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# Accuracy of Fetal Trans-Cerebellar Diameter in Evaluation of Gestational Age

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## Abstract

**Background:** The diagnosis of fetal development problems, as well as the scheduling of elective birth, depends on an accurate gestational age (GA). In assessing gestational age in the second trimester, transcerebellar diameter (TCD) is an important biometric marker.

**Aim and objectives:** To determine the reliability of using trans-cerebellar diameter measurements to predict gestational age in healthy, single-baby pregnancies.

**Subjects and methods:** One hundred twenty individuals were enrolled in the prospective longitudinal comparative descriptive research at the obstetrics and gynecology departments of Al-Azhar University Hospital (Assiut) and General Sohag Hospital. The research took during the period from January 2022 to May 2023.

**Result:** There was a highly statistically significant alteration amongst estimated gestational age by each modality (G.A-TCD, G.A-FL, G.A-BPD, and G.A-AC) and actual GA through evaluation visits and time. Accuracy within 3 days and one week significantly increased through time. There was no significant change between Actual GA and estimated gestational age by trans cerebellar diameter. However, there was a significant difference between other modalities and actual GA.

**Conclusion:** The trans-cerebellar diameter of the fetus is a reliable predictor of the gestational age of the fetus. Its readings are highly correlated with the latest menstrual cycle's estimated gestational age.

**Keywords:** Trans-Cerebellar Diameter (TCD), Gestational Age (GA), Ultrasonography (USG)

## 1. Introduction

Accurate pregnancy age assessment plays a significant role in the reduction of pre and post-date labor, which improves both fetal and maternal care and reduces perinatal complications. It is the only way to know the adequate timing of mandatory interventions and the avoidance of early or late interventions.<sup>1</sup>

The length of time of a pregnancy can be estimated with the use of ultrasonography (USG), which measures the fetus and utilizes its size as an indirect indicator of the woman's menstrual age. The biparietal diameter (BPD), abdominal circumference (AC), head circumference (HC), and femur length (FL) are some of the various measures that are being used at this time.<sup>2</sup>

These criteria have little therapeutic use in establishing GA in late pregnancy, measuring fetal development in ambiguous-dated pregnancies, or addressing any other pregnancy

issues, such as post-date pregnancy. This was explained by the increased biological variability as gestational age progressed. Serial ultrasonographic screening in the third trimester is essential to diagnose abnormal fetal growth for proper fetal surveillance and management.<sup>3</sup>

The assessment of the fetal cranium's posterior fossa has been approved as part of the normal obstetrical ultrasonographic examination. The Cerebellum's size, or transverse cerebellar diameter, is significant because it is a valuable biometric marker in determining gestational age in the second trimester.<sup>4</sup>

Trans-cerebellar diameter can be utilized with confidence in situations of femur achondroplasia where femur length is inconsistent. Because TCD appears to be unaffected by intrauterine growth restriction (IUGR), assessing Trans-Cerebellar Diameter is particularly useful when intrauterine growth restriction is suspected, or GA is unknown.<sup>5</sup>

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The greatest portion of the rear brain, the Cerebellum, is encircled by the dense petrous ridges on the sides as well as the occipital bone on the bottom, which is positioned perpendicular to the plane of maximum extrinsic compression. Deformation by extrinsic pressure should, in theory, be less of a problem for the Cerebellum and posterior fossa than it is for the parietal bones.<sup>6</sup>

The purpose of this research was to assess the reliability of using trans-cerebellar diameter measurements to predict gestational age in healthy, uncomplicated pregnancies.

## 2. Patients and methods

The prospective longitudinal comparative descriptive study had been conducted on 120 patients, at the department of obstetrics & gynecology, Al-Azhar university hospital (Assiut) and General Sohag hospital. The study was done from January 2022 till May 2023.

A total of 120 persons were enrolled in the trial. They came to our clinic for six visits during their pregnancy; the first visit was in (14 -16 weeks), The second visit was in (20 weeks), The third visit was in (24 weeks), The fourth visit was in (28 weeks), The fifth visit was in (32 weeks) and The sixth visit was in (36 weeks).

