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**Original Research Article**

# A study of ultrasonographic transcerebellar diameter in assessment of fetal gestational age

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## ABSTRACT

**Background:** Accurate assessment of gestational age is of paramount importance for the clinician to impart holistic antenatal care and is also essential prerequisite to plan the various clinical tests and interventions. Ultrasound (USG) morphometric measurements of fetal parts have been used to assess gestational age of the fetus with improved accuracy. The present study aims at comparing the ultrasonographic measurement of transverse cerebellar diameter (TCD) with other previously established fetal ultrasound biometric parameters, to study its role in patients of suspected intrauterine growth retardation (IUGR) and to study ultrasonographic appearance of fetal cerebellum with advancing gestational age.
**Methods:** A total of 153 pregnant women who were referred for antenatal ultrasound examination were divided into two groups-Group I had 137 healthy pregnant women with normal fetuses between 14-40 weeks of gestation and Group II had 16 patients suspected to have IUGR clinically.
**Results:** In group I, there was a curvilinear relationship between TCD and BPD, TCD and HC, TCD and AC and TCD and FL with correlation coefficients being 0.9810, 0.9181, 0.9649 and 0.9513 respectively. In group II, TCD correlated with gestational age predicted by last menstrual period. The remaining biometric parameters in group-II predicted a fetus of much earlier grade. The study findings also suggested a gradual and steady change in ultrasonographic appearances of cerebellum with advancing gestation.
**Conclusions:** Ultrasonographic measurement of TCD shows excellent correlation with advancing gestational age and with other previously established biometric parameters. TCD can serve as an independent and reliable indicator of gestational age and a standard against which aberrations in fetal growth may be compared.

**Keywords:** Fetus, Gestational age, Transverse cerebellar diameter, Ultrasound

## INTRODUCTION

Accurate assessment of gestational age is of paramount importance for the clinician to impart holistic antenatal care and is also essential prerequisite to plan the various clinical tests and interventions. Ultrasound (USG) morphometric measurements of fetal parts have been used to assess gestational age of the fetus with improved accuracy. Studies in fetal biometry have included the fetal body, head and long bone measurements. Fetal transverse cerebellar diameter is one such parameter that has evoked the interest of a variety of researchers and still continues to be studied.[1-6] Various normograms have been formulated and the role of TCD has been studied in the assessment of gestation age in third trimester.[7] Studies have also been carried out to evaluate its role in small-for-gestational age and growth retarded fetuses.[8-10]

The present study has evaluated the role of ultrasonographic measurement of transverse cerebellar diameter (TCD) in fetal dating and compared it with other previously established fetal USG biometric parameters. We have also studied the role of measurement of transverse cerebellar diameter in patients of suspected intrauterine growth retardation (IUGR) and an attempt has been made to assess the ultrasonographic appearance of fetal cerebellum with advancing gestational age.

## METHODS

The subjects for this study were taken from the antenatal outpatient department (OPD) of a large service hospital. The study was spread over a period of 24 months from March 2014 to March 2016. The study population consisted of a total of 153 subjects and included pregnant women who were referred for antenatal USG examination. The patients belonged to various ethnic groups and socio-economic groups. Patients with severe fetal malformation at the time of first ultrasound examination and patients with multiple gestations were excluded from the study. These 153 patients were divided into two groups-group I had 137 healthy pregnant women with morphologically normal fetuses between 14-40 weeks of gestation and group II had 16 patients of suspected IUGR. The USG equipment used for the study was GE Logiq P5 USG machine with multi-frequency curvilinear transducer.

The subjects at the time of initial visit for antenatal examination were worked up as routine antenatal patients with obstetric and medical history, clinical examination, laboratory examination for Haemoglobin (Hb), blood grouping, urine examination, initial transvaginal or trans-abdominal USG scan before 8weeks gestation for dating the pregnancy using crown-rump length (CRL) measurements. All subjects were issued standard antenatal cards with additional columns appended for recording the USG findings. The patients were briefed about the frequency of antenatal examinations.

