

## Role of Sonological Fetal Cerebellar Measurement in Gestational Age Determination



### Medical Science

**KEYWORDS :** BPD, HC, AC, TDC, CGA, EDD

\* **Dr. B. Venkateswarlu**

Professor, Department of Radio Diagnosis, Alluri Sitarama Raju Academy of Medical Sciences, Eluru – 534005, W.G.Dist, A.P Corresponding Author

**Dr. S.V.Rao**

Professor, Department of Radio Diagnosis, Alluri Sitarama Raju Academy of Medical Sciences, Eluru – 534005, W.G.Dist, A.P

### ABSTRACT

*obstetric sonography plays, an important role in accurate determination of intrauterine gestational age. By determining accurate gestational age we can anticipate normal spontaneous delivery or to plan elective delivery with in time frame of term pregnancy. It is non invasive, non-ionizing in nature, easy availability and cost effectiveness leading to wider acceptability. USG is safer for the patient, fetus, and sinologist. Measuring transverse cerebellar diameter is to validate it as an additional morphological measurement of fetal growth with less variability.*

### AIMS AND OBJECTIVES

1. To perform obstetric ultrasonography in healthy women with uncomplicated pregnancy between the 28th 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.
2. To derive nomogram for estimating the gestational age of the fetus from ultrasonographically measured transverse cerebellar diameter.

### PATIENTS AND METHODS

A prospective study was done in 100 healthy women with uncomplicated pregnancy between the 28th week of gestation and term referred from routine antenatal clinic in outpatient and in-patient sections of Obstetrics and Gynecology department of Alluri Sitarama Raju Academy of Medical Sciences, Eluru. This study is 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.

### CONCLUSIONS

- 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/AC ratio was 14.924 +/- 2SD
- TCD can be used as a reliable parameter for determination of gestational age in
- regular obstetric scans.

### INTRODUCTION

Obstetric sonography plays an important role in the accurate determination of intrauterine gestational age. Knowledge of gestational age is important in following ways: i) To anticipate normal spontaneous delivery or to plan elective delivery within the time frame of a term pregnancy (38weeks to 42 weeks). ii) To evaluate the fetal growth. iv) Gestational age influences the management decision if the fetus is diagnosed with an anomaly. Hence all important clinical decisions are influenced by the gestational age.

The last two decades have seen a tremendous progress in application of ultrasound as a diagnostic modality revolutionizing the management towards better care. This is particularly due to its non-invasive, non-ionizing nature, easy availability and cost effectiveness leading to wider acceptability. The exemplary

safety record of diagnostic ultrasound is probably an important reason that it has become so widely used<sup>1</sup>. Ultrasound is safe for the patient, the fetus and the sonologist. There is no reported risk of ionizing radiation as in radiography,<sup>2</sup> or any other known biological or embryotoxic effect. It does not require any injections as sometimes needed in

imaging studies<sup>3</sup>. A single or repeated intrauterine exposure to ultrasound, early or late in pregnancy does not carry the known risk of development of lymphatic or myeloid childhood leukemia<sup>4</sup>, as with X-rays. It is not associated with any harm to early fetal life, growth and vision or hearing during childhood<sup>5</sup>. Similarly no adverse effects have been observed on neurological development and subsequent school performance of the children<sup>6</sup>.

Sonographic measurement of fetal biparietal diameter is a well accepted predictor of gestational age.<sup>7</sup> 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<sup>8</sup>. 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 %<sup>9</sup>. There are conditions like oligohydromnios, multiple gestation, breech presentation and intrauterine growth restriction (IUGR) that can alter the shape of the fetal skull which in turn can affect the BPD and increase the variability<sup>10</sup>. The present study is being undertaken to measure the transverse cerebellar diameter (TCD) to validate it as an additional morphological measurement of fetal 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<sup>10</sup> and can be a more accurate parameter for the determination of gestational age.

