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# Estimation of Gestational Age in Third Trimester of Pregnancy by Fetal Transcerebellar Diameter and its Accuracy

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## Abstract

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**Objective:** estimation of accurate gestational age correctly remains a crucial step in the antenatal care provided to all pregnant women. Our aim was to find out if transcerebellar diameter (TCD) could aid precisely in detecting accurate gestational age using ultrasound.

**Patients and methods:** One hundred and three healthy women with singleton pregnancy were included. Pregnancies complicated with fetal anomalies, intrauterine growth restriction or death were excluded. Eligible participants were examined extensively by ultrasound to confirm the gestational age using TCD, biparietal diameter (BPD) and femur length (FL). Then, data were collected and statistically analyzed comparing the three measurements.

**Results:** TCD was accurate within in 88.3% of the cases, while FL was accurate in 65% of the cases and BPD was accurate 51.5%. Bland-Altman comparison of actual GA and GA estimated by TCD, FL and BPD showed narrow limits of agreement indicated low bias and better test with TCD, thus GA estimated by TCD was the best. There was good correlation between actual GA and GA estimated by TCD ( $r=0.989^{**}$ ,  $p< 0.001$ ).

**Conclusion:** TCD is the highest statistically significant measurement which could be used in the third trimester for assessing the gestational age compared with FL and BPD without any effect of parity, gestational age or fetal presentation on its accuracy.

## INTRODUCTION

The pregnancy date estimation is mandatory for the pregnant ladies to have the expected time of delivery in which various tests will be taken to achieve the estimated time. There are methods used to determine the gestational age including the date of the first day of the last menstrual cycle, clinical assessment, and ultrasonography [1]. The four basic measurements, including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), can be performed using standard American institute of ultrasound in Medicine guidelines[2].

In third trimester, various ultrasound parameters including FL are used for gestational age assessment, yet it shows a margin of error of two to three weeks from the actual gestational age [3]. Also, the BPD shows a margin of error of three or four weeks from actual gestation because of the large biological variations in fetal skull shape and size [4].

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In third trimester when there is excessive molding of the head, BPD and HC become unreliable, in this case transcerebellar diameter (TCD) becomes a reliable marker for estimation of gestation since the cerebellum is not liable to change in its form and size as it is protected very well inside the posterior fossa surrounded by dense petrous and occipital bones [5].

TCD can better predict gestational age especially in cases where there is variation of fetal head shape, such as dolichocephaly and brachycephaly [6,7]. TCD applied in cases where it is difficult or impossible to calculate biparietal diameter, or cases where it is unsuitable because of the expressed molding of head [8]. In this study we compare between the TCD the BPD and the FL in accuracy of assessment of gestational age in the third trimester.

### **Patients and methods**

Prospective cross-sectional study carried out between January 2019 and June 2019 in Obstetrics and Gynecology Department, Kasr-AlAiny medical school, Cairo University after obtaining the approval from the local ethical committee. Pregnant women were recruited from the obstetrics outpatient clinic while attending for routine antenatal care between 31 to 36 weeks a total 103 women were examined for this study.

The sample size calculated according to equation [9]:

$$N = 4\sigma^2 (Z_{crit} + Z_{power})^2 / D^2$$

N= Total sample size which is the sum of the sizes of both comparison groups

$\sigma$  = The standard deviation of each groups, assumed to be equal in both groups=1

Zcrit= The desired significance criterion. =0.05

Zpower = Desired statistical power. =80%

D = The minimum expected difference.

The calculation showed that we should include at least 100 women to achieve study power of 80%. Women in the age range from 18 to 40 years old with healthy singleton pregnancy at 31-36 weeks' gestation (calculated by the first day of last menstrual periods and confirmed by 1st trimester ultrasound scan) were included. Exclusion criteria were intrauterine growth restriction, intrauterine fetal death, and congenital anomalies of fetus.