During USG, for each patient, several biometric parameters were obtained including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and transverse cerebellar diameter (TCD). Each patient was serially examined four times with USG; the first visit ranging between 14-18weeks of gestation. The examination findings were recorded.

The data was collated and subsequently analyzed and the value of transverse cerebellar diameter in fetal dating was compared with other previously established morphometric parameters. The nomogram for predicting menstrual age for transverse cerebellar diameter from Hill LM, Guzick D, Fries J et al, was used in our study for comparison.[11] For USG scanning, no special preparation was required. The patient was scanned in the supine position with the operator seated to the right of the patient. The patient's abdomen was smeared with ultrasound gel to achieve acoustic coupling. BPD was measured on an axial section of oval appearing fetal head at the level of thalami with no cerebellum visualised.

The section included continuous midline echo of falx cerebri in anterior 1/3$^{rd}$ which was broken in middle by cavum septum pellucidum and thalami on each side. The calipers were placed on outer table (leading edge) and the inner table of the skull vault. HC was measured on the same section as for the BPD. The circumference was directly measured on the screen using electronic calipers to the circumference. AC was measured at the level of the fetal liver using a cross-sectional view that included visualisation of intrahepatic portion of the umbilical vein and stomach bubble and non-visualisation of kidneys.

For FL measurement, the longest axis of ossified femoral diaphysis was measured. The measurement was made of the shaft only, excluding the unfused epiphysis. For measuring transverse cerebellar diameter (TCD), the landmarks of the thalami, cavum septum pellucidum, and the third ventricle were identified; then by slightly rotating the transducer below the thalamic plane, the posterior fossa was revealed with the characteristic butterfly-like appearance of the cerebellum. Transverse cerebellar diameter measurements were obtained from the outer to outer margins of the cerebellum in the posterior fossa. The appearance of the fetal cerebellum with advancing gestational age was also recorded during examination of each patient and this appearance was graded as grade-I, II and III using Hashimoto et al, grading criteria.[4]

## RESULTS

A total of 160 patients were originally included in this study. 07 patients out of these were lost to follow-up and were excluded from this study. Hence, total 153 pregnant women formed the basis of this study. These patients were divided into two groups. Group I had 137 healthy pregnant women with normal fetuses between 14 and 40 weeks of gestation.

All these fetuses were found to be normal at postnatal examination. Group II had 16 patients of suspected IUGR with menstrual age ranging from 26 weeks to 36.5 weeks. All these group-II fetuses either had normal early USG scans before 20 weeks of gestation or an initial USG examination that was commensurate with last menstrual period (Table 1).

**Table 1: Study population groups.**

| Groups | Number of patients |
|---|---|
| Group I | 137 |
| Group II | 16 |
| Total | 153 |

Group I: Healthy pregnant women, Group II: Suspected IUGR pregnant women

***Group I results***

Since each patient in group I was examined serially with USG four times at different periods of gestation, so, total 548 cases (137 patients) were registered for USG during this study.

These tabulated, sorted and correlation coefficient calculated between TCD and GA, TCD and BPD, TCD and HC, TCD and FL and TCD and AC (Table 2).

**Table 2: Correlation coefficient (r) between TCD and various biometric parameters.**

| Biometric parameters | Coefficient of correlation (r) |
|---|---|
| TCD and GA | 0.9893 |
| TCD and BPD | 0.9810 |
| TCD and HC | 0.9181 |
| TCD and FL | 0.9649 |
| TCD and AC | 0.9513 |

**Table 3: Third order polynomial equations describing the curvilinear relationship between TCD and various biometric parameters.**

| Biometric parameters | Polynomial Equation |
|---|---|
| TCD and GA | GA = 4.9685 + 0.62917(TCD) +0.0055146($TCD^2$) - 0.00011246($TCD^3$) |
| TCD and BPD | BPD = -13.246+ 3.3439 (TCD) -0.027041 ($TCD^2$) +0.000022091($TCD^3$) |
| TCD and HC | HC = -138.3572+ 22.7755 (TCD) -0.45337 ($TCD^2$) + 0.0036079 ($TCD^3$) |
| TCD and FL | FL = -18.093+ 2.8595 (TCD) -0.02353 ($TCD^2$) +0.000043664 ($TCD^3$) |
| TCD and AC | AC = -36.7419+ 9.5925 (TCD) -0.023434 ($TCD^2$) -0.00051388 ($TCD^3$) |

Regression analysis was carried out and scatter plots of TCD and GA, TCD and BPD, TCD and HC, TCD and FL, TCD and AC were generated. A curvilinear relationship was found between these parameters which followed a third order polynomial equation. These equations are summarized in Table 3 and Figures 1-5.

