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# Diagnostic accuracy of Trans-cerebellar diameter for estimation of gestational age and prediction of fetal weight in diabetic patients

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## **Ethical approval:**

Study protocol was approved by the institutional board of ethics, and informed consents were obtained from all subjects included in the study.

**Conflict of interest:** No conflict of interest.

**Financial support:** No financial support.

## **Abstract**

**Objectives:** To evaluate the diagnostic accuracy of TCD in prediction of gestational age and fetal weight in diabetic patients.

**Subjects and methods:** This prospective cross-sectional study was conducted on 84 pregnant women at third trimester of pregnancy who attended the antenatal care in the outpatient clinic at our hospital during the period from November 2019 to November 2021. Measurements of the TCD was performed and correlated with gestational age based on last normal menstrual period (LNMP) as well as estimated fetal weight. The study was approved by the Ethics Committee, and all patients gave their informed consent before inclusion in the study.

**Results:** The mean age  $\pm$  SD ratio of the study group was  $29.45 \pm 6.16$  years. The study group included 84 consecutive diabetic pregnant women; 2 females with diabetes type A1 (2.4%), 28 females with diabetes type A2 (33.3%), 33 females with diabetes type B (39.3%), and 21 females with diabetes type C (25%). The mean fetal TCD  $\pm$  SD ratio at 32-34 weeks was  $40.17 \pm 2.95$  mm and at 37 weeks was  $50.42 \pm 3.04$  mm. we found that there is a statistically significant positive correlation between TCD and estimated fetal weight at 32-34 weeks ( $r = 0.294$ ,  $p = 0.007$ ) and at 37 weeks ( $r = 0.475$ ,  $p < 0.001$ ). TCD has 94.1% accuracy in detection of the actual gestational age at 32-34 weeks and 95.2% accuracy in detection of the actual gestational age at 37 weeks.

**Conclusion:** The current study has demonstrated that there is a statistically significant positive correlation between TCD and Estimated fetal weight at third trimester of pregnancy. TCD can be used as an accurate reliable method for the assessment of gestational age in third trimester. We recom-

mend to conduct this study on larger sample size for further documentation of the proposed assumption.

**Keywords:** Trans-cerebellar diameter, Gestational age, Fetal weight, Diabetic patients.

## **Introduction**

Diabetes is the most common medical problem with pregnancy. Approximately 90% of these cases are those having gestational diabetes mellitus (GDM) that affects 2–5% of all pregnancies, while preexisting type 2 diabetes accounts for 8% of such cases (1).

Poor control of preexisting (pregestational) or gestational diabetes during organogenesis period (up to about 10 wk. gestation) increases the risk of major congenital malformations and spontaneous abortion; while, poor control of diabetes later in pregnancy increases the risk of fetal macrosomia, preeclampsia, shoulder dystocia, cesarean delivery and stillbirth (2).

It has been suggested that the diabetic environment may have undesired effects on placental function and development. It is important to be precise that these effects will depend on the time period in pregnancy (3).

The fetal growth profiles leading to macrosomia in diabetic pregnancies should be known to understand the pathophysiology, because it may help to design preventive strategies, however; there is limited general information on the growth profiles in diabetic pregnancies. Previous studies in such pregnancies had indicated that fetal growth accelerates between 18 and 24 weeks' gestation (4).

The keystone in decision-making about the optimal timing of delivery in diabetes in pregnancies is the accurate knowledge of fetal gestational age (FGA), as about 10% - 45% of women do not know their last menstrual period (LMP) and at times they first attend the antenatal clinics in their last trimester of pregnancy (5). This may result in iatrogenic premature deliveries, leading to

increased perinatal morbidity and mortality.

Estimation of gestational age using ultrasonographically derived fetal parameters such as Biparietal diameter (BPD) and femur length (FL) is perhaps the cornerstone in obstetrics and is an important component in the management of pregnancies (6). There are some limitations with using such parameters such as BPD and HC after 26 weeks as they may be unreliable in cases of moulding of fetal skull (7). Also, is unreliable to use femur length in calculation of gestational age in some cases like achondroplasia. A new parameter for estimation of gestational age has been developed which is trans-cerebellar diameter (TCD).

