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Comparative Study Between Transcerebellar Diameter with Biparietal Diameter with Femur Length for Gestational Age Measurement Accuracy in Third Trimester of Pregnancy

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Abstract

Background: Accurately estimating a patient's gestational age (GA) is crucial for managing antenatal care and developing a treatment plan.

Aim: The purpose of this research was to determine the most reliable method for estimating a woman's GA by matching the transcerebellar diameter (TCD) to the biparietal diameter (BPD) to the femur length (FL) in the third trimester.

Patients and methods: In Luxor, at Al-Hussien University Hospital and Isis Specialized Hospital, researchers analyzed data from their obstetrics and gynecology patients in a prospective observational study. This study was done on 150 pregnant females in third trimester pregnancy, their age ranged among 18–34 years with mean value of 26.659 ± 4.062 years. The mean BMI was 24.972 ± 2.263 . Regarding the parity, 8.7 % were primigravida and 22.7 % have history of previous abortion. Biophysical profile ranged between 8 and 10.

Results: GA assessment by TCD has the highest accuracy of 92 % while GA assessment by BPD has accuracy of 74 % and GA assessment by FL has accuracy of 72 %.

Conclusion: In the third trimester, determining a woman's GA is best done with the TCD, then the BPD, and finally the FL.

Keywords: Biparietal, Femur, Gestational age, Transcerebellar

1. Introduction

For the purpose of planning delivery procedures such as induction of labor or cesarean section, an accurate estimation of the gestational age (GA) and predicted date of delivery is crucial.¹

Preterm delivery and growth restriction in the third trimester are two common causes of low birth weight, and gestational dating can help distinguish between the two.²

Most women use their last menstrual period to determine when they became pregnant, but this method is unreliable due to factors such as

forgetfulness, irregular cycles, variations in ovulation date, conception in lactational amenorrhea, and bleeding in the first trimester.³

Fetal biometric markers like biparietal diameter (BPD), femur length (FL), abdominal circumference (AC) and head circumference (HC) are regularly measured during ultrasonography to estimate GA. Ultrasound can reliably be used for gestational dates in the first trimester, but by the third trimester, discrepancies can reach more than 3 weeks.⁴

The BPD is the gold standard for estimating a pregnancy's progress. Despite the fact that new

information has shown that HC is preferable to the BPD,⁵ it is still widely employed.

In the second and third trimesters of pregnancy, FL is a highly helpful biometric parameter. After 14 weeks of gestation, it may be measured accurately due to its uniform linear expansion. 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.⁶

Researchers have taken an interest in the fetal transcerebellar diameter (TCD) as a sonographic measure for estimating GA.⁷

Ultrasound allows detection of the fetal cerebellum as early as 10–20 weeks postmenstrual. The TCD is directly proportional to the number of weeks of gestation in the second trimester. As the fetal cerebellum grows in mm beyond the fetal GA, the curve flattens in the third trimester, and the margin of interobserver error shrinks.⁸

The TCD, in contrast to the AC, is not significantly affected by fetal growth constraints; thus, the GA can be accurately predicted with the TCD even in trimester.⁹

The purpose of this research is to identify a reliable method for estimating a woman's GA in the third trimester by contrasting the TCD with the BPD and the FL.

2. Patients and methods

A prospective observational research in which information was gathered from the randomly assigned patient. Al-Hussien University Hospital and Isis Specialized Hospital in Luxor hosted the study's obstetricians and gynecologists. After the faculty's ethical review board approved the protocol, it was implemented. There were 150 pregnant women included in the study, all of them were in their third trimester.

All pregnant women had their GA confirmed by their menstrual cycles, first trimester ultrasounds, and their mothers' medical histories, and they all gave their informed consent before taking part in the study. Some of the tests performed included a full blood count, blood grouping, Rh testing, blood glucose testing, thyroid-stimulating hormone testing, urinalysis, and investigation of liver and kidney function.

GA, placental position, amniotic fluid index, biophysical profile, fetal biometry (including BPD and FL and TCDs), and Doppler tests were also determined for each patient via ultrasound. Specifically, a Logic P5 ultrasound equipment equipped with Doppler was used. SPSS (statistical program for social science, Cairo, Egypt), version 20 was used for the analysis of data.