### AIMS AND OBJECTIVES

1. To perform obstetric ultrasonography in healthy women with uncomplicated pregnancy between the 28th 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.
2. To derive nomogram for estimating the gestational age of the fetus from ultrasonographically measured transverse cerebellar diameter

Obstetric sonography plays an important role in the accurate

determination of intrauterine gestational age. Knowledge of gestational age is important in following ways: i) To anticipate normal spontaneous delivery or to plan elective delivery within the time frame of a term pregnancy (38weeks to 42 weeks). ii) To evaluate the fetal growth. iv) Gestational age influences the management decision if the fetus is diagnosed with an anomaly. Hence all important clinical decisions are influenced by the gestational age.

**PATIENTS AND METHODS**

A prospective study was done in 100 healthy women with uncomplicated pregnancy between the 28th week of gestation and term referred from routine antenatal clinic in outpatient and in-patient sections of Obstetrics and Gynecology department of Alluri Sitarama Raju Academy of Medical Sciences, Eluru. This study is 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.

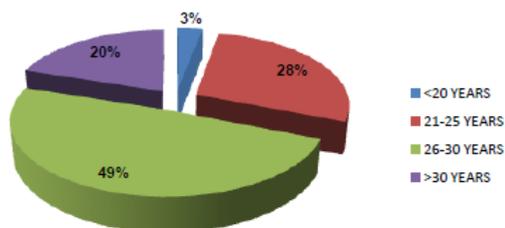
**INCLUSION CRITERIA**

Healthy women with uncomplicated pregnancy between the 28th week of gestation and term.

**EXCLUSION CRITERIA**

1. Unknown or inaccurate date of last menstrual period.
2. Oligohydramnios.
3. 5. Diabetic mother.
4. 6. Pregnancy induced hypertension.
5. 9. Multiple gestation.
6. 10. Fetal chromosomal abnormalities
7. 12. Intrauterine growth restriction.
13. Any other known maternal and fetal abnormality.

**RESULTS**



**AGE DISTRIBUTION**

The age of 100 patients included in the study was in the range of 20 to 35 years with the mean age of 27.38 years and standard deviation of 3.558. Out of these 100 patients included in the study, 3 were in the age group of < 20 years, 28 were in the age group of 21-25 years, 49 were in the age group of 26-30 years and 20 were in the age group of > 30 years.

**GRAVIDA DISTRIBUTION**

GRAVIDA	NUMBER OF CASES	PERCENTAGE
PRIMI	67	67%
MULTI	33	33%
TOTAL	100	100%

**PARITY DISTRIBUTIONS**

PARITY	NUMBER OF CASES	PERCENTAGE
0	69	69%
1	24	24%
2	5	5%
3	1	1%
4	1	1%
Total	100	100%

**CORRELATION CO-EFFICIENT OF TCD WITH CGA, BPD, HC, AC AND FL IN THIRD TRIMESTER**

Combination of parameters	Pearson's correlation co-efficient (r)	Significance
TCD vs. CGA	0.916	P<0.001
TCD vs. BPD	0.904	P<0.001
TCD vs. HC	0.903	P<0.001
TCD vs. AC	0.913	P<0.001
TCD vs. FL	0.937	P<0.001

This table reveals the association between the fetal measurements and TCD. The correlation was best for TCD vs. FL (r : 0.937). The correlation for TCD vs. CGA, BPD, HC and AC was almost similar (r : 0.916, 0.904, 0.903 and 0.913 respectively). All the correlations were statistically significant.

**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 fetal biometric parameters for gestational dating are clinically important for the optimal obstetric management of pregnancies. In this prospective study of 100 healthy women with uncomplicated pregnancy, a correlation is suggested between the gestational age and TCD. A linear relationship was found during the third (28 wks to term) trimester between the cerebellar growth measured in mm (millimeters) and the gestational age in weeks.

