Research Paper

Volume : 4 | Issue : 10 | October 2015 • ISSN No 2277 - 8179

# Correlation Between Fetal Biometry and Fetal Transverse Cerebellar Diameter in Determination of Gestational Age from the 15Th Week of Gestation to Term in Healthy Women with Uncomplicated Pregnancy

Medical Science

**KEYWORDS :** Fetal Transverse Cerebellar Diameter (TCD); Gestational age (GA); Ultrasound

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## ABSTRACT

*Objective: To perform obstetric ultrasonography in healthy women with uncomplicated pregnancy between the 15th week of gestation and term to determine a correlation between the transverse cerebellar diameter and the gestational age as determined by the last menstrual period and other sonographic parameters like biparietal diameter, head circumference, abdominal circumference and femur length. Materials and methods: 300 healthy women with uncomplicated pregnancy between the 15th week of gestation and term from the Obstetrics and Gynaecology department of J.S.S Hospitals, Mysore will be included in this study. The study period is for eighteen months; from october 2012 to June 2014. Gestational age for the measured TCD is obtained from the reference chart "Predicted menstrual age for transverse cerebellar diameter of 14 mm to 56 mm". Results: TCD positively correlated with BPD, HC, AC and FL. Nomogram of the TCD shows that there is a linear relationship between the cerebellar growth and gestational age. Conclusion: TCD can be used as a reliable parameter for determination of gestational age.*

## INTRODUCTION

Prediction of gestational age (GA) based on sonographic fetal parameters is perhaps the cornerstone in modern obstetrics and continues to remain an important component in the management of pregnancies with fetuses who have growth disturbances. The transverse cerebellar diameter (TCD) serves as a reliable predictor of GA in the fetus and is a standard against which aberrations in other fetal parameters can be compared, especially when the GA cannot be determined by the date of the last menstrual period or an early pregnancy scan [1-3].

A variety of sonographic fetal parameters have been shown to correlate well with GA. Sonographic measurement of foetal biparietal diameter is a well accepted predictor of gestational age[4,5] However there is a high variability in the calculated gestational age which increases as pregnancy progresses with maximum difference approximating 3.6 weeks in the third trimester. [6,7] The estimation of gestational age from individual parameters like the HC, AC, and FL also shows a similar variability. Using all the above parameters this variability can be reduced by 25% to 30 %.[8] There are conditions like oligohydromnios, multiple gestation, breech presentation and intrauterine growth restriction (IUGR) that can alter the shape of the foetal skull which in turn can affect the BPD and increase the variability.[9] Multiple gestations and IUGR can also affect the abdominal and femoral measurement. The present study is being undertaken to measure the transverse cerebellar diameter (TCD) to validate it as a additional morphological measurement of foetal growth with less variability. The cerebellum and posterior fossa are aligned perpendicular to the plane of maximum

extrinsic compression. Hence they are able to withstand deformation by extrinsic pressure than the parietal bones [9] and can be a more accurate parameter for the determination of gestational age.

## OBJECTIVE OF THE STUDY

1. To perform obstetric ultrasonography in healthy women with uncomplicated pregnancy between the 15th week of gestation and term to determine the correlation between the transverse cerebellar diameter and the gestational age as determined by the last menstrual period and other Sonographic parameters like biparietal diameter, head circumference, abdominal circumference and femur length.
2. To derive nomogram for estimating the gestational age of the foetus from ultrasonographically measured transverse cerebellar diameter.

## MATERIALS AND METHOD

A prospective study was done in 300 healthy women with uncomplicated pregnancy between the 15th week of gestation and term in out patient and in-patient sections of Obstetrics and Gynaecology department of JSS Hospitals, Mysore.

This study was undertaken to determine a correlation between the transverse cerebellar diameter and the gestational age as determined by the last menstrual period and other sonographic parameters like biparietal diameter, head circumference, abdominal circumference and femur length.

## INCLUSION CRITERIA

Healthy women with uncomplicated pregnancy between the 15th week of gestation and term.

## EXCLUSION CRITERIA

1. Unknown or inaccurate date of last menstrual period.
2. Irregular menstrual cycles.
3. Oligohydramnios.
4. Polyhydramnios.
5. Diabetic mother.
6. Pregnancy induced hypertension.
7. Pre eclampsia.
8. Dolichocephalic skull.
9. Multiple gestation.
10. Fetal chromosomal abnormalities.
11. Fetal anomalies.
12. Intrauterine growth restriction.
13. Any other known maternal and foetal abnormality.

## ETHICAL CLEARANCE:

The study required performing obstetric ultrasonography in normal pregnant women. Ethical clearance was obtained from the Institutional Ethical Review Committee of JSS Medical College.