All patients had transabdominal ultrasound with the head of the bed elevated by 30° and a little pillow under the right loin. Specifically, a Logic P5 ultrasound equipment equipped with Doppler was used.

The TCD was determined by observing the fetal brain from the side, namely the posterior fossa, in order to see the thalamus in the midline, the cerebellum, and the cisterna magna. Ultrasound calipers were placed on the screen and moved around the periphery of the cerebellum to get accurate measurements.

The rugby-football shaped skull was used to measure the BPD; it is more rounded at the back (occiput) and more pointed at the front (syncipit). In a straight line in the middle, halfway between the scale's extremes. Approximately one-third of the way from the syncipit to the occiput was a midline split in the cavum septum pellucidum. The lateral ventricles' two anterior horns were positioned on either side of the midline. The lateral ventricles' posterior horns, at least partially, were positioned on both sides of the body's midline. The BPD only accounts for the thickness (from outer to outer) of the top parietal bone.

When taking a femur measurement, it is essential that the FL be photographed so that both ends of the ossified metaphysis are visible. The length of the ossified diaphysis is measured along its longest axis. The angle of the femur in relation to the insonating ultrasound beams should be determined using the same method as that used to generate the reference chart. The usual insonation angle is between 45 and

Table 1. Descriptive maternal data of the studied population.

	N = 150
Age (years)	
Range	18–34
Median (IQR)	26 (7)
Mean ± SD	26.659 ± 4.062
BMI	
Range	19–29
Median (IQR)	25 (3)
Mean ± SD	24.972 ± 2.263
Parity [n (%)]	
0	13 (8.7)
1	42 (28)
2	67 (42.7)
3	31 (20.7)
Previous abortion [n (%)]	
No	116 (77.3)
Yes	34 (22.7)
Biophysical profile	
Range	8–10
Median (IQR)	9 (1)
Mean ± SD	8.625 ± 0.664

IQR, interquartile range.

90°. Except for the distal femoral epiphysis, the ossified ends of the diaphyses are where the calipers are placed. Triangular spur artifacts, which might artificially lengthen the diaphysis, should be disregarded in this measurement.

Last menstrual period and first trimester ultrasound were used to determine the percentage of pregnancies where the estimated GA was within 3 days and within 1 week of the actual GA, respectively.

3. Result

The current study included 150 pregnant women; their age ranged among 18–34 years with mean value of 26.659 ± 4.062 years. The mean BMI was 24.972 ± 2.263 . Regarding the parity, 8.7 % were

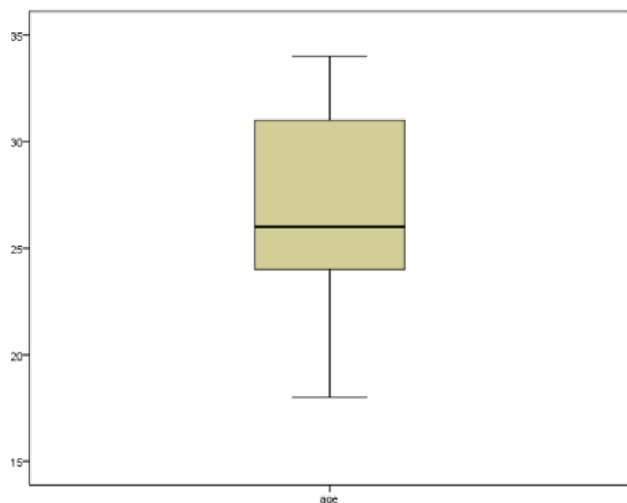


Fig. 1. Age of the studied population.

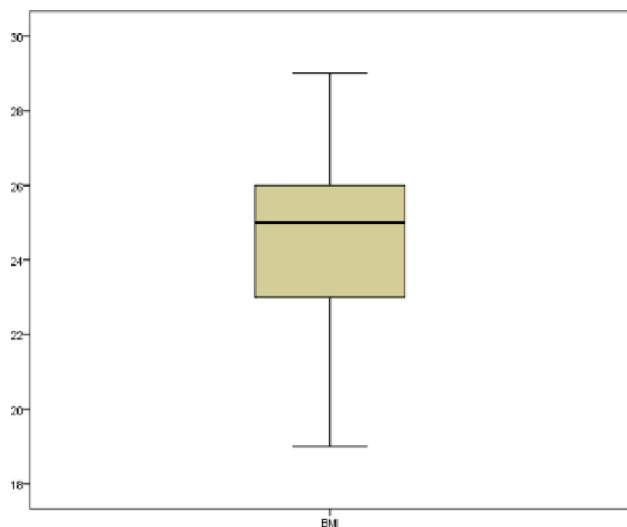


Fig. 2. BMI of the studied population.

