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To compare Transcerebellar diameter of foetus and other parameters by sonography to estimate gestational age in third trimester of pregnancy.

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Abstract

Introduction: The correct knowledge of gestational age is the cornerstone for antenatal care and management of all pregnancies. Foetal transcerebellar diameter can be measured by USG accurately and is not influenced by alterations in the fetal growth. Hence, it can be used as a reliable parameter for estimation of fetal gestational age compared to other routine parameters in third trimester. This study was done to find ability of TCD to estimate gestational age in third trimester and to compare TCD with other parameters.

Method: 100 women with live singleton pregnancy between 28 weeks to 40 weeks of gestation with known LMP were included in the study. BPD, HC, AC, FL and TCD were measured by on sonography. Data were statistically analyzed.

Results: IUGR was present in 11% pregnancies. Gestational age (in weeks) by LMP showed a significant linear correlation with BPD (R2 =0.85, p=<0.001), HC (R2 =0.91, p=<0.001), AC (R2 =0.85, p=<0.001), FL (R2 =0.87, p=<0.001) and TCD (R2 =0.97, p=<0.001). The correlation was the highest with TCD (r = 0.985) and was the least with AC (r =0.921 and BPD (r =0.921). In women with IUGR, gestational age by LMP showed a linear correlation with TCD (R2 = 0.4669, p=0.02), BPD (R2 = 0.2879, p=0.08), HC (R2 = 0.2957, p=0.08), AC (R2 =0.2930, p=0.08) and FL (R2 =0.1966, p=0.17). The correlation was the highest with TCD (r = 0.954) and was the least with BPD (r = 0.583).

Conclusion: Transverse cerebellar diameter is more reliable method of gestational age determination in third trimester of pregnancy compared to BPD and FL in normal and IUGR pregnancies.

Keywords: Ultrasonography, Transverse Cerebellar Diameter, Gestational Age.

Introduction

The correct knowledge of gestational age is the cornerstone for antenatal care and pregnancy

management from the first trimester to delivery.1 In first trimester it helps in the interpretation of biochemical serum screening test or for counselling women regarding the option of pregnancy termination if required, also helps in calculating estimated date of delivery, estimation of foetal viability. At term estimation of gestational age helps in predicting the outcomes of birth as preterm, intrauterine growth restriction, term or post term. Accurate gestational age is also important for classification of infant deaths and stillbirths.2

The three basic methods being used to help estimate GA are menstrual history, clinical examination and ultrasonography. The clinical estimate of gestational age relies on clinical history (menstrual cycle length, regularity and recall of the first day of the last menstrual period), followed by confirmation by physical examination or other signs and symptoms.3 Symphysio-pubis fundal height (SFH) is a cheap and feasible alternative, appears more accurate than other non-ultrasound based methods, and predicts gestational age at delivery best when sequential measurements are used.4,5

Ultrasonography has become an important modality during the entire gestational period playing a pivotal role in both maternal and foetal wellbeing with a goal of uneventful gestation.6 Mean sac diameter (MSD) and crown rump length (CRL) measurement are the commonest parameters used in first trimester of pregnancy.7 In second trimester various parameters which are being used include the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL).[8,9] The variability in assessing the gestational age with these parameters goes on increasing with increasing age [10,11] All these parameters are more than sufficient in any routine antenatal scan to assess the gestational age. But there are situations where measurement of these parameters has some limitations or cannot be used. Like, head circumference and biparietal diameter cannot be used in conditions affecting foetal skull e.g. hydrocephalus, anencephaly, brachycephaly or dolicocephaly. Abdominal circumference cannot be used in hydrops foetalis, macrosomia and severe growth restriction. Femoral length cannot be used in short limb dysplasia, femur achondroplasia or in deeply engaged breech. In such situations, we have to use other parameters for the estimation of gestational age and one of the useful parameters is transcerebellar diameter (TCD) because it is easily assessed and measured.8,11,12 The cerebellum is well protected in the foetal head and size of cerebellum is least affected by decrease in blood flow and deviation in fetal growth restriction or growth acceleration so it can help in accurate prediction of the gestational age and subsequent management to minimize prenatal morbidity and mortality.[10,11,13-15]

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 or suspected to have IUGR. [16] Although both BPD and TCD are accurate biometric parameters at 36 weeks of gestation, transcerebellar diameter is more reliable method of gestational age determination than biparietal diameter.[16] Therefore, TCD can be used as a tool to assist in the assessment of gestational age in third trimester.[17] Many studies have been done in world and other part of our country but in our state very few studies have been done on the use of TCD for estimation of gestational age so this study was done to find ability of TCD to estimate gestational age in third trimester and to compare TCD with other parameters.