**Inclusion Criteria:** Normal, uncomplicated pregnancy, Single fetus, Pregnant of GA between 14 and 16 weeks, Cerebellum is clearly visualized & no abnormal fetal morphology, and Women with regular cycles & excellent dates determined by: Sure, of their dates, Reliable: regular last three cycles before pregnancy without any use of hormonal contraception and confirmed by first-trimester ultrasound.

**Exclusion Criteria:** Any pregnancy-related complications (such as DM, HTN, and IUGR), Multiple pregnancies, Amniotic fluid abnormalities, Abnormal fetal head morphology, and congenital anomalies.

### Sample Size (n):

This study is based on a study carried out by Geevarghese A. The sample size was measured utilizing Epi Info STATCALC, taking into account the following assumptions: The study was done utilizing a 95% two-sided confidence level and a power of 80%, with a margin of error of 5%. The ultimate maximum sample size extracted from the Epi-Info output was 108. Therefore, the sample size was augmented to include 120 cases in order to account for any dropout throughout the follow-up period.<sup>7</sup>

$$\left( \frac{Z_{a/2} + Z_B}{P_1 - P_2} \right)^2 (p_1 q_1 + p_2 q_2)$$

Takazawa& Morita.<sup>8</sup>

n = sample size

$Z_{a/2}$  (The crucial number that demarcates the center 95% of the Z distribution)

$Z_B$  (The crucial number that demarcates the center 20% of the Z distribution)

$p_1$  = prevalence in case group

$p_2$  = prevalence in the control group.

$q = 1 - p$

### Methods

Pregnant GA between 14 and 16 weeks underwent Complete history taking, Examination (General, Abdominal, and local clinical examination), and Investigations.

The transcellular diameter (TCD) was measured by a 2D ultrasound machine as follows: The transcerebellar plane was detected when a pregnant woman was in a recumbent position. When the thalamus and cavum septum pellucidum appear on the same plane as the Cerebellum, we know that the plane is right. The trans-cerebellar diameter is the broadest measurement that is taken across the Cerebellum in a direction that is perpendicular to the falx, and it is measured in mm. After that, we monitored the ultrasonographic characteristics of the woman at the 20th, 24th, 28th, and 32nd, along with the 36th weeks of pregnancy. The measurement of the biparietal diameter was performed in the view of the lateral ventricles, which depicts the skull as having the shape of a rugby football, with the occiput and incipit being more rounded than the precuneus. In a straight line in the middle, halfway across the scale's extremes. Exactly one-third of the way from the synciput to the occiput was where the cavum septum pellucidum was cut in half. There was a perfect symmetry between the midline and the positions of the two anterior horns of the lateral ventricles. All or most of the lateral ventricles' back horns were positioned on either side of the body's median axis. Only the outer-to-outer thickness of the top parietal bone is included in the BPD.<sup>9</sup> For an accurate femur measurement, it is essential to capture an image of the FL that shows both ends of the ossified metaphysis. The ossified diaphysis was analyzed to determine its longest axis. The same method should be utilized when creating the reference chart to determine the angle between the femur and the insonating ultrasound beams. Most insonation angles fell within the range of 45 to 9 degrees. Each caliper was positioned at the terminal points of the ossified diaphysis, except the distal femoral epiphysis in cases where it was evident. Triangular spur artifacts, which might artificially lengthen the diaphysis, should be disregarded in this measurement.<sup>10</sup> Furthermore, LMP and first-trimester ultrasound were used to determine what proportion of pregnancies were correctly estimated using all three parameters (BPD, TCD, and FL) within the first three days as well as a week's time

of the actual gestational age.



Figure 1. voluson E6 ultrasound machine OF" AZHAR OB& GYN 4D UNIT"



Figure 2. Fetal skull showing TCD measurement in a fetus of 25 weeks  $\pm$  3 days' gestation. AZHAR OB& GYN 4D UNIT

#### Ethical Consideration

Written informed consent was gathered from all participants prior to inclusion in the current research, confidentiality as well as privacy were respected at all stages of the research & also the trial was approved by the managers of the hospital in which it was conducted and the local ethics committee, Faculty of Medicine, Al-Azhar