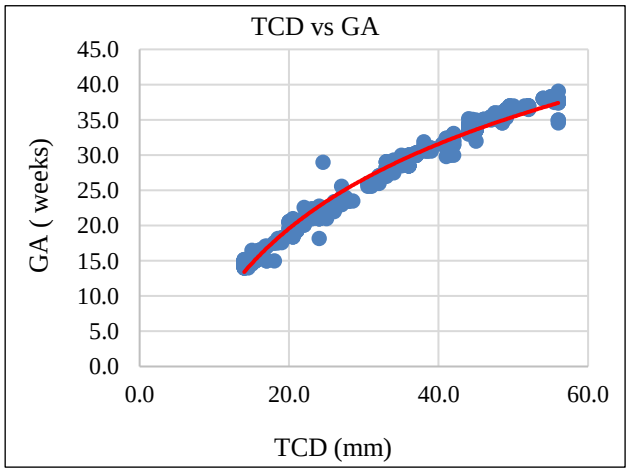


**Figure 1: Transverse cerebellar diameter (mm) against gestational age (weeks) demonstrates a curvilinear relationship.**

The appearance of cerebellum were obtained in 548 cases using Hashimoto et al grading criteria. These are tabulated in Table 4.

Median GA and median TCD observed for each grade are as shown in Table 5.

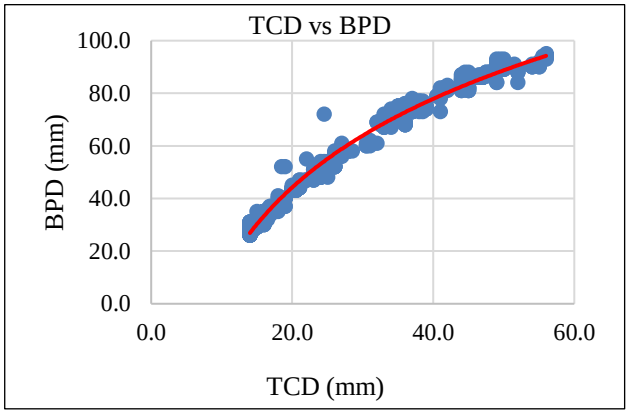


**Figure 2: Transverse cerebellar diameter (mm) against biparietal diameter (mm) demonstrates a curvilinear relationship.**

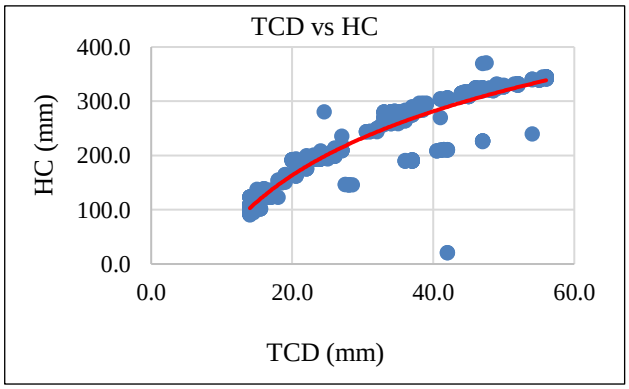


**Figure 3: Transverse cerebellar diameter (mm) against head circumference (mm) demonstrates a curvilinear relationship.**