Women included in this study were subjected to verbal consent that was obtained from all candidates. Then, full history was taken and included personal history, menstrual history, obstetric history, medical history, drug allergy, operative history and any obstetric or operative complications. Women were examined by general examination, abdominal examination and full ultrasound examination done for gestational age determination, placental position, fetal anatomy, amniotic fluid volume, confirming the fetal presentation and position and measure the fetal TCD, BPD and FL.

### **Technique of ultrasound**

- Trans-abdominal ultrasound using (TOSHIBA Xario 100) was performed on all cases while women were in a tilted position with the head of the bed raised 30 degrees and with a small pillow under the right loin [10].
- BPD measurement was taken in the transthalamic view with a rugby-football-shaped skull, rounded at the occiput and more pointed at the sinciput. Along midline halfway between the proximal and distal scale echoes. The cavum septum pellucidum divided the midline one-third of the distance from the sinciput to the occiput. The two anterior horns of the lateral ventricles proportionally located about the midline. All or part of the posterior horns of the lateral ventricles equally placed near the midline. The BPD includes the thickness of only the upper parietal bone (outer to inner measurement) [10].
- FL measurement was obtained with both ends of the ossified metaphysis are clear. The longest distance of the ossified diaphysis was measured regarding the angle between the femur and the insulating ultrasound beams that is typically between 45° and 90°. Each caliper was placed at the ends of the ossified diaphysis without containing the distal femoral epiphysis if it is evident. This dimension should eliminate triangular spur artifacts that can incorrectly encompass the diaphysis length [10].
- Measurement of the TCD was obtained by getting the transthalamic view of BPD then rotating the probe slightly downwards, allowing the posterior horns of the lateral ventricles to

disappear from the view being replaced by the cerebellum. The TCD measured at 90 degree to the long axis of the cerebellum across its widest point, using the outer to outer method. All collected data were tabulated and subjected to proper statistical analysis.

### **Statistical Analysis**

Collected data entered using Microsoft excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. Qualitative data was represented as number and percentage. Quantitative data represented by mean  $\pm$  SD. Differences between quantitative variables by independent by T test. Correlation between groups was tested by Pearson's correlation and the agreement by Kappa agreement. P value was set at  $<0.05$  for significant results.

### **Results**

One hundred and three pregnant women with healthy singleton pregnancy were included for statistical analysis. The age of pregnant women included in the study was in the range of 18 to 39 years old, the gestational age of pregnancy ranges from 31 to 36 weeks. As regards to data found in the Table (1) the mean age was 28.87, the mean gestational age was 32.93, PG were (39.8%) and the of multi gravida were (60.2%).

As regards to data found in the Table (2) the mean GA by TCD was 32.87 weeks, mean GA by BPD was 33.19 weeks and GA by FL was 32.98 weeks among studied population. When we compared TCD measurements between primipara and multipara at different gestational ages, there was no statistically significant difference between them as shown in table (3). Therefore, it seems that conditions related to multiparity as obesity or pendulous abdomen to affect TCD readings. Moreover, comparing TCD measurements according to fetal presentation, as presented in table (4), did not show any statistically significant difference. They were comparable in cephalic, breech and transverse presentation.

There was significant positive correlation between GA ultrasound parameters and their estimated GA.

The highest was with TCD followed by FL at the last BPD as found in Table (5). There was no significant difference between actual GA and GA estimated by TCD or FL measurements, while BPD cannot be used alone for estimation of GA as seen in Table (6). The frequency and percentage of correct assessment by TCD was highest followed by FL and at the last is BPD as revealed in Table (7). The narrow limits of agreement indicated low bias and better testing results accordingly GA estimated using TCD was the best as in Table (8). Finally, Table (9) showed that TCD was significant predictor for GA when compared with others.

### **Discussion**

Accurate gestational age estimation is the cornerstone in any obstetric management. Fetal development monitoring is now possible with the introduction of ultrasound. Several biometric parameters were in use for the detection of fetal gestational [11]. Among the various clinical criteria, using the first day of the last menstrual period is the most used, but it is not useful when the woman is unsure of her dates [12].