## EXAMINATION METHOD:

All the statutory requirements under PNDT act were followed. All relevant clinical history was obtained and the correct LMP was confirmed. Transabdominal ultrasonography was performed with patient in supine position. Good acoustic coupling was obtained using synthetic ultrasound gel.

Obstetric ultrasonography were performed using a 3.5 MHz convex probe. Images were recorded in the thermal films.

In all the patients following parameters were obtained - BPD, HC, AC, FL, TCD, foetal heart rate, estimated foetal weight, AFI and placental position.

Plane used for measuring biparietal diameter and head circumference were through the third ventricle and thalami. Cavum septi pellucidi must be visible in the anterior portion of the brain and the tentorial hiatus must be visible in the posterior portion of the brain. The cursors are positioned in outer edge of near calvarial wall to inner edge of far calvarial wall for BPD. For HC the cursors are positioned in outer edge of the near calvarial wall and the outer edge of the far calvarial wall.

Abdominal circumference was taken in the plane showing the umbilical vein perpendicular to the fetal spine and the stomach bubble.

The femoral length was obtained by aligning the transducer to the long axis of the diaphysis. Measurement cursors are placed at the junction of the cartilaginous epiphysis and bone and the thin bright reflection of the cartilaginous epiphysis should not be included.

Transverse cerebellar diameter is obtained in the axial plane in the cerebellar view i.e with a slight rotation of the transducer approximately 300 from the conventional thalamic plane where the biparietal diameter is measured using the cavum septi pellucidi, third ventricle and thalami as landmarks. In this plane posterior fossa with cerebellum is visualized. The cisterna magna is just posterior to the cerebellum. This plane provides the widest transcerebellar diameter.

Gestational age for the measured TCD is obtained from the reference chart "Predicted menstrual age for transverse cerebellar diameter of 14 mm to 56 mm" by Hill et.al., in his study "Transverse cerebellar diameter as a predictor of menstrual age" in 1990.[10]

**OBSERVATIONS AND RESULTS**

**DISTRIBUTION ACCORDING TO AGE:**

| Trimester | N | Mean Age | Std. Deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|
| 2 | 152 | 26.26 | 3.184 | 26.00 | 19 | 35 |
| 3 | 148 | 26.67 | 3.757 | 27.00 | 17 | 36 |
| Total | 300 | 26.46 | 3.479 | 26.00 | 17 | 36 |

The age of 300 patients included in the study was in the range of 17 to 36 years with the mean age of 26.46 years. Second trimester group of 152 patients were in the range of 19 to 35 years with mean age of 26.26 years. Third trimester group of 148 patients were in the range of 17 to 36 years with the mean age of 26.67 years. Out of 300 patients included in the study, 4 (1.3%) were in the age group of < 20 years, 113 (37.6%) were in the age group of 20-25 years, 147 (49%) were in the age group of 25-30 years and 36 (12%) were in the age group of > 30 years.

**DISTRIBUTION ACCORDING TO TRIMESTER:**

The trimester distribution of the 300 pregnant women included in the study are as follows: 148 (49 %) pregnant women were in second trimester, 152 (51 %) pregnant women were in third trimester

**DISTRIBUTION ACCORDING TO GRAVIDITY:**

| | Trimester | | |
|---|---|---|---|
| Gravida | 2 | 3 | Total |
| 1 | 116 (76.3%) | 97 (65.5%) | 213 (71.0%) |
| 2 | 28 (18.4%) | 36 (24.3%) | 64 (21.3%) |
| 3 | 6 (3.9%) | 10 (6.8%) | 16 (5.3%) |
| 4 | 0 (0%) | 2 (1.4%) | 2 (0.7%) |
| 5 | 2 (1.3%) | 1 (0.7%) | 3 (1.0%) |
| 6 | 0 (0%) | 2 (1.4%) | 2 (0.7%) |
| Total | 152 (100.0%) | 148 (100.0%) | 300 (100.0%) |
| | | | |

The gravida status of 300 pregnant women in the study ranged from gravida 1 to gravida 6. Out of 300 pregnant women, 213 (71%) were primigravida, 77 (29%) were multigravida

**DISTRIBUTION ACCORDING TO PARITY:**

| | Trimester | | |
|---|---|---|---|
| Parity | 2 | 3 | Total |
| 0 | 118 (77.6%) | 103 (69.6%) | 221 (73.7%) |
| 1 | 30 (19.7%) | 34 (23.0%) | 64 (21.3%) |
| 2 | 3 (2.0%) | 9 (6.1%) | 12 (4.0%) |
| 3 | 1 (0.7%) | 1 (0.7%) | 2 (0.7%) |
| 4 | 0 (0%) | 1 (0.7%) | 1 (0.3%) |
| Total | 152 (100.0%) | 148 (100.0%) | 300 (100.0%) |

