

Significance of Fetal Trans-Cerebellar Diameter And Fetal Kidney Length In Fetal Biometry

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ABSTRACT

Background: Antepartum care and treatment planning rely on precise gestational age (GA) assessment. Transverse cerebellar diameter (TCD) and fetal kidney length (FKL) are effective for estimating GA in cases with ambiguous dates or suspected intrauterine growth restriction (IUGR).

Objective: To evaluate the diagnostic precision of TCD and FKL measures in determining GA throughout the 2nd and 3rd trimesters, in comparison to other established parameters.

Method: The study included 170 pregnant women at the 2nd and 3rd trimesters. The TCD, FKL, biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were evaluated to ascertain GA in two cohorts: the first (14-28 weeks) and the 2nd (29-40 weeks) using sonographic evaluation.

Results: This study discovered that GA enhances FKL and TCD, exhibiting a high correlation coefficient, which signifies robust agreement and consistency, with no discrepancies in the 3rd trimester. This study identified a significant correlation between FKL and TCD and fetal GA, demonstrating a steady rise throughout pregnancy.

Conclusion: TCD and FKL may separately predict GA throughout the 2nd and 3rd trimesters.

Keywords: Transcerebellar Diameter, Fetal kidney length, Gestational Age

1. INTRODUCTION

Fetal distress, pregnancy-induced hypertension, and Rh incompatibility are among the most common reasons obstetricians must assess fetal development in order to decide whether to continue the pregnancy or discontinue it [1].

To date pregnancies throughout the prenatal period and provide optimal treatment for all patients, obstetricians rely on accurate GA assessments [2].

Whether you want to know when your baby was born or whether there were any problems with the baby's growth, you need an accurate GA measurement. Iatrogenic preterm and postmaturity, which may result from failure, increase the risk of neonatal morbidity and mortality [3].

The most common method for determining GA is ultrasound fetal biometry [4]. One of the main reasons diagnostic ultrasonography is so popular is because of its excellent safety record [5]. Recent studies have shown that the BPD, HC, AC, and FL are the most often utilized measurements. These measurements lose their reliability for estimating GA as the pregnancy advances [6].

Crucial to the management of pregnancy is the sonographic evaluation of GA using fetal biometric indicators, such as BPD, HC, FL, and AC. There are limitations to these measurements; for example, BPD becomes inaccurate after 26 weeks of gestation due to changes in skull shape. Because people with achondroplasia have shorter femurs, measuring their GA using this measure is flawed. Multiple pregnancies, oligohydramnios, polyhydramnios, breech presentation, and IUGR are some of the conditions that might affect the measures of fetal position, head circumference, foetal length, and apple core. These indicators' capacity to reliably estimate GA declines with the progression of pregnancy. Consequently, there are still obstacles to accurately determining GA in the 2nd and 3rd trimesters [7].

In order to determine GA, researchers are now looking at a plethora of non-traditional sonographic markers. Peter et al. [8] included the following parameters: amniotic fluid volume, TCD, FKL, fetal foot length, and placental grading. As BPD, HC, FL, and AC become less and less accurate for calculating GA, the foetal kidney becomes easily observable and quantifiable in the 2nd and 3rd trimesters. Despite the strong association between GA and FKL, there has been little investigation into using FKL as a biometric indicator to estimate GA [2]. Encircled by petrous ridges and the occipital bone, the cerebellum, which is located in the posterior cerebral fossa, can withstand deformation from external pressure [7]. A dependable ultrasonography metric for GA evaluation at the end of the 2nd trimester, the TCD grows rapidly and correlates linearly with GA beginning in the 2nd trimester [9]. In order to compare FKL and TCD with other known criteria for evaluating GA between 14 and 40 weeks of gestation, this study set out to evaluate the accuracy of these measures in estimating GA.

2. Patients and methods:

This research included 170 pregnant women recruited from the Fetal Medicine Unit at Kasr al-Aini Medical School Hospital, Cairo University, and Beni Suef University Hospital, who sought ultrasound abnormality, scans between May 2020 and October 2021.

Regarding the study group, they were divided into two groups:

- **Group 1:** 14-28weeks (2nd trimester)
- **Group 2:** 29-40weeks (3rd trimester)

The patient in our study underwent trans-abdominal ultrasound to ascertain GA through standard fetal biometric measurements, including BPD, HC, AC, and FL. Additionally, TCD and FKL were measured.

The inclusion criteria consisted of: singleton gestation, viable fetus, intact membranes, normal amniotic fluid index (AFI), and GA of 14 weeks or more, determined by the first day of the previous menstrual cycle in patients with certainty on their dates.

