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Original Research Article

Accuracy of transverse cerebellar diameter measurement by ultrasonography in the evaluation of foetal age

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ABSTRACT

Background: Assessment of accurate gestational age of fetus is very imperative for proper obstetric management of normal as well as IUGR pregnancies. The objective of this study was to evaluate the accuracy of transverse cerebellar diameter as against the conventional parameters of Biparietal diameter, head circumference, abdominal circumference and femur length in normal pregnant mothers between 15 to 40 weeks and in antenatal diagnosis of intrauterine growth retardation.
Methods: Study done on 100 women attending antenatal department, 80 were normal pregnancy cases and 20 were clinically suspected IUGR cases. In each patient BPD, HC, AC, FL and TCD was measured. Correlation of TCD was done with other measured parameters as well as with estimated gestational age of fetus.
Results: There was no statistically significant difference between the age and parity distributions of two groups It was seen that 18 cases were below the fifth percentile for AC and HC, 19 cases were below the fifth percentile for BPD and 16 cases were below the fifth percentile for FL. In 16 out of 20 cases the TCD values were within the normal range. Only in 4 cases the TCD values were below the 5th percentile. This difference in number of cases below the 5th percentile for BPD, HC, AC, FL and TCD was statistically significant (p-value=0.001). In 20 IUGR cases the gestational age predicted by transverse cerebellar diameter measurements closely correlated with gestational age predicted by last menstrual period.
Conclusions: It was found that there is good correlation between TCD and other parameters. Also, TCD shows good correlation with gestational age. It is better than BPD in circumstances like excessive moulding and dolichocephaly. Also, TCD measurement is not fraught with problems as encountered in FL measurement.

Keywords: Abdominal circumference, Biparietal diameter, Femur length, Head circumference

INTRODUCTION

The commonest problem an obstetrician faces frequently is the assessment of fetal maturity for either prolonging the pregnancy or terminating it, for complications such as fetal distress, pregnancy induced hypertension, diabetes and Rh incompatibility diseases. The means that are widely accepted for estimating fetal maturity are Gestational age, weight of the fetus. The methods used to estimate gestational age (GA) and predict the expected date of delivery are menstrual history, clinical examination, perception of fetal movement and Nagele's rule.[1] Nagele's rule is in women with regular cycles and certain LMP, the EDD is calculated by adding 7 days to the first day of the LMP and then adding 9 months. A menstrual history could be misleading for a number of reasons, such as, many women do not accurately recall the first day of last menstrual period, particularly if they are not trying to conceive. LMP may be unreliable or misleading because of oligomenorrhea, abnormal bleeding events, use of oral contraceptives and becoming pregnant in the first ovulatory cycle after a recent

delivery. Ovulating very early (<day 11) or very late (>day 21) in the menstrual cycle.

The most common indication for obstetric sonogram is related to uncertainty regarding the gestational age and presently the most effective way to date pregnancy is by the use of ultrasound. Accurate assessment of gestational age of fetus, major congenital anomalies, fetal growth, wellbeing and maturity all have become possible due to the availability of ultrasound.[1]

Ultrasonography helps in evaluating the duration of pregnancy based on measurement of the fetus, using size as an indirect indicator of menstrual age. Currently the various parameters which are being used include the Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and Femur length (FL).[2,3] However, the variability in assessing the gestational age with these parameters goes on increasing with increasing gestational age.[4,5]

Transverse cerebellar diameter (TCD) measurement is highly accurate in correct assessment of gestational age especially in cases where the last menstrual periods are not exactly known. It is important to identify fetal growth restriction antenatally because it is associated with increased perinatal morbidity and mortality. In cases of intrauterine growth retardation, the Biparietal diameter, head circumference/abdominal circumference (HC/AC) ratio and estimated gestational age can be used to assess fetal maturity only if correct gestational age is known. If the gestational age is uncertain it is difficult to differentiate between appropriate for gestational age and small for gestational age fetus.[6]

TCD has emerged as a useful parameter for assessing fetal growth retardation.[7] The purpose of the current study is to evaluate the accuracy of transverse cerebellar diameter as against the conventional parameters in assessing gestational age in normal pregnant mothers between 15 to 40 weeks and its usefulness in antenatal diagnosis of intrauterine growth retardation.