Table 2. Gestational age through evaluation visits

	INITIAL VISIT	SECOND VISIT (GA: 20W)	THIRD VISIT (GA: 24)	FOURTH VISIT (FA: 28)	FIFTH VISIT (GA: 32)	SIXTH VISIT (GA: 36)	P. VALUE
G.A-TCD	105.93 $\pm$ 7.11	142.1 $\pm$ 4.77	171.03 $\pm$ 4.1	199.28 $\pm$ 3.76	227.07 $\pm$ 3.14	254.78 $\pm$ 2.57	<0.0001*
G.A-FL	103.29 $\pm$ 7.72	141.56 $\pm$ 6.33	170.09 $\pm$ 5.67	198.28 $\pm$ 4.72	227.56 $\pm$ 3.61	254.51 $\pm$ 3.07	<0.0001*
G.A-BPD	102.33 $\pm$ 6.8	137.6 $\pm$ 3.71	169.73 $\pm$ 5.7	198.59 $\pm$ 4.81	226.69 $\pm$ 3.67	254.73 $\pm$ 3.18	<0.0001*
G.A-AC	101.8 $\pm$ 7.05	139.93 $\pm$ 6.47	169.34 $\pm$ 6.32	198.06 $\pm$ 5.47	227.18 $\pm$ 4.21	254.48 $\pm$ 3.33	<0.0001*

There was a highly statistically significant alteration among estimated GA by each modality (G.A-TCD, G.A-FL, G.A-BPD and G.A-AC) and actual gestational age through evaluation visits. GA was increased with actual GA through estimations. (Table 2)

Table 3. Difference with actual age through time

	INITIAL VISIT	SECOND VISIT (GA: 20W)	THIRD VISIT (GA: 24)	FOURTH VISIT (FA: 28)	FIFTH VISIT (GA: 32)	SIXTH VISIT (GA: 36)	P. VALUE
G.A-TCD	3.86 $\pm$ 3.31	3.54 $\pm$ 3.1	2.76 $\pm$ 2.66	2.37 $\pm$ 2.44	2.06 $\pm$ 1.9	1.61 $\pm$ 1.55	<0.0001*
G.A-FL	5.83 $\pm$ 4.25	5.15 $\pm$ 3.81	4.12 $\pm$ 3.71	2.92 $\pm$ 3.25	2.25 $\pm$ 2.6	1.94 $\pm$ 2.01	<0.0001*
G.A-BPD	6.13 $\pm$ 3.37	5.36 $\pm$ 3.55	4.57 $\pm$ 3.4	3.33 $\pm$ 2.97	2.43 $\pm$ 2.58	2.12 $\pm$ 2.17	<0.0001*
G.A-AC	6.85 $\pm$ 3.23	6.1 $\pm$ 3.53	5.22 $\pm$ 3.67	3.83 $\pm$ 3.45	2.64 $\pm$ 2.96	2.26 $\pm$ 2.31	<0.0001*

A highly significant statistical the discrepancy existed among estimated gestational age by each modality (G.A-TCD, G.A-FL, G.A-BPD and G.A-AC) and actual GA through time. Difference with actual age significantly decreased through time. (Table 3)

Table 4. Accuracy within 3 days through time

	INITIAL VISIT	SECOND VISIT (GA: 20W)	THIRD VISIT (GA: 24)	FOURTH VISIT (FA: 28)	FIFTH VISIT (GA: 32)	SIXTH VISIT (GA: 36)	P. VALUE
G.A-TCD	71 (59.17%)	79 (65.83%)	94 (78.33%)	103 (85.83%)	110 (91.67%)	115 (95.83%)	<0.0001*
G.A-FL	44 (36.67%)	54 (45%)	68 (56.67%)	92 (76.67%)	105 (87.5%)	109 (90.83%)	<0.0001*
G.A-BPD	29 (24.17%)	46 (38.33%)	62 (51.67%)	82 (68.33%)	101 (84.17%)	107 (89.17%)	<0.0001*
G.A-AC	26 (21.67%)	40 (33.33%)	52 (43.33%)	78 (65%)	95 (79.17%)	105 (87.5%)	<0.0001*

University, Egypt. There will be no other uses for collected data.

#### Data Management and Statistical Analysis

History, laboratory investigations, basic clinical examination, and outcome measures were coded, entered, and then analyzed in Microsoft Excel. SPSS version 22.0 was employed to analyze the data. Qualitative data is represented by numbers as well as percentages, whereas quantitative information is represented by mean  $\pm$  SD. Pearson's correlation or Spearman's correlation was used to test for significance. P value was chosen at below 0.05 for significant findings and less than 0.001 for strong significance.