The exclusion criteria included: patients uncertain of dates, patients with multiple gestations, and patients with chronic medical conditions (such as diabetes mellitus or hypertension).

Method:

Consent was secured from the pregnant volunteers included in the research following an explanation of the study's goal and the procedures to be done. Comprehensive History; the evaluation comprises the individual's name, demographic distribution, full obstetric history, and menstrual history, including the first day of the LMP, GA documentation, as well as medical and surgical history. Transabdominal ultrasound examination utilizing the GE Voluson E10, particularly to examine the fetus BPD, HC, AC, FL, TCD, and FKL as markers for GA computation. The ultrasound procedure employed comprised completing a trans-abdominal ultrasound on all patients while the females were positioned with the head of the bed raised at 30 degrees. The following measurements were recorded:

Measurement of the BPD:

The lateral ventricles view was obtained: The shape of the skull resembles that of a rugby ball, with a more tapered front and a rounded back (occiput). Midway between the two ends of the scale is where you'll hear an echo. Moving from the front to the rear of the head, the cavum septum pellucidum divided the midline by a 3rd. When viewed from a central perspective, the two front lobes of the lateral ventricles are in perfect harmony. The lateral ventricles' posterior horns lie in a perfectly symmetrical pattern along the midline. The BPD is defined as the outer-to-outer measurement of the top parietal bone's thickness.

Regarding the measurement of the TCD, As the cerebellum takes the position of the posterior horns of the lateral ventricles in the acquired trans-thalamic picture of BPD, a modest downward rotation of the probe towards the fetal neck causes them to disappear. We used the outer-to-outer method to estimate the T.C.D., which is perpendicular to the cerebellum's long axis at its broadest point.

It is best to estimate **the femur length** when imaging clearly shows both ends of the ossified metaphysis. This test determines how long the ossified diaphysis may be. It is important to utilize the same method for creating the reference chart for the angle between the femur and the insonating ultrasound beams. It is common practice to use an incidence angle between 45 and 90 degrees. When it comes to placing the calipers, be sure to put each one at the ends of the ossified diaphysis. If the distal femoral epiphysis is visible, then leave it out. In order to get an accurate reading of the diaphysis length, this measurement has to stay away from triangular spur artifacts. In a perfect world, the femur measurement would follow the belly circumference measurement. It is common practice to see a cross-section of the upper femur for measurement after positioning the probe caudally from the AC section until the iliac bones are visible. All of the femur's length should be visible and the section should not be oblique if you can see soft tissue beyond the femur's ends and the bone shouldn't blend with the thigh skin anywhere. To find the femur's length, we measured it from the metaphysis, which is located in the middle of the bone, and from the other end, our reference point.

In relation to the assessment of the FKL, following the establishment of an optimal transverse plane of the fetus at the level of the four heart chambers, transverse scanning proceeded in a cephalocaudal direction until the fetal kidneys became visible. Subsequently, the probe was positioned at a 90-degree angle to align with the longitudinal axes of the kidneys, in relation to the midline tubular anechoic abdominal aorta. With meticulous attention to detail, the screen captured and retained the most comprehensive longitudinal image displaying the upper and lower outer poles of each kidney. After reading the instructions provided by **Bertagnoli et al. [10]**, researchers used electronic calipers to measure the kidneys' length from the top to the bottom of the organ. To account for any differences in measurement between observers, we took three readings from each kidney and averaged them all up in millimeters. The adrenal glands were excluded from the measurements by means of precautions.

Ethical considerations:

The current study was conducted in accordance with the principles outlined in the Declaration of Helsinki (1975, revised in 2013). The investigation was approved by research ethical committee of faculty of medicine at Beni-Suef University (REC). The approval number is (FMBSUREC/03092019/Nazif). The study adheres to both national and international guidelines. Informed consent was obtained from all study participants before study after explanation of all study procedures. All data were expressed as anonymous. Confidentiality was ensured for every case. Withdrawal from study was allowed for any participants without explanation or consequences.

Statistical Analysis

Gathering, refining, coding, and inputting data was into IBM SPSS version 23. Means, standard deviations, and ranges denote parametric quantitative data. Additionally included were numerical values and percentages of qualitative characteristics. The Independent t-test examined two distinct groups utilizing quantitative data and adhering to a parametric distribution. Spearman correlation coefficients assessed GA (weeks) alongside other variables. The primary variables of GA were assessed through both univariate and multivariate linear regression analysis. The receiver operating characteristic curve (AUC) determined the optimal cutoff point by evaluating its sensitivity, specificity, and the area under the curve. The confidence interval was established at 95%, accompanied by a margin of error of 5%. A p-value is deemed significant when it falls below the threshold of 0.05.