Fetal cerebellum can be detected as early as 10-11 weeks gestation by ultrasound. From the second trimester onwards, it grows in a linear correlation with gestational age. Trans-cerebellar diameter is least affected by external factors as it is surrounded by dense petrous bone which allows its use for estimating GA even in third trimester (8).

TCD is the least affected parameter in cases of growth restriction, so accurate gestational age can be predicted with it (8). TCD measurement has been evolved as a novel parameter and has been proposed to be more precise in the assessment of GA (9). This study was conducted to evaluate the accuracy of TCD over other parameters of gestational age of 30-40 weeks.

## **Patients and methods**

This prospective cross sectional study was conducted on 84 diabetic pregnant patients between 32-34 weeks of pregnancy, during the period from November 2019 to November 2021 at outpatient clinic of our hospital; the institutional ethical review board approved the study.

The study was conducted at the outpatient clinic to determine the correlation between transverse cerebellar diameter (TCD) and gestational age in third trimester of pregnancy as well as estimated fetal weight.

**Inclusion and exclusion criteria**

All patients were diagnosed as controlled pre-gestational or gestational diabetes, with singleton and non-anomalous fetuses, who were sure of dates calculated by first day of last normal menstrual period. Pregnant women with anomalous fetus on ultrasound, medical disorders like hypertension, chronic renal disease, intra uterine death (IUD), multiple gestations on ultrasound, accidental hemorrhage and premature rupture of membranes were excluded from the study.

**Maternal data:**

- Patient’s history, age, height, BMI, parity and LMP were recorded.
- Type of diabetes according to White classification(10) was recorded

**Fetal data:**

- Fetal measurements were done using Mindray DC-40 ultrasound equipment at 32-34 and at 37 weeks of gestation to measure fetal trans-cerebellar diameter (TCD), biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL) at 32-34 and at 37 weeks of gestation.
- TCD was measured at 90 degree to the long axis of the cerebellum across its widest point, using the outer to outer method.
- Measurement of estimated fetal weight by ultrasound (by femur length, bi-parietal diameter and abdominal circumference) at 32-34 and at 37 weeks of gestation, based on
- Hadlock2:Log10 (weight) = 1.335 – (0.0034 X AC X FL) + (0.0316 X BPD) + (0.0457 X AC) + (0.1623 X FL). (11)
- Measurement of actual neonatal birth weight.

**Sample size**

The calculated sample size of the study will be 84 participants at 5%level of significance and 80% power of the study, using the following formula (Daniel, 1999).

$$n = \frac{Z^2 * P * (1-P)}{d^2}$$

Where

Z = 1.96 for 95% confidence level.  
 p = expected percentage of correlation between TCD and FL (94.2%).  
 d = precision (Margin of error) = 0.05 (15)

**Ethical consideration**

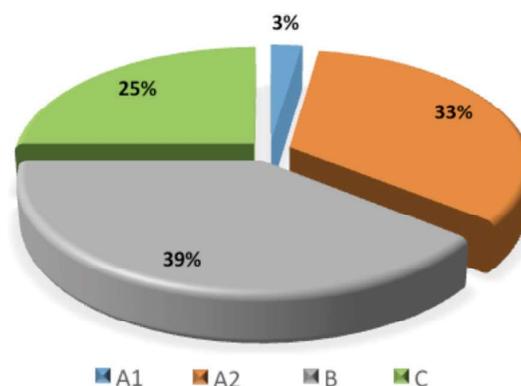
Written informed consents were taken from the participants after being informed about the objectives and purposes of the study. Confidentiality and privacy had been maintained throughout the study.

**Statistical analysis**

The collected data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 21). Mean ± standard deviation was computed for demographic data, estimated fetal weight, and trans-cerebellar diameter (TCD). Association between categorical variables was tested using Chi-square test. The study groups were compared with ANOVA test. The results were considered significant when p value ≤ 0.05.

**Results**

This study was conducted on 84 consecutive diabetic pregnant women; 2 females with diabetes type A1 (2.4%), 28 females with diabetes type A2 (33.3%), 33 females with diabetes type B (39.3%), and 21 females with diabetes type C (25%) figure (1).