**SECOND TRIMESTER CORRELATION:**

| Combination Parameters | Of Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| TCD VS CGA | 0.894 | P<0.001 |
| TCD VS BPD | 0.881 | P<0.001 |
| TCD VS HC | 0.906 | P<0.001 |
| TCD VS AC | 0.901 | P<0.001 |
| TCD VS FL | 0.913 | P<0.001 |

The above table shows the association between foetal measurements with TCD. The correlation was best for TCD vs FL (r : 0.913) and least for TCD vs BPD (r : 0.881). All the correlations were statistically significant.

| Parameters | Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| CGA VS BPD | 0.898 | P<0.001 |
| CGA VS HC | 0.919 | P<0.001 |
| CGA VS AC | 0.921 | P<0.001 |
| CGA VS FL | 0.920 | P<0.001 |
| CGA VS TCD | 0.894 | P<0.001 |

This table shows the association between the foetal measurements and CGA. The correlation was best for CGA vs AC (r : 0.921) and least for CGA vs TCD (r : 0.894) All the correlations were statistically significant.

**THIRD TRIMESTER CORRELATION:**

| Combination Parameters | Of Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| TCD VS CGA | 0.960 | P<0.001 |
| TCD VS BPD | 0.963 | P<0.001 |
| TCD VS HC | 0.963 | P<0.001 |
| TCD VS AC | 0.960 | P<0.001 |
| TCD VS FL | 0.970 | P<0.001 |

This table reveals the association between the foetal measurements and TCD. The correlation was best for TCD vs FL (r : 0.970). The correlation for TCD vs CGA, BPD, HC and AC was almost similar (r : 0.960, 0.963, 0.963 and 0.970 respectively). All the correlations were statistically significant.

| Parameters | Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| **CGA VS BPD** | 0.937 | P<0.001 |
| **CGA VS HC** | 0.947 | P<0.001 |
| **CGA VS AC** | 0.952 | P<0.001 |

Volume : 4 | Issue : 10 | October 2015 • ISSN No 2277 - 8179

| | | |
|---|---|---|
| **CGA VS FL** | 0.960 | P<0.001 |
| **CGA VS TCD** | 0.960 | P<0.001 |

The above table shows the association between foetal measurements with CGA. The correlation was best for CGA vs FL and CGA vs TCD (r : 0.960). All the correlations were statistically significant

**COMBINATION OF SECOND AND THIRD TRIMESTER CORRELATION:**

| Combination Of Parameters | Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| TCD VS CGA | 0.985 | P<0.001 |
| TCD VS BPD | 0.985 | P<0.001 |
| TCD VS HC | 0.986 | P<0.001 |
| TCD VS AC | 0.984 | P<0.001 |
| TCD VS FL | 0.987 | P<0.001 |

The above shown table reveals the association between the foetal measurements and TCD. The correlation for TCD vs CGA, BPD, HC, AC and FL was almost similar (r : 0.985, 0.985, 0.986, 0.984 and 0.987 respectively). The correlation was best for TCD vs FL (r : 0.987). All the correlations were statistically significant

| Parameters | Pearson's Correlation Co-Efficient (r) | Significance |
|---|---|---|
| CGA VS BPD | 0.978 | P<0.001 |
| CGA VS HC | 0.982 | P<0.001 |
| CGA VS AC | 0.983 | P<0.001 |
| CGA VS FL | 0.985 | P<0.001 |
| CGA VS TCD | 0.985 | P<0.001 |

This table shows the association between the foetal measurements and CGA. The correlation for CGA vs BPD, HC, AC, FL and TCD was almost similar (r : 0.978, 0.982, 0.983, 0.985 and 0.985 respectively). The correlation was best for CGA vs FL and CGA vs TCD (r : 0.985). All the correlations were statistically significant.