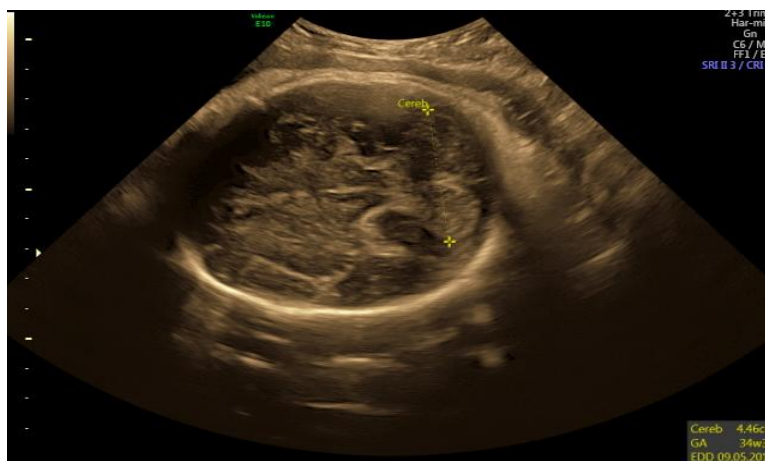


Figure (1): TCD measured in pregnant woman 23 years old with GA =34wks + 3days



Figure (1): BPD measurement in pregnant women 33wks+5days of gestation



Figure (2): FL measured in pregnant woman 23 years old, 32wks+3days of gestation

2. RESULTS

Table (1): Comparison between the two studied groups regarding age and BMI

		Group A (15 - 28) wks No. = 85	Group B (29 - 40) wks No. = 85	Test value	P-value	Sig.
Age	Mean $\pm$ SD	30.69 $\pm$ 5.87	30.27 $\pm$ 3.84	0.557•	0.578	NS
	Range	19 – 40	22 – 36			
BMI	Mean $\pm$ SD	26.09 $\pm$ 3.21	26.16 $\pm$ 1.89	-0.162•	0.871	NS
	Range	19 – 32	22.11 – 28.69			

•: Independent t-test

The preceding table indicates that no statistically significant difference was observed between the two groups under

investigation concerning age and BMI, with p-values of 0.578 and 0.871, respectively.

Table (2): Comparison between the two studied groups regarding BPD, HC, AC and FL

		Group A (15 - 28) wks No. = 85	Group B (29 - 40) wks No. = 85	Test value	P-value	Sig.
BPD	Mean ± SD	56.27 ± 11.19	80.53 ± 11.40	-13.997•	0.000	HS
	Range	29.7 – 74.5	32 – 96			
HC	Mean ± SD	209.29 ± 41.69	304.38 ± 26.95	-17.659•	0.000	HS
	Range	115 – 285	267.4 – 359			
AC	Mean ± SD	183.60 ± 38.94	289.24 ± 34.88	-18.631•	0.000	HS
	Range	90 – 253	235 – 356			
FL	Mean ± SD	40.79 ± 9.02	64.61 ± 7.50	-18.720•	0.000	HS
	Range	18.2 – 55.4	55 – 81			

•: Independent t-test

The preceding table indicates a statistically significant increase in BPD, HC, AC, and FL in group B compared to group A, with a p-value of less than 0.001 for all measurements.

Table (3): Comparison between the two studied groups regarding TCD, RKL, LKL and average KL

		Group A (15 - 28) wks No. = 85	Group B (29 - 40) wks No. = 85	Test value	P-value	Sig.
TCD	Mean ± SD	24.64 ± 5.39	41.23 ± 5.80	-19.306•	0.000	HS
	Range	13 – 34	33.2 – 53			
RKL	Mean ± SD	24.46 ± 6.33	38.32 ± 4.30	-16.696•	0.000	HS
	Range	11 – 40	29 – 46			
LKL	Mean ± SD	24.56 ± 6.33	38.59 ± 3.66	-17.682•	0.000	HS
	Range	12 – 40	32 – 45			
Average KL	Mean ± SD	24.51 ± 6.27	38.45 ± 3.91	-17.403•	0.000	HS
	Range	11.5 – 39.5	30.5 – 45.5			

•: Independent t-test

The preceding table indicates a statistically significant increase in TCD, RKL, LKL, and average KL in group B compared to group A, with a p-value of less than 0.001 for all measurements.