**Figure (1): Type of diabetes among the studied group**

The demographic characteristics showed no statistically significant difference ( $P \geq 0.05$ ) among study groups as regard age and parity. However; the maternal weight was a statistically significant different between study groups ( $P=0.001$ ), as shown in table (1).

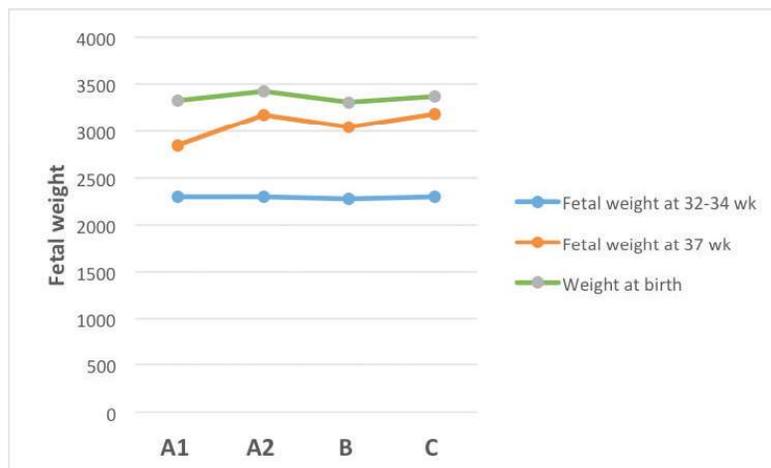
**Table (1): Demographic data among studied groups.**

	TypeA1 n=2 (2.4%)	TypeA2 n=28 (33.3%)	TypeB n=33 (39.3%)	Type C n=21 (25%)	Total n=84 (100%)	Test of significance (p value)
<b>Maternal age (years)</b>	22.5±3.54	28.54±6.12	28.94±5.73	32.14±6.26	29.45±6.16	0.057
<b>Maternal weight</b> Mean ± SD	88.5±4.95	79.96±6.54	87.61±7.45	85.90±7.06	84.65±7.70	0.001
<b>Parity</b> Mean ± SD	0.00±0.00	1.43±0.99	1.45±0.97	1.76±0.99	1.49±1.00	0.103

As shown in table (2) and figure (2), the mean fetal weight at 32-34 weeks was 2291.44±173.02 grams, at 37 weeks was 3117.79±460.86 grams, and at birth was 3363.3±436.39 grams with no significant difference between study groups.

**Table (2): Association between type of DM and fetal weight**

	TypeA1 n=2 (2.4%)	TypeA2 n=28 (33.3%)	TypeB n=33 (39.3%)	Type C n=21 (25%)	Total n=84 (100%)	Test of significance (p value)
<b>Estimated Fetal weight at 32-34</b> Mean ± SD	2300±70.71	2303.82±169.68	2275.93±188.37	2298.47±166.36	2291.44±173.025	0.933
<b>Estimated Fetal weight at 37</b> Mean ± SD	2846.5±43.13	3173.92±430.67	3043.82±461.65	3185.05±514.20	3117.79±460.86	0.500
<b>weight at birth</b> Mean ± SD	3325±35.35	3425±399.51	3310±415.08	3367±537.61	3359.75±436.49	0.793

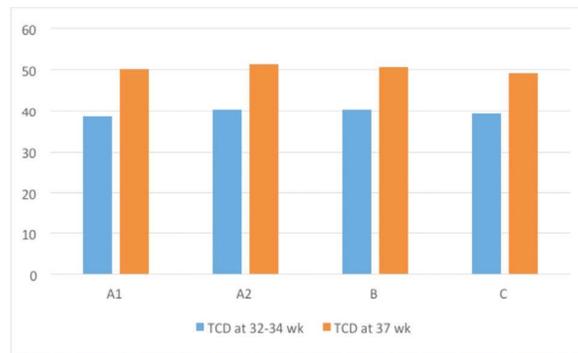


**Figure (2): Association between type of DM and fetal weight**

As shown in table (3), the mean TCD at 32-34 weeks was  $40.17 \pm 2.95$  mm and at 37 weeks was  $50.42 \pm 3.04$  mm with no significant difference between study groups.