Data were together and submitted for statistical analysis. The following statistical tests and parameters were utilized (Standard deviation (SD), Mean, and sensitivity specificity predictive value).

### 3. Results

Table 1. Basal characteristics of included subjects

PARAMETERS	VALUE (N = 120)
AGE (YEARS)	23.43 $\pm$ 2.63
BMI (KG/M <sup>2</sup> )	22.45 $\pm$ 1.16
RESIDENCE	
URBAN	63 (52.5%)
RURAL	57 (47.5%)
LMP (DAYS)	108.07 $\pm$ 5.69
LMP RELIABILITY	120 (100%)
ONE FETUS	120 (100%)
GESTATIONAL AGE (DAYS)	108.07 $\pm$ 5.69

The mean age of 23.43 years and living in residence, representing 52.5% of the total sample. BMI was within normal 22.45  $\pm$  1.16Kg/m<sup>2</sup>. The LMP (last menstrual period) was reported to have high reliability for all subjects. All subjects had a single fetus and a gestational age of 108.07  $\pm$  5.69 days. (Table 1)



A highly statistically significant distinctions existed amongst estimated GA by each modality (G.A-TCD, G.A-FL, G.A-BPD and G.A-AC) and actual gestational age regarding accuracy within 3 days through time. Accuracy within 3 days significantly increased through time (Table 4)

Table 5. Accuracy within one week through time

	INITIAL VISIT	SECOND VISIT (GA: 20W)	THIRD VISIT (GA: 24)	FOURTH VISIT (FA: 28)	FIFTH VISIT (GA: 32)	SIXTH VISIT (GA: 36)	P. VALUE
G.A-TCD	93 (77.5%)	101 (84.17%)	107 (89.17%)	112 (93.33%)	116 (96.67%)	118 (98.33%)	<0.0001*
G.A-FL	78 (65%)	87 (72.5%)	99 (82.5%)	107 (89.17%)	113 (94.17%)	116 (96.67%)	<0.0001*
G.A-BPD	55 (45.83%)	72 (60%)	85 (70.83%)	100 (83.33%)	109 (90.83%)	113 (94.17%)	<0.0001*
G.A-AC	42 (35%)	55 (45.83%)	68 (56.67%)	90 (75%)	104 (86.67%)	111 (92.5%)	<0.0001*

Changes were highly statistically significant amongst estimated GA by each modality (G.A-TCD, G.A-FL, G.A-BPD and G.A-AC) and actual GA regarding accuracy within one week through time. (Table 5)

#### 4. Discussion

In our study, the mean age was 23.43 years and living in residence, representing 52.5% of the total sample. The LMP (last menstrual period) was reported to be highly reliable for all subjects. All subjects had a single fetus and a gestational age of  $108.07 \pm 5.69$  days.

Sixty healthy pregnant women had regular USG tests, and the measurements gained matched those reported by Prasad et al. Women who became pregnant ranged in age from eighteen to thirty-five. Most of the pregnancies (41.70%) were in the first 27th week of pregnancy. Of all pregnancies, 38.3 percent occurred during weeks thirty-three and forty, while twenty percent of them happened within weeks twenty-seven and thirty-two. Fifty percent of the cases were first-time mothers, 40 percent were pregnant for the second time, and 5 percent were pregnant for the third or fourth time. <sup>11</sup>

In our trial there was significant variance amongst each estimated GA & actual GA in the initial visit. There was significant change among assessed gestational age and each other as (G.A-TCD), (G.A-FL), (G.A-BPD) and (G.A-AC).

We found that the Accuracy within 3 days for estimating gestational age was highest for G.A-TCD (trans cerebellar diameter) with 71 subjects (59.17%), followed by G.A-FL (femur length) with 44 subjects (36.67%), G.A-BPD (biparietal diameter) with 29 subjects (24.17%), and G.A-AC (abdominal circumference) with 26 subjects (21.67%). There was a significant difference among modalities regarding Accuracy within 3 days.