METHODS

It is a cross-sectional study, data were collected from 100 antenatal women of gestational age 15-40 weeks attending, Department of Radiodiagnosis, Mediciti institute of Medical sciences, Ghanpur, from 1st January, 2015 to 30th September 2016. Ethics committee of Mediciti Institute of medical sciences approved the study. Total 100 cases out of which 80 were normal pregnancies (unassociated with any medical disorder) and 20 were clinically suspected IUGR pregnancies.

Inclusion criteria

Normal singleton pregnancies of 15 and 40 weeks gestation with known last menstrual period. Clinically suspected intrauterine growth retardation.

Exclusion criteria

Congenital malformations, Multiple pregnancies.

Philips HD 7, Envisor system

The transducer used was a 3.5Mhz convex array transducer. The patient was placed in supine position. The transducer was placed on the skin surface after applying the coupling agent. In each patient BPD, HC, AC, FL and TCD were measured.

- AC: Measurement was taken on transverse scan at the level of stomach and intrahepatic portion of the umbilical vein.
- BPD: Measurement was taken from trans-axial sonograms of fetal head at the level of paired thalami and cavum septum pellucidi. The BPD is measured from the outer edge of the cranium nearest the transducer to the inner edge of cranium farthest from the transducer.
- HC: Measurement was taken in the same plane as that of BPD. Measured by tracing along the outer edge of cranium using ellipse method.
- FL: Measurement was taken from the greater trochanter to the lateral condyle.
- TCD: The cerebellar view is obtained by rotating the transducer in the axial plane centered on the thalamus to show the cerebellar hemispheres. This view shows cerebellum, the cistern magna and the cavum septum pellucidi. The cerebellum characteristically appears as two lobules on either side of the midline in the posterior cranial fossa. The widest diameter of the cerebellum is measured.

From the above measured parameters, gestational age and effective fetal weight was computed by the ultrasound machine based on Hadlock tables by using regression equations from combination of measurements (computation software package).

Measured BPD, HC, AC, FL and TCD was recorded in millimeters. Duration of pregnancy in weeks was recorded to the nearest menstrual week and reporting the gestational age to 1 or 2 decimal points was avoided.

IUGR cases

20 IUGR patients (with known LMP) were scanned in the above stated manner. All the biometric parameters were measured. Gestational age and weight was computed in above stated manner. Criteria used for confirming fetal growth restriction are:

Estimated fetal weight less than 10th percentile of expected for that gestational age. Decreased amniotic fluid volume, elevated FL/AC ratio, HC/AC ratio.

- To evaluate the accuracy of transverse cerebellar diameter against other measured parameters in normal pregnant women between 15 to 40 weeks
- To evaluate the accuracy of transverse cerebellar diameter in antenatal diagnosis of IUGR.
- To derive nomogram for estimating the gestational age of the fetus from the measured transverse cerebellar diameter.

Regression analysis was used to compare TCD with BPD, HC, AC and FL in normal pregnancy. Comparison was made between measured TCD, BPD, HC, AC, FL values and gestational age using regression analysis in both normal and IUGR pregnancies. Nomograms were derived by taking 5th, 50th and 95th percentile values in normal pregnancies.

In IUGR cases TCD, BPD, HC, AC and FL measurements were less than the 5th percentile for the gestational age when compared with nomograms derived from normal pregnancies. This analysis was done with Fischer's exact test. P-values less than 0.05 was considered significant.

The statistical software namely SPSS statistical package for windows was used for the analysis of data. Microsoft word and Excel have been used to generate graphs, tables etc.