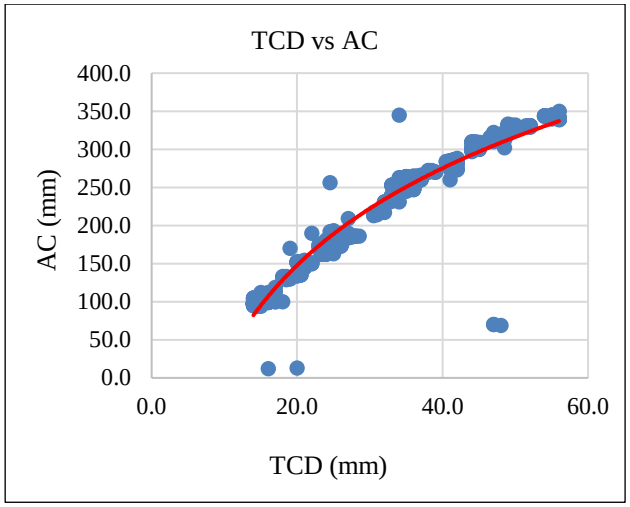


**Figure 4: Transverse cerebellar diameter (mm) against abdominal circumference (mm) demonstrates a curvilinear relationship.**

**Table 4: Percentage of cases having cerebellar grade I, grade II and grade III as per Hashimoto et al criteria.**

| Cerebellar grade | Percentage |
|---|---|
| Grade I | 53.01% |
| Grade II | 21.02% |
| Grade III | 25.95% |

**Table 5: Median GA in weeks (wks) and median TCD in millimetres (mm) for the three cerebellar grades.**

| Grade | Median GA (wks) | Median TCD (mm) |
|---|---|---|
| Grade I | 18.3 | 19 |
| Grade II | 30.0 | 36 |
| Grade III | 35.2 | 47 |

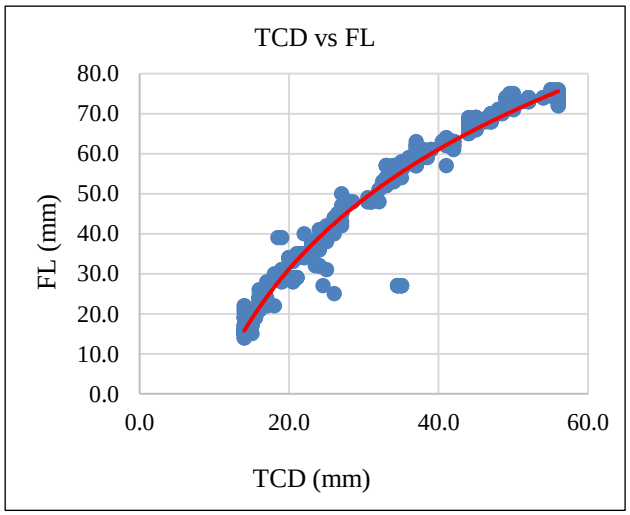


**Figure 5: Transverse cerebellar diameter (mm) against femoral length (mm) demonstrates a curvilinear relationship.**

***Group II results***

In group II, 16 patients with suspected IUGR were registered for USG. In these cases, the TCD was commensurate with gestational age as predicted by last menstrual period. It remained within the mean range for gestational age at that particular time of gestation. The remaining biometric parameters predicted a fetus of much earlier age. The disparity in gestational age (between that predicted by TCD and that predicted by the remaining biometric parameters) was consistently greater than 2.5weeks (i.e. greater than 2SD above mean value). Additionally, the measurements of the BPD, HC, FL and AC were at or below the 5$^{th}$ percentile for gestational age (Figure 6, 7, 8, 9 and 10).