Material and Methods

This was a hospital based cross-sectional study done in the Department of Obstetrics and Gynaecology. 100 women with live singleton pregnancy between 28 weeks to 40 weeks of gestation and willing to participate in the study were included after obtaining written informed consent. Women who conceived spontaneously and with known LMP were included in the study. Women with associated medical disorders and with congenital malformation of foetus were excluded. Gestational age was assessed by LMP. A transabdominal ultrasound scan was done in all cases. BPD, HC, AC and FL were measured. Fetal TCD was measured using the widest diameter of the cerebellum. The transventricular or transverse axial plane defined by the appearance of 'arrow-like' image of central midline echo intercepted in the anterior third by the cavum septum pellucid and the frontal horns of the lateral ventricles (feathers) was first identified. The transducer was slightly rotated (~30°) from this plane to get the transcerebellar plane that was used to acquire the image of the cerebellum. The measurement was made in plane showing the cisterna magna (CM) and nuchal fold (NF), with callipers placed 'out- to – out' on the margin of the widest diameter of the cerebellum.

All the data collected were entered in the MS Excel sheet and statistically analyzed. The relationship between gestational age in weeks to transcerebellar diameter in millimeters was analyzed by simple linear regression. Correlation of foetal TCD with BPD, HC, AC and femur length was also determined by using linear regression analysis. P value < 0.05 was taken as significant.

Results

Majority of the women were in the age group 18-25 years (57%), Hindu (70%), gravid 2 (37%) and belonged to middle socio-economic status (65%). IUGR was diagnosed in 11% women. (Table 1)

Table 2 shows mean of various foetal biometric parameters according to gestational age (by LMP). Mean TCD was 33.50 ± 0.71 mm at 28 weeks and gradually increased with increase in gestational age to 55.25 ± 3.77 mm at 40 weeks of gestation. Mean BPD increased from 71.00 ± 1.41 mm at 28 weeks to 88.50 ± 3.42 mm at 40 weeks. Mean HC increased from 261.25 ± 6.01mm at 28 weeks to 325.00 ± 4.62 mm at 40 weeks. Mean AC increased from 231.50 ± 7.78 mm at 28 weeks to 324.50 ± 18.57 mm at 40 weeks. Mean FL increased from 48.00 ± 2.83 mm at 28 weeks to 71.50 ± 3.32 mm at 40 weeks. All parameters showed a linear relationship with gestational age in weeks, as shown in scattered diagram. (Fig 1)

Gestational age (in weeks) by LMP showed a significant linear correlation with BPD (R2 =0.85, p=<0.001), HC (R2 =0.91, p=<0.001), AC (R2 =0.85, p=<0.001), FL (R2 =0.87, p=<0.001) and TCD (R2 =0.97, p=<0.001). The correlation was the highest with TCD (r = 0.985), followed by HC (r = 0.954), FL (r = 0.933) and was the least with AC (r =0.921 and BPD (r =0.921). (Table 3, Fig 2)

In women with IUGR, gestational age by LMP showed a linear correlation with TCD (R2 = 0.4669, p=0.02), BPD (R2 = 0.2879, p=0.08), HC (R2 = 0.2957, p=0.08), AC (R2 =0.2930, p=0.08) and FL (R2 =0.1966, p=0.17). The correlation was the highest with TCD (r = 0.954), followed by HC (r =0.860), FL (r =0.728), AC (r = 0.693) and was the least with BPD (r = 0.583). (Table 4, Fig 3)

There was a significant linear correlation between TCD and gestational by LMP (R2 =0.97, p=<0.001), BPD (R2 =0.88, p=<0.001), HC (R2 =0.93, p=<0.001), AC (R2 =0.87, p=<0.001) and FL (R2 =0.88, p=<0.001). The

correlation was the highest with GA by LMP (r = 0.985, followed by HC (r = 0.965), FL (r = 0.938), BPD (r =0.938).and was the least with AC (r = 0.933). (Table 5) The scatterplot (Fig 4) depicts the correlation between POG (Weeks) (LMP) and TCD (mm). There was a very strong positive correlation between POG (Weeks) (LMP) and TCD (mm), and this correlation was statistically significant (r = 0.97, p = <0.001).