**Table (3): Association between type of DM and TCD**

	TypeA1 n=2 (2.4%)	TypeA2 n=28 (33.3%)	TypeB n=33 (39.3%)	Type C n=21 (25%)	Total n=84 (100%)	Test of significance (p value)
<b>TCD at 32-34 weeks</b> Mean $\pm$ SD	38.50 $\pm$ 0.71	40.53 $\pm$ 2.50	40.48 $\pm$ 2.76	39.33 $\pm$ 3.75	40.17 $\pm$ 2.95	0.377
<b>TCD at 37 weeks</b> Mean $\pm$ SD	50.00 $\pm$ 0.0	51.21 $\pm$ 2.11	50.51 $\pm$ 3.17	49.24 $\pm$ 3.74	50.42 $\pm$ 3.04	0.162

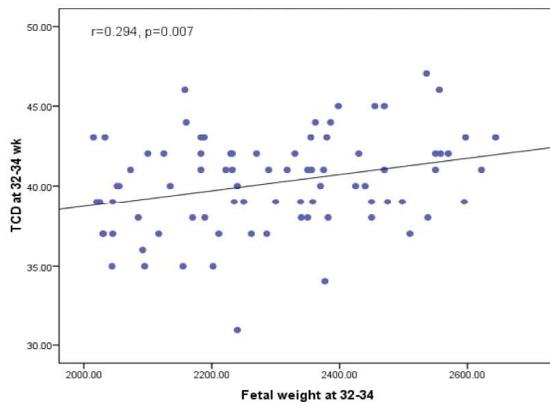


**Figure (3): Association between type of DM and TCD**

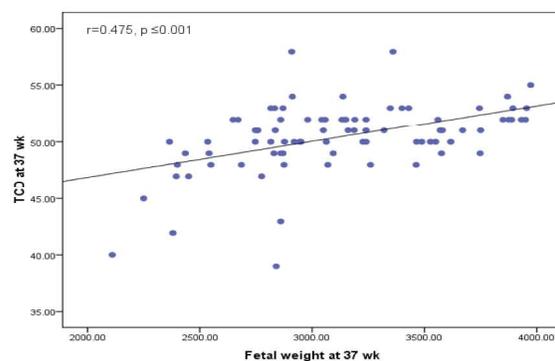
There was a statistically significant positive correlation between TCD and Fetal weight at 32-34 weeks ( $r = 0.294$ ,  $p = 0.007$ ) and at 37 weeks ( $r = 0.475$ ,  $p < 0.001$ ) as seen in table (4) and figure (4&5).

**Table (4): Correlation between TCD at estimated fetal weight**

	r	P value
<b>TCD &amp; EFW at 32-34 weeks</b>	0.294	<b>0.007*</b>
<b>TCD &amp; EFW at 37 weeks</b>	0.475	<b><math>\leq 0.001</math>*</b>



**Figure (4): Scatter diagram for positive correlation between TCD at 32-34 wk and fetal weight at 32-34 wk**



**Figure (5): Scatter diagram for positive correlation between TCD at 37 wk and fetal weight at 37wk**

TCD has about 94.1% accuracy in detection of the actual gestational age at 32-34 weeks, and it has about 95.2% accuracy in detection of the actual gestational age at 37 weeks.

**Table (5): Diagnostic accuracy of TCD in detection of GA**

	Actual GA (calculated by first date of LNMP)	Gestational age by TCD	P value
<b>GA at 32-34 weeks</b>			
True	84 (100%)	79 (94.1%)	0.059
False	0 (0%)	5 (5.9%)	
<b>GA at 37 weeks</b>			
True	84 (100%)	80 (95.2%)	0.121
False	0 (0%)	4 (4.8%)	

Fischer exact test was used

## **Discussion**

The transverse cerebellar diameter (TCD) is considered one of the most reliable growth ultrasound parameters, especially in early gestation. The fetal cerebellum that consists of a midline part called the vermis and two lateral hemispheres displays progressive growth over the entire gestation period, thus, it can be used to predict GA during pregnancy (12).