Table 2. Fetal ultrasonography parameters of the studied population.

	N = 150
TCD	
Range	20–36
Median (IQR)	26 (7)
Mean ± SD	27.455 ± 4.241
BPD	
Range	57–77
Median (IQR)	65 (11)
Mean ± SD	66.278 ± 6.317
FL	
Range	32–53
Median (IQR)	38 (13)
Mean ± SD	40.734 ± 6.882
HC	
Range	30–36
Median (IQR)	33 (2)
Mean ± SD	33.000 ± 1.534
AC	
Range	32–37
Median (IQR)	34 (2)
Mean ± SD	34.163 ± 1.457
AFI	
Range	10–18
Median (IQR)	14 (3)
Mean ± SD	13.639 ± 1.797

AFI, amniotic fluid index; BPD, biparietal diameter; FL, femur length; IQR, interquartile range; TCD, transcerebellar diameter.

primigravida and 22.7 % have history of previous abortion. Biophysical profile ranged between 8 and 10 (Table 1, Figs. 1 and 2).

TCD ranged between 20 and 36 with mean value of 27.455 ± 4.241 , BPD ranged between 57 and 77 with mean value of 66.278 ± 6.317 , FL ranged between 32 and 35 with mean value of 40.734 ± 6.882 , HC ranged between 30 and 36 with mean value of 33.000 ± 1.534 , AC ranged between 32 and 37 with mean value of 34.163 ± 1.457 , amniotic fluid index (AFI) ranged between 10 and 18 with mean value of

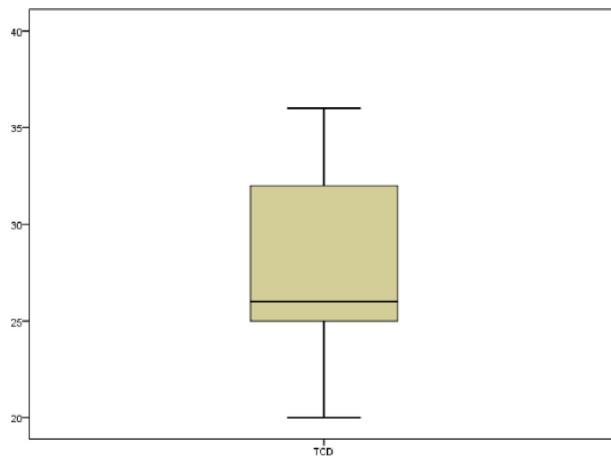


Fig. 3. TCD of the studied population. TCD, transcerebellar diameter.

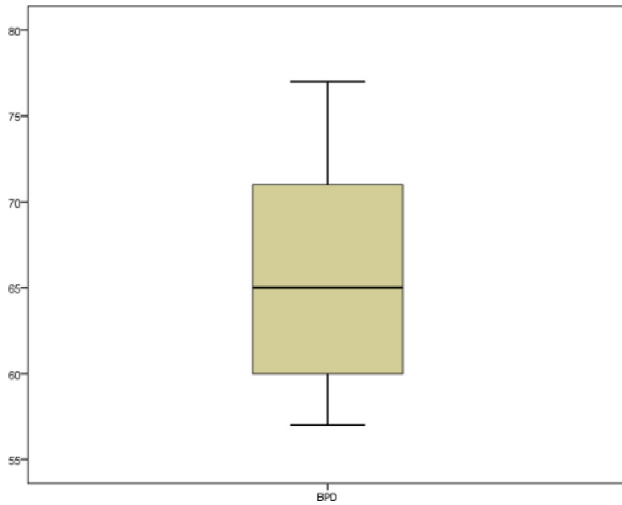


Fig. 4. BPD of the studied population. BPD, biparietal diameter.