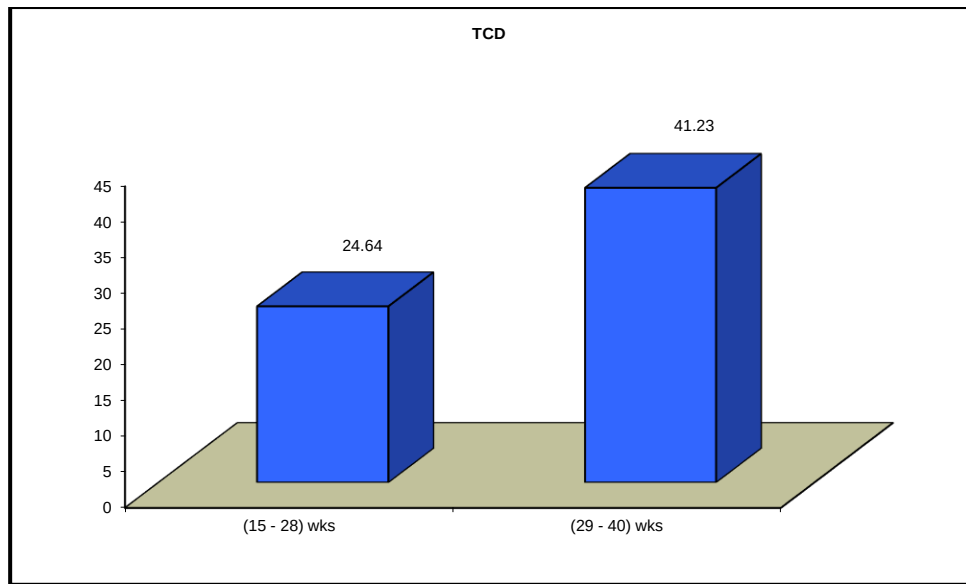


Figure (4): Comparison between the two studied groups regarding TCD

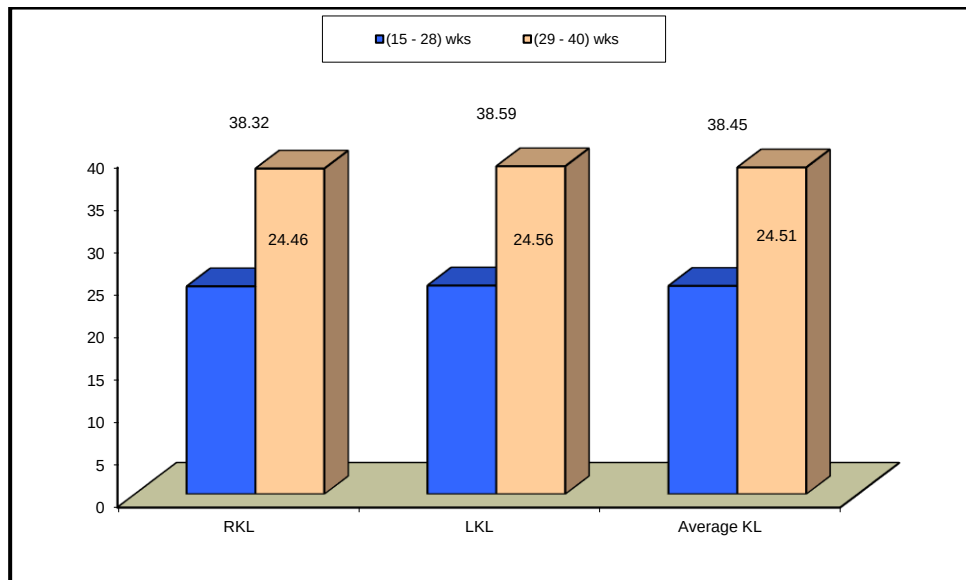


Figure (5): Comparison between the two studied groups regarding RKL, LKL and average KL

Table (4): Correlation of GA (weeks) with the other studied parameters in all the studied patients

	GA	
	r	P-value
Age	0.047	0.545
BMI	0.086	0.263
BPD	0.899**	< 0.001
HC	0.971**	< 0.001
AC	0.988**	< 0.001

FL	0.989**	< 0.001
TCD	0.987**	< 0.001
RKL	0.919**	< 0.001
LKL	0.936**	< 0.001
Average KL	0.931**	< 0.001

P-value < 0.01: Highly significant, Spearman correlation coefficient

The preceding table indicates that no statistically significant correlation was identified between GA (weeks) and either age or BMI of the subjects examined. However, a statistically significant positive correlation was observed between GA (weeks) and BPD, HC, AC, FL, TCD, RKL, LKL, as well as average KL.