In order to ensure that there was no statistically significant difference between the two study groups i.e. normal pregnancy patients and IUGR patients with regards to age student t test was used compare the age distribution between the two groups. P-values less than 0.05 were considered significant. Chi square test was used to ensure that there was no statistically significant difference between the two study groups with regards to parity.

Regression analysis was done to compare each ultrasonographically measured parameter i.e. TCD, BPD, HC, AC and FL with the gestational age of fetus in both normal and IUGR groups. Correlation coefficients were then used to compare TCD with BPD, HC, AC and FL in normal pregnancies. Data measured in normal pregnancy patients was then utilized to establish nomograms by taking the 5th, 50th and 95th percentile values.

In the IUGR group number of patients with TCD, BPD, HC, AC and FL values below the fifth percentile were computed using the nomograms derived from normal pregnancies. These patients were then analyzed using Fischer's exact test. P-values less than 0.05 were considered significant.

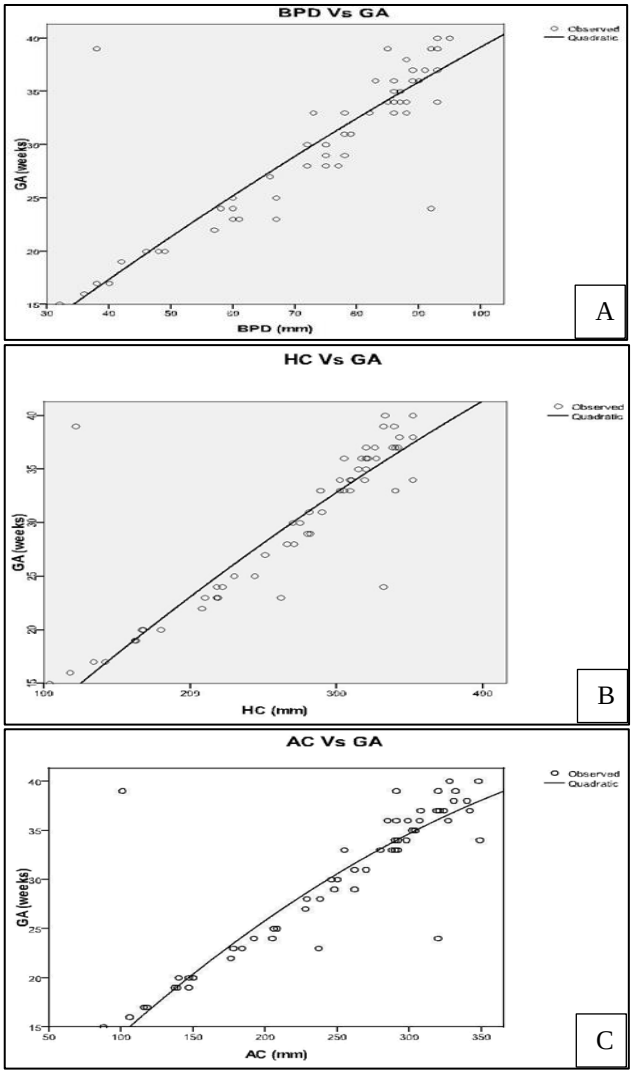
RESULTS

In this study 100 cases were studied out of which 80 were normal pregnancies and 20 were IUGR cases.

Table 1: Demographic distribution of normal and IUGR pregnancy patients.

	Normal pregnancies	IUGR pregnancies	P-value
Age (Years) Mean±SD	22.1±3.02	23.8±2.63	0.87
Primigravida	39	9	0.83
Gravida- 2	26	6	
Gravida- 3	14	4	
Gravida- 4	1	1	
Total	80	20	

The p-value was found to be 0.87 which indicates that there is no statistically significant difference between the age distributions of two groups. Among the 80 normal pregnancies 39 were primigravida, 26 were gravida 2, 14 were gravida 3 and 1 was gravida 4. Among the 20 IUGR pregnant women 9 were primigravida, 6 were gravida 2, 4 were gravida 3 and 1 was gravida 4. Comparison was done between the two groups with regards to parity using Chi square test. The p-value was found to be 0.83 which indicates that there was no statistically significant difference between the parity distributions of two groups.