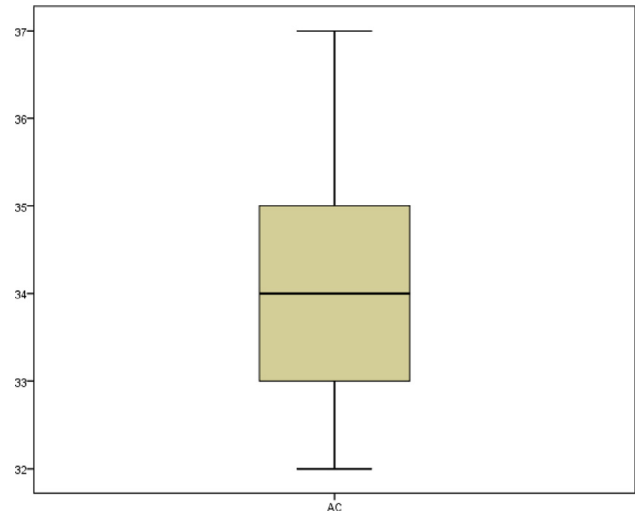


Fig. 7. AC of the studied population. AC, abdominal circumference.

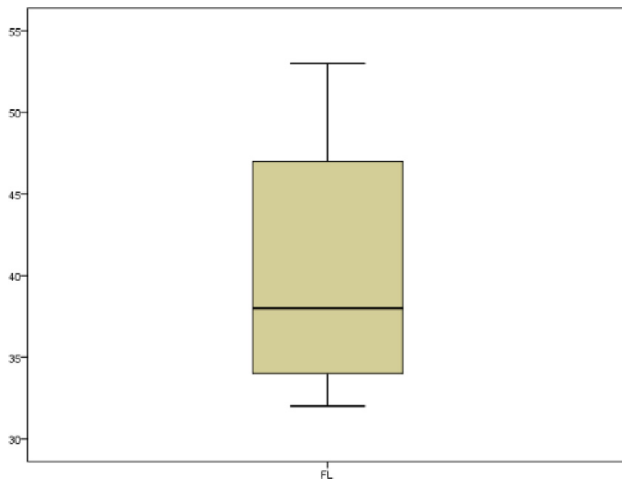


Fig. 5. FL of the studied population. FL, femur length.

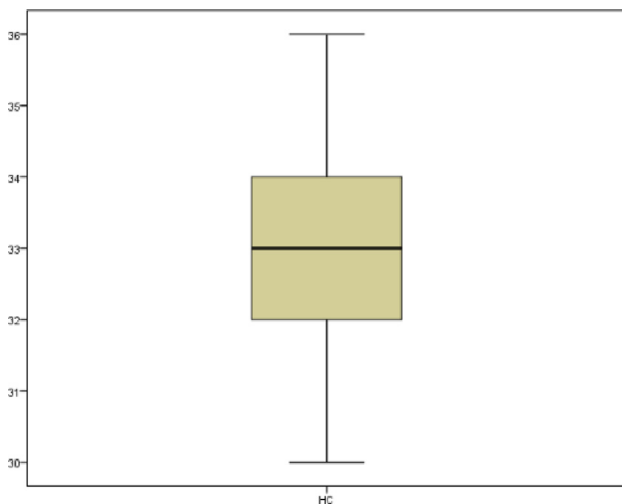


Fig. 6. HC of the studied population.

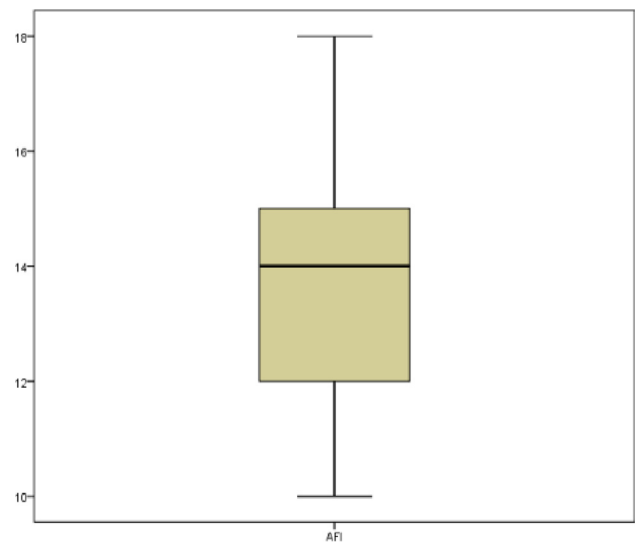


Fig. 8. AFI of the studied population AFI, amniotic fluid index..