The cerebellum represents the earliest system to begin to develop in neural system and the last one to complete after birth and it is representing the most complex structure in the embryo [13]. TCD may be a more reliable predictor than BPD since the external pressure does not affect the posterior fossa, for example in fetal malposition as breech presentation or with oligohydramnios, which may induce distortion of the fetal head [11].

Because TCD seems unaffected by intrauterine growth restriction measuring TCD is especially advantageous when it is suspected or when GA is uncertain or with macrosomia [14].

The aim of this study is to compare the accuracy of TCD measurement in estimation of the gestational age in the third trimester with the current fetal biometric measurements (FL and BPD) and gestational age estimated by last menstrual period. The mean age of studied group was 28.87 years the mean gestational age was 32.93 weeks at time of measurement. All the studied group had singleton uncomplicated pregnancy, with known LMP.

In the present study the mean GA estimated by TCD was 32.87 weeks, mean age estimated by

BPD was 33.19 weeks, and that estimated by FL was 32.98 weeks. The three sonographic measurements were compared to the actual gestational age estimated by LMP, and measurement of the mean gestational age was 32.932 weeks, the means of gestational age estimated by TCD near to the actual GA.

A study in 2013 studied demonstrated that TCD was a reliable method of gestational age determination in third trimester than BPD [4]. A study in 2014 stated that TCD gave correct assessment corresponding to the gestational age by LMP in 80.1% of patients, and as FL in 70.9% of patients [3].

A study in 2014, studied pregnant women in their third trimester to determine the accuracy of the TCD in assessment of gestational age. The TCD considered a dependable method for assessing gestation in third trimester of pregnancy [15].

A study in 2004, concluded that TCD measurement gave a gestational age within 3 days in 59% and within 1 week in 90%. While the FL gave a gestational age within 3 days in 46% and within 1 week in 80%. While, the BPD gave a gestational age within 3 days in 29.5% and within 1 week 60%, being the least accurate measurement amongst the 3 ones used [16].

A study in 2016, studied pregnant women in the period of 15 to 40 weeks. They performed a linear correlation between TCD and GA and the progressive changes in cerebellum from grade I to grade III with advancing gestational age [11].

A study in 2015, studied pregnant women between the 15th week of gestation and term. TCD positively correlated with BPD, HC, AC and FL so that TCD can be used as a reliable parameter for determination of gestational age [17].

A study in 2003, studied pregnant women for usefulness of TCD as a sole parameter for calculating gestation in the third trimester. The gestational age by TCD, BPD, FL and AC compared with actual gestation. The gestational age measured by TCD correlated with that measured by FL [18].

A study in 2015, studied pregnant women in the second and third trimesters. The accuracy of TCD in detection of GA was constant throughout the second and third trimesters of pregnancy [19].

Bhimarao et al. conducted a study over one year on 50 clinically suspected IUGR and showed one of the important limitations in the ultrasound study that it depended on the operator for precise measurement, there was also technical limitation due to the dense shadowing in the posterior fossa in the third trimester, which may limit adequate visualization of the cerebellum [20].

Naqvi et al. asked two US Maternal-Fetal trainers and 10 trainees participating in a 3-day hands-on fetal biometry workshop to join his study. To assess agreement, 3 trainees and 1 trainer obtained two measurements of the BPD, HC and TCD from 16 pregnant women in the second and third trimester. Agreement was assessed by Bland Altman plots, TCD measurements obtained by trainees were 0.2 cm less than expert measurements, this represented a 12.7% difference. Self-reported confidence in obtaining TCD measurements increased following the training. That meant sonography trainees can obtain acceptable TCD measurements in late pregnancy after a brief didactic and hands-on training workshop [21].