The TCD is a reliable indicator of GA in the fetus and can be an alternative to other parameters, particularly when GA cannot be determined by routine methods of early pregnancy scanning or the date of the last menstrual cycle (13). Despite this, to the best of our knowledge, no previous studies have assessed the role of TCD in assessment of gestational age in the diabetic pregnant mothers only. For this reason, the current study was conducted to evaluate the diagnostic accuracy of trans-cerebellar diameter in prediction of gestational age and fetal weight in diabetic patients.

This study was conducted on 84 consecutive diabetic pregnant women; 2 females with diabetes type A1 (2.4%), 28 females with diabetes type A2 (33.3%), 33 females with diabetes type B (39.3%), and 21 females with diabetes type C (25%). In the current study, TCD has 94.1% accuracy in detection of the actual gestational age at 32-34 weeks

and 95.2% accuracy in detection of the actual gestational age at 37 weeks.

Previous research studies that were performed on TCD measurements evaluation, clearly displayed and showed that TCD was a reliable trusted tool of measurement to calculate the fetal gestational age, it is believed to be more reliable than HC, BPD, FL and AC when the precise fetal gestational age calculation was desired. It could be even considered a dependable and reliable tool of measurement helping the settled formulas of fetal gestational age in either singleton or twin gestation (14).

In a previous study, it was found that TCD measurement had accuracy of 91.7% at 36 weeks of gestation (13). In the cross sectional study by Chavez MR et al, TCD accuracy in third trimester was found to be 94.0% which supports our study predictability (15). Dilmen et al, had studied 330 pregnant women and found a very close relation between TCD and estimated GA.(16)

Another research was applied on 50 patients from the start of the 2nd trimester till term. TCD measurement was used to detect the gestational age. There was a significant relationship between TCD and GA, concluding that TCD is a useful and an accurate tool for GA estimation (17).

Another retrospective, cross-sectional analytic study of normally developing fetuses

and 73 fetuses with IUGR between 24 and 34 weeks gestation was done, researchers found that the TCD measurements are spared in cases of IUGR.(18).

In the current study, there is a statistically significant positive correlation between TCD and estimated fetal weight at 32-34 weeks ( $r= 0.294$ ,  $p= 0.007$ ) and at 37 weeks ( $r= 0.475$ ,  $p < 0.001$ ). Prasad and Likhitha detected a good correlation between the GA and TCD throughout the third trimester and even in the case of Intrauterine growth retardation (IUGR) (12). Akl et al. performed a research in Egypt conducted in the third trimester of 150 pregnant women to evaluate the accuracy of TCD in the assessment of GA, and concluded that TCD is a reliable tool for assessing gestational age in the third trimester of pregnancy (19).

Reddy et al. Evaluated accuracy of predicting GA using the fetal trans-cerebellar Diameter (TCD) and comparing TCD with other existing GA parameters in 15 to 40 weeks of gestation. It was shown that TCD is a reliable measure in the calculation of gestational age in the second and third trimesters, since its value is closely related to those of GA by LMP. It can be also a good predictor of gestational age compared to other parameters, especially in the third trimester (20).

The main strength point of this study is that it is the first study to assess the diagnostic accuracy of TCD in estimating the GA and determining the correlation with the fetal weight and the type of diabetes in the included cases.

The main limitation of the current study is the small sample size and being a single center study, which limit the power of the obtained results. Also, we didn't perform correlation between TCD and other sonographic fetal measurements. Further studies may be required to overcome these limitations.

## **Conclusion**

The current study has demonstrated that there is a statistically significant positive correlation between TCD and Estimated fetal weight at third trimester of pregnancy. TCD can be used as an accurate reliable method for the assessment of gestational age in third trimester. We recommend to conduct this study on larger sample size for further documentation of the proposed assumption.

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**Legends to tables:**

**Table (1):** Demographic data among studied groups.

**Table (2):** Association between type of DM and fetal weight.

**Table (3):** Association between type of DM and TCD.

**Table (4):** Correlation between TCD at estimated fetal weight

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**List of abbreviation:**

**AC:** Abdominal circumference

**BMI:** body mass index.

**BPD:** Bi parietal diameter

**FL:** Femur length

**IUGR:**intrauterine growth restriction.

**SD:**standard deviation.

**SPSS:**Statistical Package of Social Science.