13.639 ± 1.797 (Table 2, Figs. 3–8) (see Figs. 9 and 10).

Regardless the method of assessment, the GA of the studied population ranged between 30 and 35 weeks. The mean GA by date and early ultrasound was 32.095 ± 1.396 . The mean GA by TCD was 32.381 ± 1.491 , the mean GA by BPD was 32.462 ± 1.639 , and the mean GA by FL was 32.462 ± 1.639 (Table 3).

GA assessment by TCD has the highest accuracy of 92 % while GA assessment by BPD has accuracy of 74 % and GA assessment by FL has accuracy of 72 % (Table 4).

GA assessment by TCD has statistically significant more accuracy than GA assessment by BPD (Table 5).

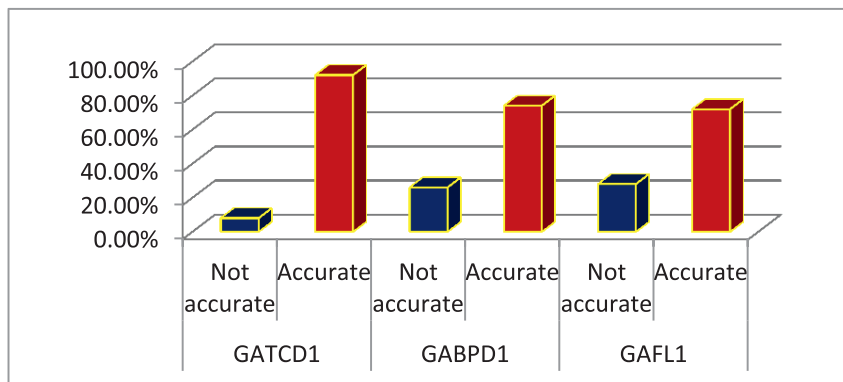


Fig. 9. GA accuracy of the studied population. GA, gestational age.

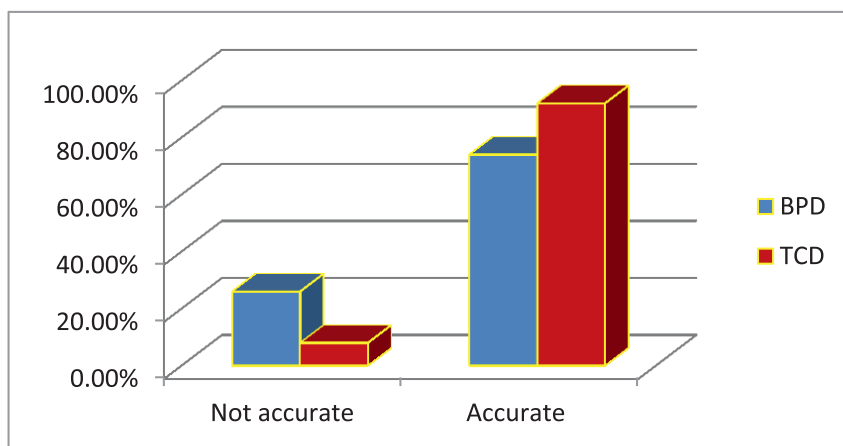


Fig. 10. Accuracy of GA assessment by TCD & BPD. BPD, biparietal diameter; GA, gestational age; TCD, transcerebellar diameter.

There is statistically significant high agreement among TCD and BPD GA assessments, despite the

fact that TCD provides more accurate assessments of GA (Table 6).

GA assessment by TCD has statistically significant more accuracy than GA assessment by FL (Table 7).

Despite that GA assessment by TCD is more accurate than FL but there is statistically significant high agreement between GA assessment by TCD and FL (Table 8).

Table 3. Gestational age assessment of the studied population.