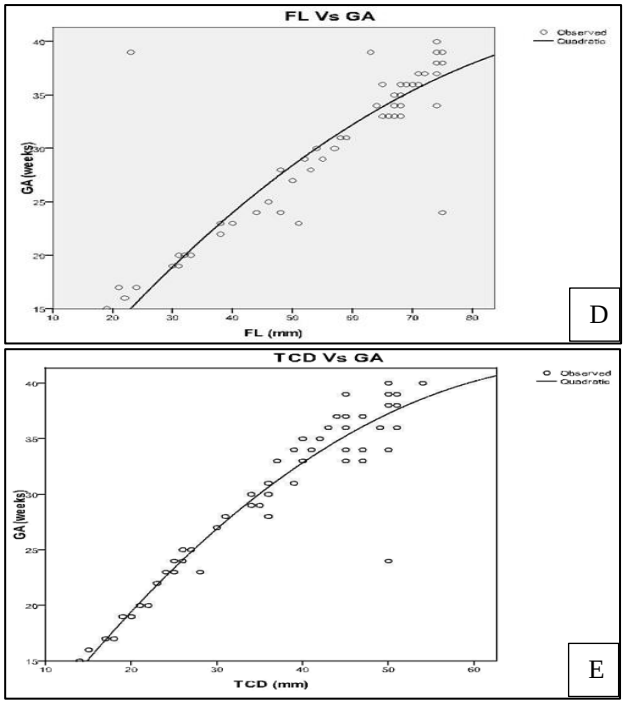


Figure 1: Scatter diagram in relationship with Gestational age, BPD, HC, AC, FL and TCD respectively.

For the 80 normal pregnancy patients initially all the parameters i.e. TCD, BPD, AC, FL and HC were measured ultrasonographically in millimeters.

By using the ultrasonographically derived data nomograms were devised for BPD, HC, AC, FL and TCD in case of normal pregnancies. The nomograms show mean measurements in millimeter (mm) for each parameter at 5th, 50th and 95th percentile for the corresponding gestational age. Of all the parameters TCD showed best correlation with gestational age (R^2=0.996). The correlation was comparatively less strong between gestational age and other parameters. For all IUGR pregnancy cases the BPD, HC, AC, FL and the TCD measurements were compared with nomograms derived from normal pregnancies. Number of patients with BPD, HC, AC, FL and TCD values below 5th percentile values were recorded.

It was seen that 18 cases were below the fifth percentile for AC and HC, 19 cases were below the fifth percentile for BPD and 16 cases were below the fifth percentile for FL. In16 out of 20 cases the TCD values were within the normal range. Only in 4 cases the TCD values were below the 5th percentile. This difference in number of cases below the 5th percentile for BPD, HC, AC, FL and TCD was statistically significant (p-value=0.001) (Table 2).

Table 2: Table showing number of IUGR cases with BPD, HC, AC, FL and TCD values below the fifth percentile when compared with nomograms derived from normal pregnancies.

Parameter	Number of cases with values below 5th percentile	Number of cases with values within normal range	P-value
BPD	19	1	0.001 TCD vs. BPD, HC, AC, FL
HC	18	2	
AC	18	2	
FL	16	4	
TCD	4	16	

In 20 IUGR cases the gestational age predicted by transverse cerebellar diameter measurements closely correlated with gestational age predicted by last menstrual period.

However, the gestational age predicted by BPD, HC, AC and FL was well below that predicted by last menstrual period. Further the disparity in gestational age predicted by BPD, HC, AC, FL and that predicted by TCD was consistently greater than 2.5 weeks (i.e. >2 SD above mean).

