of our patients even if they are unsure of their dates.

## REFERENCES

1. Salomon LJ, Alfirevic Z, Berghella V, Bilardo C, Hernandez-Andrade E, Johnsen SL, Kalache K, Leung KY, Malinger G, Munoz H, Prefumo F, Toi A, Lee W (2015): Practice guidelines for performance of the routine midtrimester fetal ultrasound scan. *Ultrasound Obstet Gynecol.*, 37: 116–126.
2. Butt K and Lim K (2014): Determination of gestational age by ultrasound. *J Obstet Gynaecol Can.*, 36(2): 171–181.
3. Julia AS, Hamzeiou KS, Rajagopalan V, Kim K, Barkovich AJ, Habas PA (2012): 3D morphometric analysis of human fetal cerebellar development. In: Julia AS, Hamzeiou KS, Rajagopalan V, editors. *The cerebellum*. Philadelphia: Mosby.

4. **Reddy RH, Prashanth K and Ajit M (2017):** Significance of foetal transcerebellar diameter in foetal biometry: A pilot study. *Journal of Clinical and Diagnostic Research*, 11(6): TC01-TC04.
5. **Akl S, Mohammed M, Bahaa El-din A, Mohammed A (2014):** Accuracy of Transcerebellar Diameter at the Third Trimester in Estimating the Gestational Age in Singleton Pregnancy. *Med. J. Cairo Univ.*, 82(1): 879-884.
6. **Hadlock FP, Deter RL, Harrist RB, Park SK (1982):** Fetal biparietal diameter: Rational choice of plane of section for sonographic measurement. *AJR.*, 138: 871.
7. **Salomon L, Alfirevic Z, Berghella V, Bilardo C, Hernandez-Andrade E, Johnsen S, Kalache K, Leung KY, Malinger G and Munoz H (2011):** Practice guidelines for performance of the routine mid-trimester fetal ultrasound scan. *Ultrasound in Obstetrics & Gynecology*, 37: 116-126.
8. **Lemer JP (2004):** Fetal growth and well being. *Obstet Gynecol Clin North Am.*, 31: 159-176.
9. **Naseem F, Ali S, Basit U, Fatima N (2014):** Assessment of gestational age: Comparison between transcerebellar diameter versus femur length on ultrasound in third trimester of pregnancy. *Professional Med J.*, 21(2): 412-417.
10. **Kuklisova M, Aljabar P, Srinivasan L, Counsell SJ, Doria V, Serag A (2011):** A dynamic 4D probabilistic atlas of the developing brain. *Neuroimage.*, 54: 2750-2763.
11. **Baschat AA (2011):** Fetal growth disorders. In: Baschat AA, editor. *High risk pregnancy*. St. Louis: Saunders.
12. **Rotmensch S, Goldstein J, Liberati M, Shalev J, Ben-Rafael Z, Copel JA (1997):** Foetal transcerebellar diameter in down's syndrome. *Obstet Gynecol.*, 89(4): 534-37.
13. **Chavez MR, Ananth CV, Smulian JC, Yeo L, Oyelese Y, Vintzileos AM (2004):** Foetal transcerebellar diameter measurement with particular emphasis in the third trimester: a reliable predictor of gestational age. *Am J Obstet Gynecol.*, 191:79-84.
14. **Chavez MR, Ananth CV, Kaminsky LM, Smulian JC, Yeo L, Vintzileos AM (2006):** Foetal transcerebellar diameter measurement for prediction of gestational age in twins. *American Journal of Obstetrics and Gynecology*, 195(6): 1596-600.
15. **Chavez MR, Ananth CV, Smulian JC and Vintzileos AM (2007):** Fetal transcerebellar diameter measurement for prediction of gestational age at the extremes of fetal growth. *Journal of Ultrasound in Medicine*, 26: 1167-1171.
16. **Joshi BR (2010):** Foetal transcerebellar diameter nomogram in Nepalese population. *Journal of Institute of Medicine*, 32(1): 19-23.
17. **Goel P, Singla M, Ghai R, Jain S, Budhiraga V, Babu R (2010):** Transverse cerebellar diameter-a marker for estimation of gestational age. *J. Anat. Soc. India*, 59(2): 158-161.
18. **Gupta AD, Banerjee A, Rammurthy N, Revati P, Jose J (2012):** Gestational age estimation using transcerebellar diameter with grading of foetal cerebellar growth. *National Journal of Clinical Anatomy*, 1(3): 115-20.
19. **Naseem F, Fatima N, Yasmeen S, Saleem S (2013):** Comparison Between Transcerebellar Diameter with Biparietal Diameter of Ultrasound for Gestational Age Measurement in Third Trimester of Pregnancy *Journal of the College of Physicians and Surgeons Pakistan*, 23(5): 322-325.
20. **Prasad BS and Likhitha S (2014):** Cerebellar measurements with ultrasonography in evaluation of fetal age. *IOSR Journal of Dental and Medical Sciences (IOSR- JDMS)*, 13(9): 49-56.