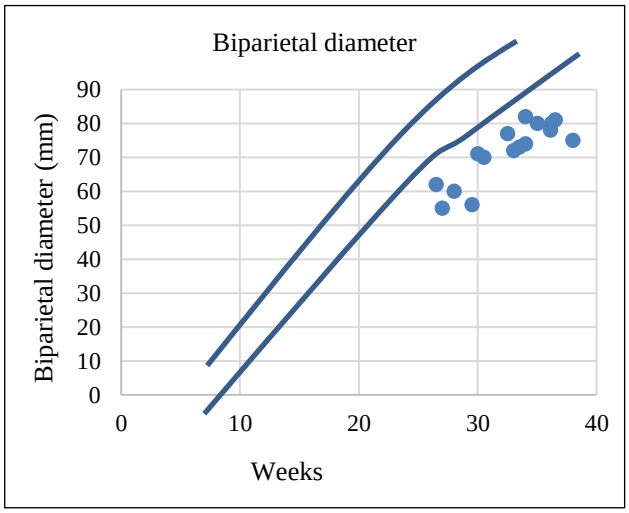


**Figure 6: Biparietal diameters of normal fetuses by Romero et al.**

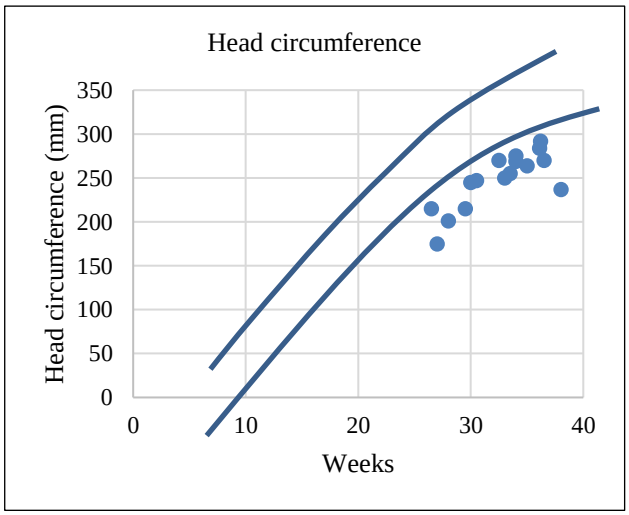


**Figure 7: Head circumference of normal fetuses by Romero et al.**

Antenatal fetal weight estimation by USG revealed fetuses to be under the 5$^{th}$ percentile (Table 6).