**PREDICTED GESTATIONAL AGE FOR TCD OF 14 TO 56 MM:**

| Cerebellum (mm) | Mean TCD Gestational Age | Std. Deviation | Cerebellum (mm) | Mean TCD Gestational Age | Std. Deviation |
|---|---|---|---|---|---|
| 14 | 15.200 | . | 35 | 29.225 | .1500 |
| 15 | 15.567 | .0577 | 36 | 29.746 | .2537 |
| 16 | 16.380 | .1789 | 37 | 30.300 | .1414 |
| 17 | 17.150 | .0707 | 38 | 31.000 | .0000 |
| 18 | 17.750 | .3619 | 39 | 31.433 | .2082 |
| 19 | 18.310 | .1663 | 40 | 31.900 | .2000 |
| 20 | 19.144 | .1761 | 41 | 32.500 | .1414 |
| 21 | 19.845 | .2964 | 42 | 33.200 | .0816 |
| 22 | 20.505 | .3681 | 43 | 33.450 | .1291 |
| 23 | 21.259 | .1622 | 44 | 34.133 | .0577 |
| 24 | 21.933 | .2817 | 45 | 34.450 | .0548 |
| 25 | 22.495 | .1791 | 46 | 34.767 | .2887 |
| 26 | 23.288 | .1246 | 47 | 34.150 | 2.5697 |
| 27 | 23.983 | .1941 | 48 | 35.767 | .2582 |
| 28 | 24.500 | .0000 | 49 | 36.180 | .1483 |
| 29 | 25.300 | .1789 | 50 | 36.429 | .1254 |
| 30 | 25.767 | .2887 | 51 | 36.800 | .2944 |
| 31 | 26.544 | .2833 | 52 | 37.225 | .0500 |
| 32 | 27.280 | .1095 | 53 | 37.400 | .0816 |
| 33 | 27.857 | .2440 | 55 | 38.000 | .1915 |
| 34 | 28.620 | .3564 | 56 | 38.100 | . |

**DISCUSSION:**

Accurate gestational dating is of paramount importance and the cornerstone for management of pregnancies. Methods to date pregnancies should be simple and straightforward, in all gestational ages. Accurate and easily reproducible sonographic foetal biometric parameters for gestational dating are clinically important for the optimal obstetric management of pregnancies. This is especially true in determining timing of a variety of gestational tests, assessing adequacy of growth and timing of delivery for the optimal obstetric outcome.

In this prospective study of 300 healthy women with uncomplicated pregnancy a correlation is suggested between the gestational age and TCD. A linear relationship was found during the second (12 wks to 24 wks) and third (24 wks to term) trimester between the cerebellar growth measured in mm (millimeters) and the gestational age in weeks. This relationship of foetal cerebellar growth and gestational age is statistically significant.

Many studies have been conducted to assess the variability in gestational age determination from TCD in second and third trimester. In the reported studies[1,11-14] this linear relationship has been established in second and third trimesters correlating well with clinical gestational age. In the present study TCD correlates well with gestational age with high correlation coefficient of 0.96 in the third trimester along with FL, as the first accurate parameters for assessing the gestational age. In second trimester, even though the correlation coefficient is significant with 0.89 the correlation coefficient is slightly less than with the other parameters. However TCD is also one of the significant measurement to be considered.

From a biological perspective cerebellum is not liable to change in form and size because of dense surrounding petrous ridges and occipital bone. This is at variance with several other biometric parameters, especially abdominal circumference, which may be drastically altered by extremes of fetal growth. Hence TCD can be eminently used where it is not possible or difficult to measure BPD or in cases where there are variations in size and shape of foetal head.

TCD has also been measured to predict mean gestational age in different ethnic groups. Foetal TCD is not independent of ethnic origin of patient. Nomogram for TCD can be developed for different countries and races to predict gestational age for a particular ethnic population. In our study, all the patients were of Indian origin and the normogram for predicting gestational age from TCD was obtained. The values were compared with a study conducted by Hill et. al.[10] and it was observed that the values reported in our study are slightly smaller. This is probably due to the difference in the ethnic origin of patients.

In the study by Nery et. al., the correlation of TCD with BPD, HC, AC and FL were statistically significant with the P value of 0.92, 0.92, 0.89 and 0.90 respectively.[14] Similarly in the present study the correlation of TCD with other foetal biometric parameters such as BPD, HC, AC and FL were statistically significant with the P value of 0.985, 0.986, 0.984 and 0.987 respectively

The results of present study and previously published studies on TCD show that additional small improvements in accurate gestational dating can be achieved by incorporating the results of TCD with some combination of other fetal biometric parameters, including biparietal diameter, head circumference, abdominal circumference, and femur length. Nevertheless, the best combination of biometric measurements remains to be determined. We recommend that TCD be used as an important sonographic biometric parameter for accurate prediction of GA.

**CONCLUSION:**

- TCD positively correlated with BPD, HC, AC and FL.
- Nomogram of the TCD shows that there is a linear relationship between the cerebellar growth and gestational age.

- TCD can be used as a reliable parameter for determination of gestational age.

**SUMMARY:**

Obstetric sonography was performed in 300 pregnant women with uncomplicated pregnancy to evaluate the efficacy of TCD as a measure to calculate the predicted gestational age. Gestational age ranges from 15 weeks to term. Only patient with known LMP, previous history of normal menstrual cycle and without any exclusion criteria were included in the study. Foetal biometry evaluated includes BPD, HC, AC, FL and TCD.

TCD was correlated with other foetal biometric parameters and clinical gestational age and the correlation was found to be significant. Nomogram of the TCD shows that there is a linear relationship between the cerebellar growth and the gestational age. So TCD can be used as a reliable parameter for determination of gestational age.

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