This relationship of fetal 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<sup>1</sup>, 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 clinical gestational age with high correlation coefficient of 0.916 in the third trimester and also with FL with a high correlation coefficient of 0.937, as the first accurate parameters for assessing the gestational age. Hence TCD is also one of the significant measurements 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 fetal head. TCD has also been measured to predict mean gestational age in different ethnic groups. Fetal 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 nomogram for predicting gestational age from TCD was obtained. The values were compared with a study conducted by Hill et.al<sup>12</sup> and it was observed that many of 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<sup>13</sup>. Similarly in the present study the correlation of TCD with other fetal biometric parameters such as BPD, HC, AC and FL were statistically significant with the P value of 0.904, 0.903, 0.913 and 0.937 respectively. In the present study, the relationship of fetal TCD to gestational age was considered in normal fetuses only. However, TCD/AC ratio was assessed with an idea of its uses as a parameter for fetal growth abnormalities. The fetal TCD / AC ratio is a gestational age independent method of assessing fetal growth<sup>14</sup>. Malik et al in their study concluded that TCD/AC is constant throughout gestation and was found to be a good tool to diagnose asymmetric IUGR. It was almost 100% accurate in diagnosing asymmetric IUGR in those cases having TCD/AC ratio exceeding 2SD's. In normal pregnant women the TCD / AC ratio was fairly constant with the mean of 13.68 +/- 0.96 irrespective of gestational age. In the present study the mean TCD/AC was 14.92% (SD: 1.0635). There was a strong linear relationship between TCD and AC.

TCD/AC ratio was 13.6 +/- 0.95% in study done by Campbell et. al. in 1991<sup>15</sup>. Meyer and his colleagues described that TCD/AC ratio is 13.69+/-0.94% in their study in 1993<sup>16</sup>. According to studies by Malik et. al. in 2003<sup>11</sup> and 2006<sup>14</sup> TCD/AC ratios were 0.14064 +/-0.059 and 0.13 respectively. In studies conducted by Malik et. Al<sup>11</sup> and Meyer et. al.<sup>16</sup> TCD/AC ratio

greater than the cut off value would be antenatally diagnosed as IUGR. So it was concluded that fetal TCD/AC ratio can be used as an independent method for antenatal diagnosis of IUGR especially in pregnancy with uncertain gestational age. 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.

## SUMMARY

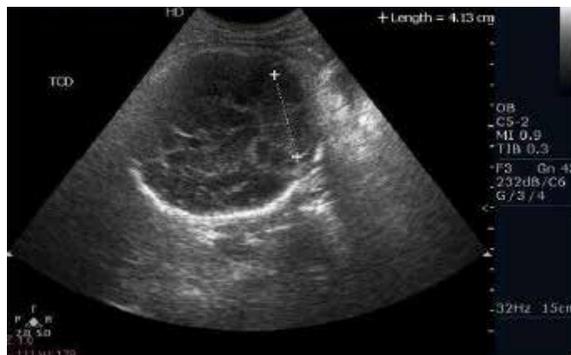
Various biometric parameters for gestational age estimation are in vogue. Transverse Cerebellar Diameter is emerging as a new parameter and is claimed to be more accurate in certain situations. In this study, obstetric sonography was performed in 100 pregnant women with uncomplicated pregnancy to evaluate the efficacy of TCD as a measure to calculate the predicted gestational age. Gestational age ranges from 28 weeks to term. Only patient with known LMP, previous history of normal menstrual cycles and without any exclusion criteria were included in the study. Fetal biometry evaluated includes BPD, HC, AC, FL and TCD. TCD was correlated with other fetal biometric parameters and clinical gestational age and the correlation was found to be significant. The mean TCD/AC ratio was 14.92%. 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 in mass studies. To conclude that a parameter value is subnormal or above normal, exact menstrual age should be known, but when it is not known, a menstrual age independent parameter is needed. TCD/AC ratio is one such parameter.

## CONCLUSIONS

- 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/AC ratio was 14.924 +/- 2SD
- TCD can be used as a reliable parameter for determination of gestational age in regular obstetric scans.