	N = 150
GA by date and early US	
Range	30–35
Median (IQR)	32 (2)
Mean ± SD	32.095 ± 1.396
GA by TCD	
Range	30–35
Median (IQR)	32 (3)
Mean ± SD	32.381 ± 1.491
GA by BPD	
Range	30–35
Median (IQR)	32 (3)
Mean ± SD	32.462 ± 1.639
GA by FL	
Range	34.3–2172
Median (IQR)	30–35
Mean ± SD	32.462 ± 1.639

BPD, biparietal diameter; FL, femur length; GA, gestational age; TCD, transcerebellar diameter; US, ultrasound.

Table 4. The accuracy of gestational age assessment of the studied population.

	N = 150 [n (%)]
GA by TCD	
Not accurate	12 (8.0)
Accurate	138 (92.0)
GA by BPD	
Not accurate	39 (26.0)
Accurate	111 (74.0)
GA by FL	
Not accurate	42 (28.0)
Accurate	108 (72.0)

BPD, biparietal diameter; FL, femur length; GA, gestational age; TCD, transcerebellar diameter.

Table 5. Comparison among gestational age assessment by transcerebellar diameter and biparietal diameter.

	BPD [n (%)]	TCD [n (%)]	χ^2 test	
			χ^2	P value
Accuracy				
Not accurate	39 (26.0)	12 (8.0)	17.222	<0.0001
Accurate	111 (74.0)	138 (92.0)		

BPD, biparietal diameter; TCD, transcerebellar diameter.

Table 6. Agreement between gestational age assessment by transcerebellar diameter and biparietal diameter.

	Value	Asymp. SE ^a	Approx. T ^b	Approx. Sig.
Measure of agreement				
Kappa	0.397	0.084	6.093	<0.0001
Number of valid cases	150			

Table 7. Comparison between gestational age assessment by transcerebellar diameter and femur length.

	FL [n (%)]	TCD [n (%)]	χ^2 test	
			χ^2	P value
Accuracy				
Not accurate	42 (28.0)	12 (8.0)	20.325	<0.0001
Accurate	108 (72.0)	138 (92.0)		

FL, femur length; TCD, transcerebellar diameter.

Table 8. Agreement among gestational age assessment by transcerebellar diameter and femur length.

	Value	Asymp. SE ^a	Approx. T ^b	Approx. Sig.
Measure of agreement				
Kappa	0.395	0.080	5.791	<0.0001
Number of valid cases	150			

4. Discussion

Estimating the mother's GA is a crucial step in providing appropriate prenatal care. It serves as the foundation for determining whether to induce labor and how to handle difficulties if they arise. Inaccurate GA estimates are associated with increased rates of maternal and fetal morbidity and mortality.¹⁰

The reliability of the last menstrual period as a reference for the GA can be affected by factors such as the woman's exposure to hormonal contraception and the regularity of her menstrual cycles in the 3 months leading up to conception. Additional difficulties exist for women in impoverished nations, such as delayed prenatal booking, inaccurate menstruation data, and irregular menstrual cycles.¹¹

After the 14th week of gestation¹² the cerebellum is plainly seen on ultrasonography as a core rectangular echogenic structure (vermix) linking two

oval echolucent structures (hemispheres). Early prenatal imaging reveals a linear association between cerebellar size and GA, beginning in the 10th or 11th week of pregnancy. Fetuses with IUGR have a brain-sparing effect that prevents damage to the cerebellum. Therefore, the TCD has been described as a reliable single indicator of GA in late pregnancy.¹³

Regarding fetal ultrasonography parameters of the studied population, TCD ranged between 20 and 36 with mean value of 27.455 ± 4.241 , BPD ranged between 57 and 77 with mean value of 66.278 ± 6.317 , FL ranged between 32 and 35 with mean value of 40.734 ± 6.882 , HC ranged between 30 and 36 with mean value of 33.000 ± 1.534 , AC ranged between 32 and 37 with mean value of 34.163 ± 1.457 , AFI ranged between 10 and 18 with mean value of 13.639 ± 1.797 .

Regardless the method of assessment, the GA of the studied population ranged between 30 and 35 weeks. The mean GA by date and early ultrasound was 32.095 ± 1.396 . The mean GA by TCD was 32.381 ± 1.491 , the mean GA by BPD was 32.462 ± 1.639 , and the mean GA by FL was 32.462 ± 1.639 .

Regarding the accuracy of GA assessment of the studied population, it was revealed that GA assessment by TCD has the highest accuracy of 92 % while GA assessment by BPD has accuracy of 74 % and GA assessment by FL has accuracy of 72 %.