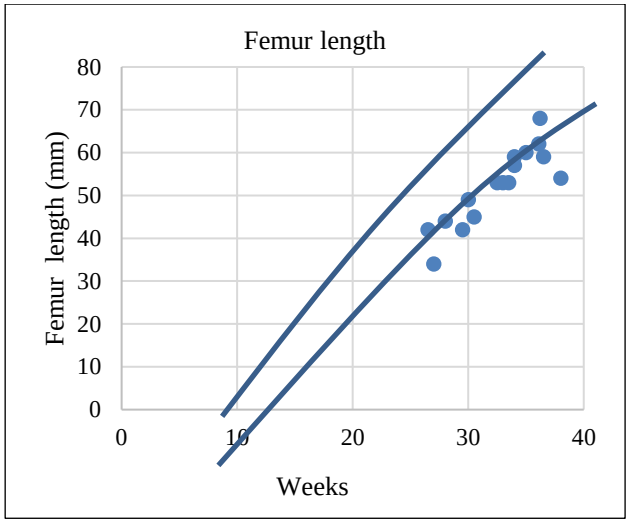


**Figure 8: Femur lengths of normal fetuses by Jeanty and Romero.**

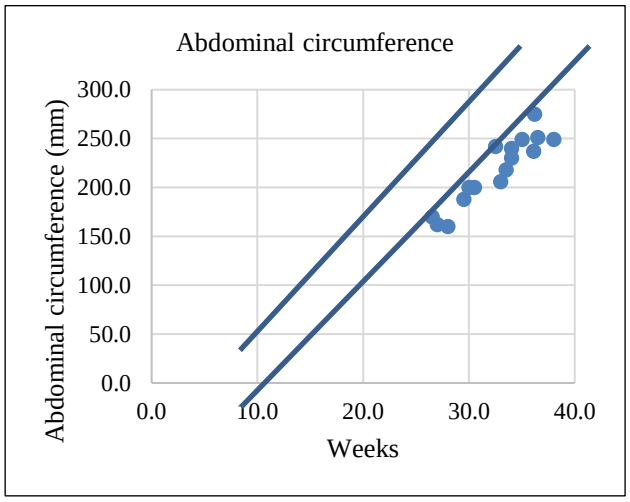


**Figure 9: Abdominal circumference of normal fetuses by Merz.**

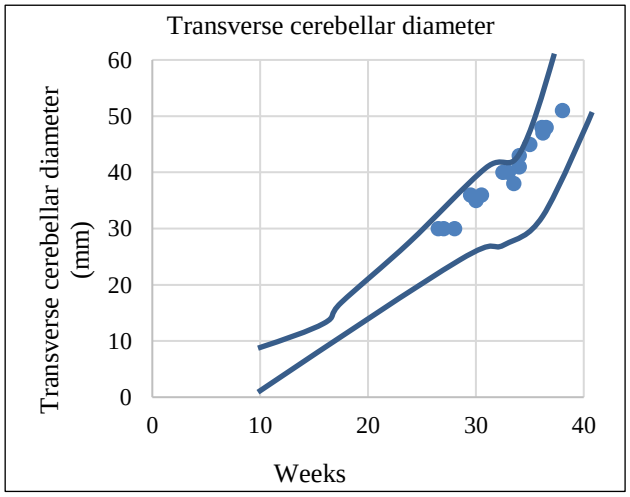


**Figure 10: Transverse cerebellar diameter of normal fetuses by Goldstein et al.**

**Table 6: Antenatal fetal weight estimation of group II fetuses.**

| IUGR case no. | Menstrual age(weeks) | Estimated fetal weight(gm.) | 5th weight percentile (gm) |
|---|---|---|---|
| 1 | 36.1 | 1454 | 2006 |
| 2 | 26.5 | 558 | 609 |
| 3 | 30 | 833 | 947 |
| 4 | 34 | 1406 | 1608 |
| 5 | 32.5 | 1240 | 1422 |
| 6 | 27 | 400 | 609 |
| 7 | 35 | 1530 | 1804 |
| 8 | 33.5 | 1045 | 1608 |
| 9 | 36.5 | 1503 | 2210 |
| 10 | 30.5 | 753 | 1090 |
| 11 | 28 | 529 | 707 |
| 12 | 36.2 | 2110 | 2210 |
| 13 | 29.5 | 629 | 947 |
| 14 | 34 | 1255 | 1608 |
| 15 | 33 | 960 | 1422 |
| 16 | 38 | 1350 | 2409 |

Postnatal clinical evaluation revealed all these neonates to be growth retarded. Their birth weights were equal to or less than the 10th percentile for gestational age.

## DISCUSSION

Accurate determination of gestational age is essential in the care and management of the pregnant patient. Information on gestational age allows the clinician, to both date the pregnancy and distinguish normal from abnormal growth patterns. It is difficult to imagine a clinical problem encountered during a pregnancy in which an accurate menstrual age is not highly desired before proceeding with an appropriate management plan.

The present study was aimed to evaluate the role of 'TCD' as an additional biometric parameter in establishing the correct gestational age of the fetus and to compare it with other previously established fetal ultrasound biometric parameters.

Our study spanned over two years and included fetuses with gestational age between 14-40weeks. It was a prospective longitudinal study with each patient serially evaluated four times by using ultrasound. Though most of similar studies carried out so far have been cross-sectional studies, few researchers have carried out longitudinal studies to evaluate the role of TCD in fetal dating.[12,9]

This study showed a curvilinear relationship between TCD and GA that was statistically significant. It also demonstrated a linear relationship between TCD and GA in the second trimester of pregnancy. Therefore, in the second trimester, TCD measurements in millimetres

(mm) are approximately equal to GA in weeks. Similar results had been reported by Goldstein et al in the year 1987.[3]

Correlation coefficient (r) between TCD and GA in our study was 0.9893 and a third order polynomial equation described the growth pattern of fetuses. This was similar to the correlation coefficient between TCD and GA found by the other researchers. Goldstein et al, had found correlation coefficient between TCD and GA to be 0.948.[3] Guan B et al, found r to be 0.99624 and Mayer WJ et al found a strong correlation between TCD and GA (r = 0.9464).[13,14] Similar results were reported by Dilmen et al, (r =0.9767) and Swaminathan et al (r = 0.89).[15,16]