## REFERENCES

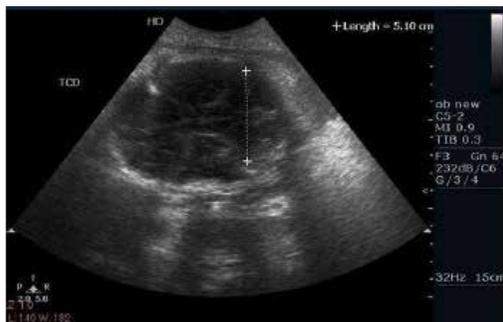
1. Nyborg, W. L. (2002). Safety of Medical Diagnostic Ultrasound, Seminars in Ultrasound, CT and MRI, 23, 5, 377-386.
2. Mahony, B. S., Callen, P. and Filly, A. R., (1985). The distal femoral epiphyseal ossification center in the assessment of third trimester menstrual age: sonographic identification and measurement, Radiology, 155, 201-204.
3. Miller, M. W., Brayman, A. A. and Abramowicz, J. S., (1998). Obstetric ultrasonography: A biophysical consideration of patient safety-the "rules" have changed, Am J Obstet Gynecol, 179, 241-254.
4. Nouburg, E., Belloc, R., Cnattingus, S., Hall, P. and Ekbon, A., (2000). Prenatal ultrasound examination and risk of childhood leukemia: case control study, BMJ, 320, 282-283.
5. Kiehl, H., Haglund, B., Waldenstrom, U. and Axelsson, O., (1997). Routine ultrasound screening in pregnancy and the children's subsequent growth, vision and hearing, Br J Obstet Gynaecol, 104, 1267-1272.
6. Salaveen, K. A., Vatten, L. J., Eik-Nes, S. H., Hugdhal, K. and Bakkeiteig, L. S., (1993). Routine ultrasonography in utero and the subsequent handedness and neurological development, BMJ, 307, 6897, 159-164.
7. Campbell, S. (1968). An improved method of fetal cephalometry by ultrasound, J Obstet Gynaecol Brit Cweth, 75, 568-576.
8. Sabbagha, R. E. and Hughey, M., (1978). Standardization of sonar cephalometry and gestational age. Obstet Gynecol, 52, 402-406.
9. Hadlock, F. P. et al., (1983). Computer assisted analysis of fetal age in the third trimester using multiple fetal growth parameters, JUM, 11, 313-316.
10. Richard D. Mcleary, Lawrence R. Kuhns and Mason Barr Jr., (1984). Ultrasonography of the fetal cerebellum, Radiology, 151, 439-442. 15. Barry B. Goldberg, (2000). Obstetric US imaging : the past 40 years, Radiology, 215, 622-629
11. Kazamasa Hashimoto, Shimoya, Toru Kanzaki, James F. Clapp and Yuji Murata, (2001). Fetal cerebellum: US appearance with advancing age, Radiology, 221, 70-74.
12. Barry B. Goldberg. Obstetric US imaging : the past 40 years. Radiology 2000. 215, 622-629
13. Martin R. Chavez et. al., (2007). Fetal transcerebellar diameter measurement for prediction of gestational age at the extremes of fetal growth, J Ultrasound Med, 26, 1167-1171.
14. Meyer, W. J. et al., (1993). The fetal transverse cerebellar diameter /abdominal circumference ratio: a gestational age - independent method of assessing fetal size, J Ultrasound Med, 12, 7, 379-382.
15. Jacquemyn, Y., Sys, SU and Verdonk, P., (2000). Fetal transverse cerebellar diameter in different ethnic groups, J Perinat Med, 28, 1, 14-19
16. Meyer et. al., (1994). Ultrasonographic detection of abnormal fetal growth with the gestational age independent transverse cerebellar diameter / abdominal circumference ratio, Am J Obstet gynocol, 171, 4, 1057-1063.



**Transverse Cerebellar Diameter measuring 41.3 mm corresponding to 32 wks 6 days gestational age.**



Transverse Cerebellar Diameter measuring 37.8 mm corresponding to 31 wks 0 days gestational age.



Transverse Cerebellar Diameter measuring 51 mm corresponding to 37 wks 1day gestational age.