Our results agreed with El-Refaie et al., who determined the following percentages for TCD, BPD, FL, and AC in estimating gestational age to within three days of the predicted value based on LMP: Fifty-nine out of a hundred individuals (59%) had an accurate assessment from TCD within three days. Fifty of the hundred participants (51%) who were assessed by FL within three days were given an accurate diagnosis. Out of 100 patients, 39 (39%) had an appropriate diagnosis from the BPD within 3 days. However, 37 out of the 100 individuals (37%) had an accurate assessment from the AC within a period of three days. <sup>12</sup>

In our study, The Accuracy within a week for estimating gestational age was highest for G.A-TCD (trans cerebellar diameter) with 93 subjects (77.5%), followed by G.A-FL (femur length) with 78 subjects (65%), G.A-BPD (biparietal diameter) with 55 subjects (45.83%), and G.A-AC (abdominal circumference) with 42 subjects (35%). There was a significant difference among modalities regarding Accuracy within a week.

Our results agreed with El-Ebeisy et al., who determined that transcerebellar diameter is a reliable parameter in estimating gestational age since its values are closely related to that of gestational age by LMP in pregnancies ranging in length from 14 weeks to 40 weeks and identified an overall agreement within 2 weeks. Within a given week, there was a large discrepancy in Accuracy across the various modes. <sup>13</sup>

In our study, there was no significant variance between Actual gestational age in the second visit and estimated GA by TCD. However, there was a significant difference between other modalities and actual GA. The study found that in the second visit, the mean alteration amongst each estimated gestational age and the actual gestational age was  $3.54 \pm 3.1$  days for G.A-TCD (trans cerebellar diameter),  $5.15 \pm 3.81$  days for G.A-FL (femur length),  $5.36 \pm 3.55$  days for G.A-BPD (biparietal diameter), and  $6.1 \pm 3.53$  days for G.A-AC (abdominal circumference).

There was a significant difference between the estimated GA and each other.

Our results agreed with Sersam et al., who, comparing the transcerebellar diameter to other commonly used fetal biometric markers between weeks 14 to 42 of pregnancy, observed a correlation of  $r=0.984$  with a significance level of 0.000. <sup>14</sup>

Our result showed that neither group differed significantly from the other in actual GA during the third visit and estimated GA by TCD. However, there was a significant difference between other modalities and actual GA.

Our results disagreed with those of Singh et al., who observed a linear growth pattern among the two, beginning in the second trimester and related to GA. TCD has been demonstrated to be correlated with GA in healthy pregnancies ( $R^2 = 0.975$ ,  $p\text{-value} < 0.001$ ). <sup>15</sup>

Our results showed that Difference between

each estimated GA and actual GA in the fourth visit. There was significant Difference among estimated GA and each other.

Our results agreed with Ahmed et al., who looked at BPD, AC, HC, FL, and TCD measures in the third trimester and found statistically significant P values under 0.001, 0.001, 0.001, 0.001, 0.001 when associated with GA by LMP.<sup>16</sup>

Our results showed that gestational age estimation through different modalities in the fifth visit (GA 32 weeks). There was no significant variance between Actual GA and expected GA by different modalities, and insignificant distinctions were identified among assessed gestational age and each other.

Our results disagreed with Bakry et al., who found that There was a significant difference between Actual GA and estimated GA by different modalities as p value<0.000.<sup>17</sup>

Our results showed that Accuracy within 3 days and one week significantly increased over time.

Our result agreed with Alalfy et al., who noticed that Sixty Egyptian women in their third and second trimesters with both straightforward as well as complex pregnancies, they determined that trans cerebellar diameter was considerably positively connected to menstrual gestational age. This finding was made by researchers who found that trans cerebellar diameter was positively correlated to menstrual gestational age.<sup>18</sup>

**Recommendations:** We recommend adequate training in the proper technique for measuring TCD to ensure Accuracy and consistency of results. Further studies with larger sample sizes and longer follow-ups are needed. TCD measurements can be a reliable indicator of gestational age in pregnant women, particularly in the second trimester. Therefore, Healthcare practitioners should consider using TCD measurements along with other fetal measurements and clinical assessments to ensure accurate gestational age estimation.

#### 4. Conclusion

The fetal transcerebellar diameter has a significant relationship with the estimated gestational age based on the time of the last menstrual cycle. The Trans-cerebellar plane was detected when a pregnant was in a recumbent position. The transcerebellar diameter of the fetus is a reliable predictor of the gestational age of the fetus.

#### Disclosure

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