Table (5): Univariate and multivariate linear regression analysis for variables associated with GA in all patients

	Univariate					Multivariate				
	Unstandardized Coefficients		Standardized Coefficients	t	P-value	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	S.E	Beta			B	S.E	Beta		
BPD	0.320	0.015	0.859	21.791	0.000	-0.001	0.006	-0.001	-0.084	0.933
HC	0.101	0.002	0.969	50.905	0.000	0.006	0.004	0.058	1.571	0.118
AC	0.095	0.001	0.990	89.286	0.000	0.030	0.006	0.318	5.242	0.000
FL	0.420	0.005	0.990	89.392	0.000	0.145	0.025	0.342	5.851	0.000
TCD	0.607	0.008	0.987	79.173	0.000	0.189	0.030	0.307	6.256	0.000
Average KL	0.656	0.020	0.928	32.389	0.000	-0.017	0.017	-0.024	-1.008	0.315

The earlier univariate linear regression analysis indicates a statistically significant association between GA and all the previously examined parameters. The multivariate linear regression analysis indicates that the key variables associated with GA across all studied cases were identified as AC, FL, and TCD.

Table (6): Correlation of GA with the other studied parameters in group A patients

	GA	
	r	P-value
Age	0.088	0.423
BMI	0.160	0.145
BPD	0.976**	< 0.001
HC	0.918**	< 0.001
AC	0.971**	< 0.001
FL	0.973**	< 0.001
TCD	0.964**	< 0.001
RKL	0.748**	< 0.001
LKL	0.791**	< 0.001
Average KL	0.788**	< 0.001

P-value < 0.05: Significant; Spearman correlation coefficient

The preceding table indicates that no statistically significant correlation was identified between GA(weeks) and the age or BMI of the subjects examined. However, a statistically significant positive correlation was observed between GA and BPD, HC, AC, FL, TCD, RKL, LKL, as well as the average KL.

Table (7): Univariate and multivariate linear regression analysis for variables associated with GA among group A

	Univariate					Multivariate				
	Unstandardized Coefficients		Standardized Coefficients	t	P-value	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	S.E	Beta			B	S.E	Beta		
BPD	0.304	0.006	0.983	48.784	< 0.001	0.136	0.026	0.438	5.187	0.000
HC	0.076	0.004	0.917	20.888	< 0.001	0.001	0.004	0.017	0.406	0.686
AC	0.087	0.002	0.974	39.192	< 0.001	0.012	0.007	0.135	1.749	0.084
FL	0.374	0.009	0.975	40.119	< 0.001	0.078	0.028	0.203	2.814	0.006
TCD	0.622	0.018	0.969	35.542	< 0.001	0.125	0.041	0.195	3.059	0.003
Average KL	0.433	0.038	0.783	11.478	< 0.001	0.012	0.015	0.021	0.770	0.443

The prior univariate linear regression analysis indicates a statistically significant connection between GA and all preceding factors. The multivariate linear regression analysis indicates that the most significant factors correlated with GA in group A patients were BPD, FL, and TCD.

Table (8): Correlation of GA (weeks) with the other studied parameters in group B

	GA	
	r	P-value
Age	0.016	0.885
BMI	0.095	0.385
BPD	0.781**	< 0.001
HC	0.940**	< 0.001
AC	0.954**	< 0.001
FL	0.946**	< 0.001
TCD	0.944**	< 0.001
RKL	0.774**	< 0.001
LKL	0.865**	< 0.001
Average KL	0.820**	< 0.001

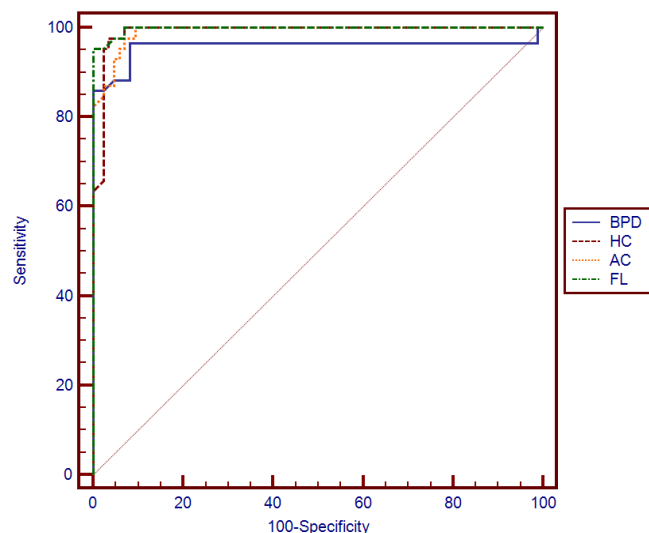
P-value < 0.05: Significant; Spearman correlation coefficient

The above table indicates that no statistically significant link was identified between GA(weeks) and either age or BMI of the participants tested, however a statistically significant positive correlation was seen between GA (weeks) and BPD, HC, AC, FL, TCD, RKL, LKL, and average KL.