DISCUSSION

Accurate gestational dating is of paramount importance and cornerstone for management of pregnancies especially those with fetuses who have growth disturbances (IUGR fetuses). In 1966 Scott and Usher reported that the death rate was nearly 8 times higher than in total study population when birth weight was below the 10th percentile.[8] Among the various clinical criteria LMP preceded by normal cycle is known to best correlate with the gestational age but it is not reliable when a woman is not sure about her last menstrual period. Ultrasonography is routinely used for dating of pregnancy. The biometric parameters used for gestational age assessment are BPD, HC, AC and FL.[2,3] However each of these parameters have their own limitation.

The variability in predicting gestational age with these parameters goes on increasing as the pregnancy advances.[9] TCD is a unique parameter for estimating the

gestational age of fetus. In this study 80 normal pregnant patients and 20 IUGR patients with known LMP were scanned between 15 to 40 weeks of gestation. There was no statistically significant difference between the two groups with regard to age and parity. (p-values were >0.05). In each patient BPD, HC, AC, FL and TCD were measured ultrasonographically. The gestational age was then correlated with each of the measured parameters. Thereafter an attempt was made to correlate TCD with other parameters.

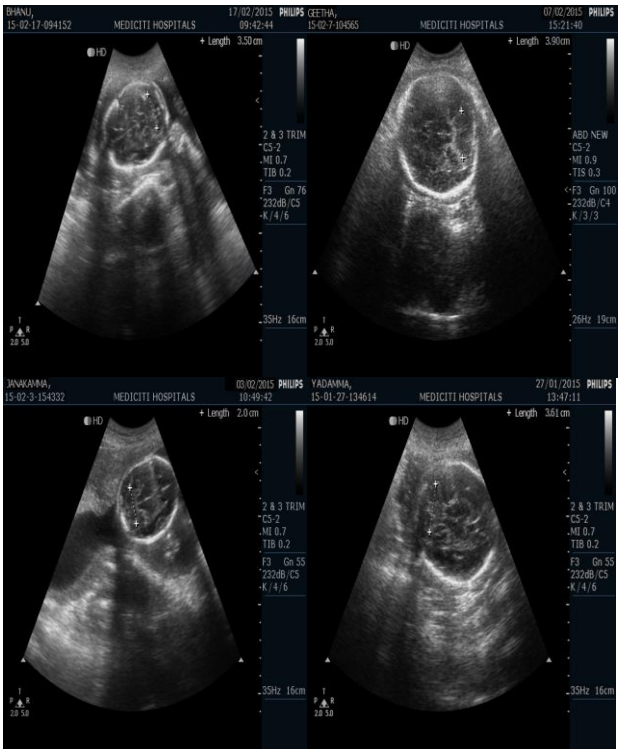


Figure 2: Ultrasound scans in study.

Nomogram was established which shows mean TCD values at 5th, 50th and 95th percentiles for the corresponding gestational age. The nomogram can be used for assessing the fetal gestational age when LMP is not known and to asses any deviation from normal growth. In this study, it was noted that early sonographic visualization of cerebellum occurred as early as 14 weeks. On ultrasonography, the characteristic image of cerebellum appears as two lobules on either side of midline in the posterior cranial fossa.

Mcleary et al studied the measurement of trans-cerebellar diameter with ultrasonography in 225 normal fetuses ranging from 15 to 39 weeks of gestational age and found it to closely correlate with BPD.[10] They proposed that the trans-cerebellar diameter may be useful in estimating fetal age, particularly in breech presentation where extrinsic pressure may deform the skull and decrease the Biparietal diameter. Similar results were found in this study. There was good correlation between BPD and TCD (R^2=0.986, p-value=0.0001). Therefore, TCD may be preferred over BPD in assessing gestational age of fetuses in circumstances where head is deformed for e.g. as in moulding or dolichocephaly.