This study found a curvilinear relationship between TCD and BPD, TCD and HC, TCD and AC, TCD and FL with correlation coefficients being 0.9810, 0.9181, 0.9649 and 0.9513 respectively (Table 2). Goldstein et al, found similar correlation between TCD and BPD (r = 0.956) and between TCD and HC (r = 0.969).[3] Meyer WJ et al, found a strong correlation between TCD and AC (r = 0.95).[14]

The equations generated by this study for TCD against GA, BPD, HC, AC and FL have been described (Table 3). Goldstein et al, found similar equations for TCD against GA, BPD and HC.[3] These are as described below: GA= 6.329 + 0.4807 (TCD) + 0.01484 ($TCD^2$) - 0.0002474 ($TCD^3$), BPD = 7.4989 + 0.3634 (TCD) + 0.01952 ($TCD^2$)-0.000304 ($TCD^3$), and HC = 9.1693 + 1.6549 (TCD) - 0.01673 ($TCD^2$). This study generated all third order polynomial equations whereas the relationship between TCD and HC was a second order polynomial in Goldstein's study.

Our study also evaluated the change in USG appearance of cerebellum with advancing gestation. A total of 548 cases (137 patients) were observed (group I) and graded for cerebellar appearances accordingly. The median GA and TCD were 18.3 weeks and 19 mm for grade I, 30 weeks and 36 mm for grade II and 35.2 weeks and 47 mm for grade III (Table 5). As compared to our results, Hashimoto et al, in their study on cerebellar appearances found median GA and TCD to be 22weeks and 22mm for grade I, 29weeks and 35mm for grade II and 36weeks and 46mm for grade III.[4] Malik et al, have also found similar results in their study with median GA and TCD as 20wks and 21mm for grade I, 31wks and 36mm for grade II and 36wks and 42mm for grade III respectively.[5]

Thus, this study findings clearly suggest a gradual and steady change in USG appearances of fetal cerebellum with advancing gestation. These changes include changes in both shape and echogenicity.

In this study, it was demonstrated that the TCD remained unaffected by fetal growth retardation, whereas most biometric parameters measured on USG were significantly affected by the overall growth retardation process. The consistent disparity between the gestational age predicted by TCD and that predicted by most other parameters was remarkable. These observations agree with previous studies that have examined the relationship of TCD to small for gestational age (SGA) fetus. Reece et al, compared 19 growth retarded fetuses with their normal population.[9] Neonatal birth weights were $<10^{th}$ percentile. All cerebellar measurements fell within normal gestational age range which led to their conclusion that TCD was unaffected by growth retardation. These findings are also similar to those reported by Duchatel F et al, who also found TCD growth not to be affected greatly in their 12 patients of severe IUGR.[1] By contrast Hill et al, have reported severe limitations for predicting GA by TCD from 44 SGA fetuses.[11] More than half of their SGA fetuses (59%) had TCD measurements that fell more than 2SD below mean.

In this study (group II), all 16 patients were classified as those of asymmetric type growth retardation based on the HC/AC ratio. This results were similar to those shown by SGA fetuses classified as asymmetric IUGR in the study by Lee W et al.[8] However, those fetuses with symmetric growth retardation also demonstrated relative preservation of cerebellar growth but to a lesser degree than observed with asymmetric IUGR. They suggest that utility for predicting GA may be less applicable to a growth retarded fetus where head size has not been spared. Similar suggestions about TCD getting affected in symmetric growth retardation have been made by Campbell WA.[17] Therefore, one limitation of our study has been non-inclusion of symmetric IUGR patients and studying utility of TCD measurements in predicting gestational ages of fetuses with symmetric IUGR.

However, this result support the hypothesis that human cerebellar growth is relatively resistant to IUGR when compared with other fetal structures that are commonly measured by antenatal USG.