Table (9): Univariate and multivariate linear regression analysis for variables associated with GA among group B patients

	Univariate					Multivariate				
	Unstandardized Coefficients		Standardized Coefficients	t	P-value	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	Std. Error	Beta			B	Std. Error	Beta		
BPD	0.104	0.031	0.344	3.341	0.001	0.002	0.007	0.007	0.284	0.777
HC	0.122	0.004	0.949	27.437	0.000	0.011	0.011	0.084	0.986	0.327
AC	0.095	0.003	0.964	32.940	0.000	0.030	0.009	0.305	3.371	0.001
FL	0.445	0.013	0.967	34.801	0.000	0.189	0.043	0.411	4.413	0.000
TCD	0.565	0.021	0.949	27.468	0.000	0.122	0.048	0.204	2.519	0.014
Average KL	0.752	0.051	0.852	14.815	0.000	-0.007	0.043	-0.008	-0.162	0.872

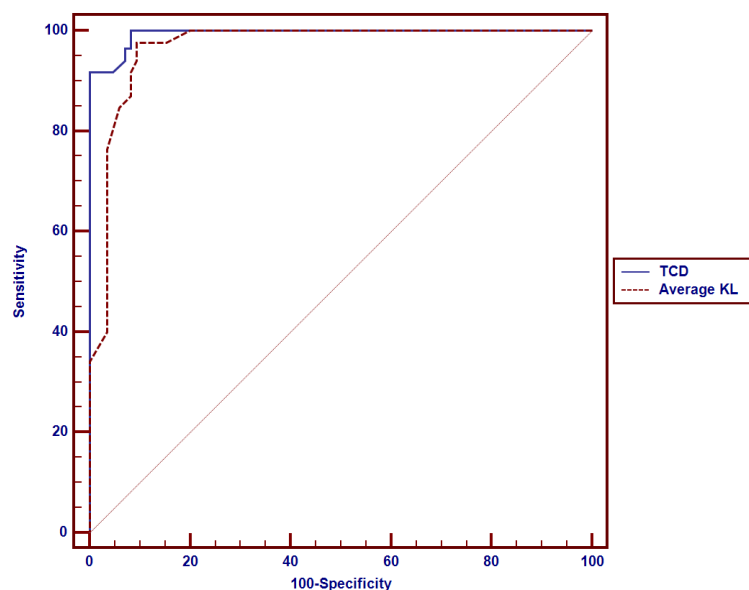
The prior univariate linear regression analysis indicates a statistically significant connection between GA and all preceding factors. The multivariate linear regression analysis indicates that the most significant factors correlated with GA in group A patients were AC, FL, and TCD.



	Cut off point	AUC	Sensitivity	Specificity	PPV	NPV
BPD	>71.8	0.958	96.47	91.76	92.10	96.30
HC	>270	0.990	97.65	96.47	96.50	97.60
AC	>231.3	0.991	100.00	90.59	91.40	100.00
FL	>55.4	0.998	95.29	100.00	100.00	95.50

Figure (6): ROC curve for BPD, HC, AC and FL to differentiate between group A and group B

The preceding ROC curve indicates that the optimal cutoff point distinguishing group A from group B concerning BPD was identified at > 71.8, exhibiting a sensitivity of 96.47%, specificity of 91.76%, and an AUC of 95.8. Conversely, for HC, the optimal cutoff point was determined at > 270, with a sensitivity of 97.65%, specificity of 96.47%, and an AUC of 99.0%. The optimal cutoff value for AC was determined to be >231.3, exhibiting a sensitivity of 100.0%, specificity of 90.59, and an AUC of 99.8%. The cutoff value for FL was determined to be > 55.4, exhibiting a sensitivity of 95.29%, specificity of 100.0%, and an AUC of 99.8%.



Variables	Cut off point	AUC	Sensitivity	Specificity	PPV	NPV	P-value
TCD	>32.7	0.994	100.00	91.76	92.4	100.0	0.030
Average KL	>32.5	0.967	97.65	90.59	91.2	97.5	

Figure (7): ROC curve for BPD, HC, AC and FL to differentiate between group A and group B

The preceding ROC curve indicates that the optimal cutoff point distinguishing group A from group B for TCD was identified at > 32.7 , exhibiting a sensitivity of 100.0%, specificity of 91.76, and an AUC of 99.4. Conversely, for average KL, the optimal cutoff point was determined at > 32.5 , with a sensitivity of 97.65%, specificity of 90.59%, and an AUC of 96.7%.