Reece et al prospectively studied ultrasonography of 371 normal pregnant women, with gestational ages ranging from 13 weeks to 40 weeks.[11] They found curvilinear relationships between the transverse diameter of the cerebellum and the gestational age (R^2=0.948; p=0.001), the biparietal diameter (R^2=0.956; p=0.0001), and the head circumference (R^2=0.969; p=0.0001). A nomogram of cerebellar measurements estimating gestational age was generated. They concluded that throughout pregnancy normative cerebellar measurements allows for estimation of gestational age that is independent of the shape of fetal head.

The result of this study is in concurrence with the above observation. In the present study, there was good correlation between TCD and gestational age (R^2=0.995, p-value=0.0001). Also, good correlation was found between TCD and BPD (R^2=0.986, p-value=0.0001) and between TCD and HC (R^2=0.984, p-value=0.0001). In this study TCD nomogram was established from ultrasonographically measured data which can be used for estimating the gestational age of fetus.

Smith et al demonstrated that the fetal cerebellum can be visualized with ultrasound throughout the second trimester.[12] Nomograms of transcerebellar diameter measurements against gestational age showed good correlation, and narrow confidence limits. The present study also showed similar results. It was noticed that early visualization of cerebellum by ultrasonography occurred as early as 14 weeks. Good visualization was seen in each case, however, measurements were easier to perform in second and early third trimester. There was good correlation between gestational age and TCD (R^2=0.995, p-value=0.0001).

Guan B found curvilinear relationship between TCD and gestational age (R^2=0.99624, p-value less than 0.0005).[13] He concluded that the function of the TCD in the evaluation of fetal growth and development is better than any other parameter. The growth of TCD slowed down in primary symmetric IUGR and was unaffected in asymmetric IUGR.

Similar results were obtained in present study. We noticed curvilinear relationship between TCD and gestational age (R^2=0.996, p-value=0.001). In all the 20 IUGR cases TCD showed good correlation with known gestational age. However, no difference was noticed in cerebellar growth in fetuses with symmetrical and asymmetrical IUGR.

Reece EA et al studied nineteen pregnant women with a clinical suspicion of intrauterine growth retardation and with gestational age confirmed by early ultrasound examination.[11] A prenatal diagnosis of intrauterine growth retardation was made in all cases based on: (1) the

transverse cerebellar diameter being consistently correlated with gestational age as predicted by the last menstrual period, whereas most of the other measurements were consistently discrepant with the transverse cerebellar diameter by more than 2.5 weeks (i.e. more than 2 SD above the mean). They therefore concluded that growth of the transverse cerebellar diameter is unaffected by intrauterine growth retardation; thus this sonographic measurement may serve as an independent and reliable correlate of gestational age against which potential deviations of growth may be compared.

In this study in IUGR pregnancies TCD measurements remained within the normal range in most cases (in 16 out of 20 cases). For other biometric parameters measurements were below the 5th percentile values in most cases (In 18 cases AC and HC values were below the 5th percentile, in 16 cases FL measurement was below 5th percentile and in 19 cases the BPD values were below the 5th percentile). The disparity in gestational age predicted by transverse cerebellar diameter and that predicted by other parameters was greater than 2.5 weeks i.e. greater than 2 SD above the mean. Thus, it is shown that TCD remains relatively unaffected in IUGR pregnancies whereas other parameters tend to deviate below the normal range. The potential importance of TCD in predicting gestational age in normal as well as in IUGR pregnancies has thus been stated.

CONCLUSION

There is good correlation between TCD and other parameters in normal pregnancies at 15 to 40 weeks of gestation. TCD is a better parameter for gestational age assessment compared to BPD and FL. TCD measurements are not affected by conditions which affect BPD. TCD can be used to predict the gestational age in IUGR pregnancies as it correlates with gestational age more closely than other parameters.

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Ethical approval: The study was approved by the institutional ethics committee

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