Consistent with the present study, 10 enrolled 200 women in their third trimester of pregnancy and found that the TCD accurately estimated the GA of 129 (64.5 % of the time) of these women within 3 days and 178 (89 %) of these women within 1 week. While 97 (48.5 %) of women and 163 (81 %) of males were given an accurate GA estimate from the FL within 3 days and 1 week, respectively. The BPD had the lowest accuracy, with correct assessments of GA occurring within 3 days in only 32.5 % of pregnant women and within 1 week in only 61.5 % of pregnant women.

Consequently, our results and previous studies showed that TCD showed the highest accuracy followed by BPD and FL. The comparison among GA assessment by TCD and BPD showed that GA assessment by TCD has statistically significant more accuracy than GA assessment by BPD. Despite that GA assessment by TCD is more accurate than BPD but there is statistically significant high agreement among GA assessment by TCD and BPD.

In agreement with the current study¹⁰ showed that, TCD has significantly higher accuracy than BPD in the assessment of GA within 3 days and 1 week. Also, in concordance with the current study¹³

reported that, GA assessment by TCD had significantly higher accuracy than BPD but there is statistically significant high agreement between GA assessment by TCD and BPD.

The comparison between GA assessment by TCD and FL, showed that GA assessment by TCD has statistically significant more accuracy than GA assessment by FL. Despite that GA assessment by TCD is more accurate than FL but there is statistically significant high agreement between GA assessment by TCD and FL.

In concordance with the current study Salem et al., 2022¹⁴ revealed that TCD has significantly higher accuracy than FL in the assessment of GA within 3 days and 5 days but nonsignificantly differed within 7 days.

TCD was found to be a more accurate way of determining GA in the third trimester than FL in a separate study of 327 pregnant women conducted by Naseem et al.¹⁵

There was no statistically significant difference between the accuracy of GA assessment by BPD and by FL, as determined by comparing the two methods. The statistical agreement between BPD and FL's evaluations of GA was also rather good.

Consistent with the current study, Aboshehata et al.¹⁶ found no significant difference between BPD and FL in the accuracy of GA evaluation. Transverse cerebellar diameter was found to be an independent predictor of GA in both normal and IUGR pregnancies, as was previously shown in research.¹⁷

This was supported by Hatata et al.¹⁸ who in multivariate linear regression analysis revealed that the most important measures associated with actual GA was found TCD followed by BPD and lastly FL with *P* values of 0.001, 0.005, and 0.013, respectively. Also, the study by Eze et al.⁸ revealed that when compared with the GA calculated using BPD, HC, AC, and FL, the GA estimated using regression models created using TCD was more in line with the actual GA.

In line with the current study, study 16 found that TCD was significantly correlated with BPD, HC, AC, and FL in healthy pregnancies. When comparing TCD to other metrics in both normal and IUGR pregnancies, the association between GA and TCD was found to be the strongest ($r = 0.993, <0.001$). This was supported by Hatata et al.¹⁸ who in multivariate linear regression analysis revealed that the most important measures associated with actual GA was found TCD followed by BPD and lastly FL with *P* values of 0.001, 0.005, and 0.013, respectively.

TCD, BPD, and FL were shown to be the most accurate, intermediate, and least accurate methods, respectively, for assessing GA in the third trimester.

Third trimester GA assessment accuracy is found to be independently predicted by TCD. There was a favorable link between TCD and the other ultrasonography indices of fetal growth, such as BPD, FL, HC, and AC, as shown in the current study. Multiple fetal biometric indicators, including TCD as assessed by sonography, were proposed to improve GA estimation.

4.1. Conclusion

According to the results of the current research, the TCD is the most reliable indicator of GA in the third trimester, followed by the BPD, and finally by the FL, which was found to be the least reliable. In normal pregnancies, TCD is an accurate tool for estimating the GA at the end of the third trimester. When BPD is impossible to measure (as in breech presentation) or when there are variances in head size and shape (as in excessive molding and dolicocephaly), this method can be employed instead. There was a favorable link between TCD and the other ultrasonography indices of fetal growth, such as BPD, FL, HC, and AC, as shown in the current study.

Conflicts of interest

There are no conflicts of interest.

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