3. DISCUSSION

Predicting GA from 14–40 weeks of gestation using fetal TCD and FKL was the goal of this study, which also compared TCD and FKL to other recognized markers.

The correlation between GA and all indicators is statistically significant, according to this study. In group (B), the most important variables related to GA were FL, TCD, and AC, according to multivariate linear regression analysis. In group (A), the most important variables were BPD, FL, and TCD. During the 2nd and 3rd trimesters, there is a clear correlation that aligns with the clinical GA. With correlation values of 0.928 and 0.987, respectively, FKL and TCD demonstrate substantial associations with GA in the present study. Growth disparities may change kidney size, although they mostly affect the transverse and anterior-posterior diameters. Nevertheless, the KL remains mostly unchanged in fetuses that are small for their GA [11]. The imaging of the kidneys in breech and vertex presentations with the back orientated laterally or posteriorly was a problem for Duval et al. [12]. Our current examination of imaging and measuring KL did not reveal any concerns. As the GA increases, the fetal kidney undergoes morphological evolution. The perinephric fat grows during pregnancy, which increases the echogenicity and makes the kidneys more visible by making them stand out from the surrounding soft tissue [13]. Suboptimal scans, caused by technical faults or maternal obesity, may often make it difficult to identify fetal kidneys. This is especially true in the early stages of gestation, when the patterns of the fetal adrenal and renal parenchyma are quite similar. The echogenic properties of the lower ribs make this problem much more complex in the near future [14].

Findings from the present study demonstrate that FKL increases linearly with GA, reaching 15.5 mm at 14 weeks and 45.5 mm at 40 weeks. TCD increases in a straight line as the GA increases, going from $13 \pm$ mm at 14 weeks to 53 mm at 40 weeks. When contrasted with the results of Kansaria and Parulekar [15], and Peter et al. [8], the FKL values at different GAs were somewhat higher. Ugur et al. [6] reported FKL values of 35.66 ± 6.61 (19–49 mm) with positive correlation between GA and FKL ($r=0.947$, $p=0.001$).

It is possible to compare the variations in other parameters to the TCD, which is a separate measure for calculating GA [16]. Research by Eze et al. [17] and George et al. [18] indicates that it begins to expand rapidly in the 2nd trimester and continues to do so in a linear fashion with GA.

The present study found a significant correlation (p value <0.001) between TCD and GA at delivery in healthy pregnancies. There was shown to be a statistically significant relationship between TCD and both BPD (p value <0.001) and HC (p value <0.001).

The results were similar in a study by **Eze et al. [19]** that included 257 pregnant women in good health, with GAs ranging from sixteen to forty weeks. There were curvilinear relationships ($p = 0.001$) between the TCD and GA. As a result, it is possible to calculate GA regardless of fetal head shape using TCD throughout pregnancy [19]. Our results are consistent with those of a study by **Bansal et al. [20]** that analyzed 650 individuals between the ages of 14 and 40 weeks into their pregnancies. A p -value less than 0.001 and a Karl Pearson correlation coefficient of 0.972305 showed substantial significance, suggesting that the TCD is similar to the GA of a fetus.

Prior studies on the assessment of TCD measures by **Cinnusamy et al. [21]** clearly showed that TCD is a trustworthy tool for estimating fetal GA, and it is generally considered more accurate than HC, FL, BPD, and AC in this respect. Going on the results of this study, it seems like a solid measuring tool for fetal GA determination in both singleton and twin pregnancies; it's accurate, trustworthy, and dependable. The 2nd and 3rd trimester assessments of BPD, HC, AC, FL, and TCD show statistically significant P values of less than 0.001 when linked with GA by LMP. Also, in singleton pregnancies, a study by **Ahmed et al. [22]** found similar conclusions concerning GA and TCD.

Interactions between GA and the measurements of BPD, HC, AC, FL, and TCD across the first, 2nd, and 3rd trimesters, as measured by LMP; showed statistically significant variations.

Fifty pregnant women (ranging in age from 20 to 40) who came in for routine ultrasounds between weeks 14 and 40 of their pregnancies were the subjects of a study by **Goel et al. [23]**. We measured GA using TCD ultrasonography. As shown in this study, regression analysis showed a strong relationship between TCD and GA, indicating that TCD is a useful indication for calculating GA.