From the study we can conclude that TCD is an accurate method for assessment of gestational age in third trimester followed by FL, and the least accurate is the BPD. It can also be used for gestational age estimation in cases who are not sure about their LMP. All previous studies concluded that TCD was more accurate than other parameters in estimation of gestational age. Therefore, further studies with larger numbers of subjects and blinded observers are needed to assess the accuracy of TCD measurement in estimation of the gestational age.

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**Table (1):** Distribution according to age and parity among study group (n=103).

| %      | Number (n = 103) | Age (In years) |
|--------|------------------|----------------|
| 3.88 % | 4                | < 20           |
| 33.00% | 34               | 21: 25         |
| 2.91%  | 3                | - 26 – 30      |
| 60.19% | 62               | > 30           |
| %      | Number (n = 103) | Parity         |
| 39.8   | 41               | Primigravida   |
| 60.2   | 62               | Multigravida   |

**Table (2):** Mean and standard deviations of all parameters GA among study group (n=103).

| Maximum | Minimum | Median | Std.Deviation | Mean     | N   | Parameters |
|---------|---------|--------|---------------|----------|-----|------------|
| 36.00   | 31.00   | 33.00  | 1.35951       | 32.932   | 103 | GA         |
| 36.00   | 30.00   | 33.40  | 1.45979       | 32.873S8 | 103 | TCD        |
| 36.00   | 30.00   | 33.00  | 1.60868       | 32.9806  | 103 | FL         |
| 36.00   | 30.00   | 33.00  | 1.32885       | 33.1942  | 103 | BPD        |

**Table (3):** TCD according to parity clustered by gestational age among studied group (n=103).

| GA            | Parity | n. | Mean ± SD   | p-value   |
|---------------|--------|----|-------------|-----------|
| 31 w (n=20)   | Primi  | 5  | 35.02± 0.52 | 0.12(NS)  |
|               | Multi  | 15 | 34.6± 0.43  |           |
| 32 w (n=18)   | Primi  | 9  | 36.4± 0.56  | 0.11(NS)  |
|               | Multi  | 9  | 36.6± 0.44  |           |
| 33 w (n=32)   | Primi  | 9  | 38.4± 0.24  | 0.074(NS) |
|               | Multi  | 23 | 38.07± 0.47 |           |
| 34 w (n=17)   | Primi  | 12 | 39.25± 0.27 | 0.10(NS)  |
|               | Multi  | 5  | 39.04± 0.19 |           |
| 35-36w (n=16) | Primi  | 6  | 40.6± 0.68  | 0.26(NS)  |
|               | Multi  | 10 | 41.0± 0.56  |           |

**Table (4):** TCD level according to position among studied group (n=103).

| Position   | n. | TCD  |      |           | KW test | P value   |
|------------|----|------|------|-----------|---------|-----------|
|            |    | Mean | ± SD | Range     |         |           |
| Cephalic   | 70 | 37.8 | 2.04 | 34.1-41.9 | 3.06    | 0.21 (NS) |
| Breech     | 21 | 38.2 | 1.97 | 34.6-41.0 |         |           |
| Transverse | 12 | 36.9 | 2.05 | 34.1-41.5 |         |           |

**Table (5):** Correlations between GA estimated by LMP and GA estimated by sonar parameters among studied group (n=103).

| p value | r value | Parameters |
|---------|---------|------------|
| <0.001  | 0.989** | TCD        |
| <0.001  | 0.824** | FL         |
| <0.001  | 0.762** | BPD        |

**Table (6):** Paired analysis between actual GA and GA estimated by sonar parameters from 31 to 36 weeks among studied group (n=103).

|        |     | Mean    | N   | Std. Deviation | Paired t | P      |
|--------|-----|---------|-----|----------------|----------|--------|
| Pair 1 | GA  | 32.9320 | 103 | 1.35951        | 1.124    | 0.121  |
|        | TCD | 32.8738 | 103 | 1.45979        |          |        |
| Pair 2 | GA  | 32.9320 | 103 | 1.35951        | -2.187   | 0.034* |
|        | BPD | 33.1942 | 103 | 1.32885        |          |        |
| Pair 3 | GA  | 32.9320 | 103 | 1.35951        | -0.541   | 0.593  |
|        | FL  | 32.9806 | 103 | 1.60868        |          |        |