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## REFERENCES

1. Duchatel F, Mennesson B, Berseneff H, Oury JF. Antenatal echographic measurement of the fetal cerebellum. Significance in the evaluation of fetal development. J Gynecol Obstet Biol Reprod (Paris). 1989;18(7):879-83.
2. Goel P, Singla M, Ghal R, Jain S, Budhiraja V, Babu CSR. Transverse cerebellar diameter-a marker for estimation of gestational age. J Anat Soc India. 2010 Dec;59(2):158-61.
3. Goldstein I, Reece EA, Pilu G, Bovicelli L, Hobbins JC. Cerebellar measurements with ultrasonography in the evaluation of fetal growth and development. Am J Obstet Gynecol. 1987 May 1;156(5):1065-9.

4. Hashimoto K, Shimizu T, Shimoya K, Kanzaki T, Clapp JF, Murata Y. Fetal Cerebellum: US appearance with advancing gestational age. radiology. 2001 Oct 1;221(1):70-4.
5. Malik R, Pandya VK, Shrivastava P. Gestational age estimation using transcerebellar diameter with grading of fetal cerebellum and evaluation of TCD/AC (Transcerebellar diameter/abdominal circumference) ratio as a gestational age independent parameter. Indian J Radiol Imaging. 2003 Feb 1;13(1):95.
6. Naseem F, Fatima N, Yasmeen S, Saleem S. Comparison between transcerebellar diameter with biparietal diameter of ultrasound for gestational age measurement in third trimester of pregnancy. J Coll Physicians Surg Pak. 2013 May 1;23(5):322-5.
7. Chavez MR, Ananth CV, Smulian JC, Lashley S, Kontopoulos EV, Vintzileos AM. Fetal transcerebellar diameter nomogram in singleton gestations with special emphasis in the third trimester: A comparison with previously published nomograms. Am J Obstet Gynecol. 2003 Oct 1;189(4):1021-5.
8. Lee W, Barton S, Comstock CH, Bajorek S, Batton D, Kirk JS. Transverse cerebellar diameter: A useful predictor of gestational age for fetuses with asymmetric growth retardation. Am J Obstet Gynecol. 1991 Oct 1;165(4):1044-50.
9. Reece EA, Goldstein I, Pilu G, Hobbins JC. Fetal cerebellar growth unaffected by intrauterine growth retardation: A new parameter for prenatal diagnosis. Am J Obstet Gynecol. 1987 Sep 1;157(3):632-8.
10. Snijders RJ, De Courcy-Wheeler RH, Nicolaides KH. Intrauterine growth retardation and fetal transverse cerebellar diameter. Prenatal diagnosis. 1994 Dec;14(12):1101-5.
11. Hill LM, Guzick D, Fries J. Transverse cerebellar diameter as a predictor of menstrual age. Obstet Gynecol. 1990;75:983.
12. Uerpairojkit B, Charoenvidhya D, Manotaya S, Tanawattanachareon S, Wacharaprechanont T, Tannirandorn Y. Fetal transverse cerebellar diameter in Thai population. J Med Assoc Thail Chotmaihet Thangphaet. 2001 Jun;84 Suppl 1:S346-51.
13. Guan B. Surveillance of fetal growth and fetal cerebellar transverse diameter by ultrasonographic measurement. Zhonghua Yi Xue Za Zhi. 1992 Feb;72(2):65-7.
14. Meyer WJ, Gauthier D, Ramakrishnan V, Sipos J. Ultrasonographic detection of abnormal fetal growth with the gestational age-independent, transverse cerebellar diameter/abdominal circumference ratio. Am J Obstet Gynecol. 1994 Oct 1;171(4):1057-63.
15. Dilmen G, Toppare MF, Turhan NÖ, Öztürk M, Işik S. Transverse cerebellar diameter and transverse cerebellar diameter/abdominal circumference index for assessing fetal growth. Fetal Diagn Ther. 1996;11(1):50-6.
16. Swaminathan M, Davies MW, Davis PG, Betheras FR. Transverse cerebellar diameter on cranial ultrasound scan in preterm neonates in an Australian population. J Paedia Child Health. 1999;35(4):346-9.
17. Campbell WA, Nardi D, Vintzileos AM, Rodis JF, Turner GW, Egan JF. Transverse cerebellar diameter/abdominal circumference ratio throughout pregnancy: a gestational age-independent method to assess fetal growth. Obstet Gynecol. 1991;77(6):893-6.

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