In **Uzair et al. [24]** work, TCD correctly estimates GA throughout the first, late, and 3rd trimesters of the 2nd trimester using linear regression analysis. In order to determine how well TCD diameter measures GA in fetuses, during their second and third trimesters, 200 pregnant women participated in a sonographic evaluation. A very reliable link was between the mean fetal GA and the TCD-GA, which is a strong positive linear relationship. This suggests that measuring TCD could be a way to determine the fetal GA.

The present study shows that measuring the TCD is a reliable way to precisely calculate GA in fetuses with development restrictions.

After adjusting for GA using LMP, the intraclass correlation coefficient of fetal biometry and TCD shows that TCD has the highest relationship with BPD (0.983), then FL (0.979), and HC (0.975), with AC (0.974) showing the lowest accuracy.

Additionally, **Singh et al. [25]** found that TCD was significantly associated with GA as measured by LMP and other biometric fetal measurements. Both normal and IUGR pregnancies showed a strong correlation between TCD and GA. In normal pregnancies, the TCD to AC ratio was rather constant, but in IUGR pregnancies, it was higher. So, in both healthy and IUGR pregnancies, the TCD and TCD/AC ratio could be useful objective measures for estimating GA.

Research by **Eze et al. [17]** shown that TCD measurements are accurate and reliable for determining GA, even when the fetus is developing rapidly. When wondering about the GA and suspecting IUGR; the TCD is very useful, according to the majority of research. TCD stands out with a value of 0.931, beating out HC with 0.877, FL with 0.863, AC with 0.823, and BPD with an accuracy of 0.809. Fetal biometry and TCD, when connected to GA by LMP in the late 2nd trimester, showed that TCD has the highest at 0.989, followed by BPD at 0.924, HC at 0.920, FL at 0.915, and AC at 0.893.

Fetal biometry and TCD have the highest intraclass correlation coefficient (0.939) when correlated to GA by LMP in cases where GA is greater than 30 weeks. BPD comes in at 0.683, HC at 0.652, FL at 0.630, and AC at 0.603. This agrees with what **Ado et al. [26]** discovered, the range for TCD in second- and third-trimester fetuses was 15.9–57.5 mm. The TCD parameter was more accurate (± 1.753 days) than BPD (± 2.298 days), HC (± 2.337 days), and AC (± 4.342 days) and marginally less accurate than FL (± 1.165 days) in predicting GA among study subjects ($P < 0.001$). TCD is a reliable and accurate parameter for GA estimation in late second- and third-trimester pregnancies when compared with established fetal biometric parameters among pregnant women in Nigeria.

Alalfy, [27] set out to compare the accuracy of TCD with that of other fetal biometric measurements in estimating GA, including BPD, HC, AC, and FL. Fetuses with IUGR were all included in this investigation. The results showed that with values of 0.43 mm, 1.27 mm, 1.0 mm, 1.56 mm, and 1.28 mm, respectively, for TCD, BPD, HC, AC, and FL, the IQR of the disparity between LMP and sonographic GA was the smallest.

All data in the 2nd trimester showed a GA that nearly matched with that of the LMP, according to the study by **Reddy et al. [7]**, which compared the mean GA based on all parameters to the GA based on the LMP. During the 2nd trimester, the average GA of TCD was 21.12 weeks, which was quite similar to the GA found by LMP. The average GA of a TCD during the 3rd trimester was more closely related to the GA as assessed by the LMP. Our analysis of the overall mean GA showed

that TCD had a stronger correlation with LMP than the other variables.

In their study on singleton pregnancies, **Gupta et al. [28]** discovered that measuring TCD correctly indicated the GA of pregnant women who were unclear about their LMP. The researchers reported a good correlation ($r=+0.946$, $r^2=89.6\%$, $p<0.001$). Improving TCD throughout pregnancy made it easier to assess how the cerebellum was developing.

Using ultrasonography, Bavini et al. [32] evaluated TCD HC, AC, and FL in 100 pregnant women between the ages of 18 and 35 who were in their third trimester of a singleton pregnancy. The women included those with a GA of 28 weeks or more and a verified LMP. After 32 weeks of gestation, the accuracy of GA assessment by BPD gradually decreases, while HC and FL both show a drop after 36 weeks, and AC shows a decline after 28 weeks. The TCD shown the best connection ($r = 0.979$; $p < 0.0001$) among all sonographic measurements for determining GA, whereas the AC showed the weakest correlation.

4. CONCLUSIONS

Both TCD and FKL are reliable indicators of GA throughout the 2nd and 3rd trimesters. TCD is the measure least influenced by IUGR, therefore serving as a solitary metric for estimating GA. Our findings further indicate that TCD is unaffected by maternal age, and parity seems to have no impact on TCD as well.

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