**Table (7):** Comparison of correct assessment of gestational age by TCD, FL and BPD among studied group (103).

| Correct assessment of gestational age by TCD<br>(Frequency and percentages) |              |     |    |      | Correct assessment of gestational age by FL<br>(Frequency and percentages) |              |     |    |      | Correct assessment of gestational age by BPD<br>(Frequency and percentages) |              |     |    |      |
|---|--------------|-----|----|------|--|--------------|-----|----|------|---|--------------|-----|----|------|
| Weeks of gestation  | Total no (n) | yes | no | %    | Weeks of gestation   | Total no (n) | yes | no | %    | Weeks of gestation  | Total no (n) | yes | no | %    |
| 31  | 20           | 14  | 6  | 70   | 31   | 20           | 12  | 8  | 60   | 31  | 20           | 6   | 12 | 50   |
| 32  | 18           | 16  | 2  | 88.9 | 32   | 18           | 10  | 8  | 55.6 | 32  | 18           | 6   | 12 | 33.3 |
| 33  | 32           | 31  | 1  | 96.9 | 33   | 32           | 25  | 7  | 78.1 | 33  | 32           | 25  | 7  | 78.1 |
| 34  | 17           | 15  | 2  | 88.2 | 34   | 17           | 10  | 7  | 58.8 | 34  | 17           | 7   | 10 | 41.1 |
| 35  | 14           | 13  | 1  | 92.9 | 35   | 14           | 9   | 5  | 64.2 | 35  | 14           | 8   | 6  | 57.1 |
| 36  | 2            | 2   | 0  | 100  | 36   | 2            | 1   | 1  | 50   | 36  | 2            | 1   | 1  | 50   |
| Total   | 103          | 91  | 12 | 88.3 | Total  | 103          | 67  | 36 | 65   | Total   | 103          | 53  | 50 | 51.5 |

**Table (8):** Bland-Altman comparison of GA by LMP and GA by TCD, FL and BPD

| GA (TCD) vs. GA (LMP) in weeks          |                           |
|---|---------------------------|
| Limits of agreement                     | -0.412 to 0.529           |
| Mean difference (95% CI)                | 0.058 (0.012 to 0.104)    |
| Range                                   | 30.5 to 36                |
| Pitman's test of difference in variance | <0.001                    |
| GA (BPD) vs. GA (LMP) in weeks          |                           |
| Limits of agreement                     | -2.082 to 1.557           |
| Mean difference (95% CI)                | -0.262 (-0.444 to -0.081) |
| Range                                   | 30.5 to 36                |
| Pitman's test of difference in variance | 0.724                     |
| GA (FL) vs. GA (LMP) in weeks           |                           |
| Limits of agreement                     | -1.835 to 1.738           |
| Mean difference (95% CI)                | -0.048 (-0.227 to 0.130)  |
| Range                                   | 30.5 to 36                |
| Pitman's test of difference in variance | 0.003                     |

**Table (9):** Simple linear regression analysis for TCD as a predictor of GA.

| Model summary | R2                          | Adjusted R2 |                           | SEE         | F    | P-value     |
|---------------|-----------------------------|-------------|---------------------------|-------------|------|-------------|
|               | 0.942                       | 0.942       |                           | 0.32        | 1647 | <0.001(HS)  |
| Variable      | Unstandardized Coefficients |             | Standardized Coefficients | 95% CI of B | t    | P           |
|               | B                           | Std. Error  | Beta                      |             |      |             |
| (Constant)    | 8.55                        | 0.6         |                           | 7.3-9.7     | 14.2 | <0.001 (HS) |
| TCD           | 0.65                        | 0.016       | 0.971                     | 0.61-0.68   | 40.5 | <0.001 (HS) |