Discussion

Majority of the women in present study were in the age group 18-25 years (57%) followed by those aged 26-30 years (31%) which is comparable with the observation made by Lilyan W Sersam et al18 where majority of the women belonged to age groups 20-24 years (30.8%) and 25-29 years (30.8%). In present study majority of the women belonged to middle socio-economic status followed by upper socio-economic status (18%) and lower socio-economic status (17%) which is in contrast to that observed by B Abdul Malik et al19. They observed that 54.8% of the respondents/subjects are belonging to the lower class followed by medium class (16.6%) and only 3.0% of the respondents/ subjects belonged to the high class.

In present study majority of the women were second gravid (37%) followed primigravida (33%) and 30% women were gravid 3 or more. Results of present study were in contrast with results of Lilyan W Sersam et al18 and Sumanta Kumar Mandal et al20. They observed that 49% and 53.8% women respectively were primigravida. In this study 89% women had normal pregnancies and IUGR was present in 11% women. Results of present pregnancy were comparable with results of Ravindernath ML et al21 where 80% women had normal pregnancies and 20% had IUGR. In a study done by Mathur Y et al22, 10.5% women had IUGR and 89.5% had normal pregnancies. Dashottar S et al23 in their study detected IUGR in 13% pregnancy.

In this study various mean of foetal parameters (TCD, BPD, HC, AC and FL) showed a linear relationship with gestational age. There was progressive increase in TCD from 28 weeks to 40 weeks in present study which is consistent with studies done by Eze et al6, Lilyan W Sersam et al18, Dashottar S et al23 and Jayaprakash N24.

In present study gestational age by LMP showed a significant linear correlation with BPD (R2 =0.85, p=<0.001), HC (R2 =0.91, p=<0.001), AC (R2 =0.85, p=<0.001), FL (R2 =0.87, p=<0.001) and TCD (R2 =0.97, p=<0.001). The correlation was the highest with TCD (r = 0.985, followed by HC (0.954), FL (0.933) and was the least with AC (0.921 and BPD (0.921). The results of present study were consistent with results of Prasad VN et al25. They observed a good correlation between GA by LMP and BPD (r =0.964, p=<0.001), HC (r =0.982, p=<0.001), AC (r =0.965, p=<0.001), FL (r =0.983, p=<0.001) and TCD (r =0.989, p=<0.001). They also observed that correlation was the highest with TCD with the correlation coefficient being 0.989, followed by FL (0.983), HC (0.982), AC (0.965) and was the least with BPD (0.964). In another study done by YAE El Sayed et al26 a strong correlation was observed between GA by LMP and BPD (r =0.894, p=0.000), HC (r =0.916, p=0.000), AC (r =0.818, p=0.000), FL (r =0.944, p=0.000) and TCD (r =0.978, p=0.000). In their study correlation of GA by LMP was highest for TCD (0.978) followed by FL (0.944), HC (0.916), BPD (0.894) and was least for AC (0.818). Hatata et al27 in their study showed a positive correlation between GA by LMP and TCD, BPD, HC, AC And FL. They also observed that the most significant variables associated with actual GA was TCD followed by BPD and lastly FL with p-value = 0.001, 0.005 and 0.013 respectively.

In present study Gestational age by LMP showed a linear correlation with TCD (R2 = 0.91, p=<0.001), BPD (R2 = 0.34, p=0.141), HC (R2 = 0.74, p=0.003), AC (R2 =0.48, p=0.059) and FL (R2 =0.53, p=0.03) in women with IUGR. The correlation was the highest with TCD (r = 0.954), followed by HC (0.860), FL (0.728), AC (0.693) and was the least with BPD (0.583). Results of the present studies were in line with results of previous studies. Hatata et al27 in their study observed that in women with IUGR, gestational age by LMP showed highest correlation with TCD (p = 0.001) followed by BPD (0.005) and least with FL (0.013). YAE El-Sayed et al26 in their study showed that in normal pregnancy all USG parameters were significantly positive correlated with GA but highest was TCD but in IUGR only TCD, AC and FL showed significant positive correlation but correlation was highest with TCD (r = 0.828, p = 0.000) followed by FL (r = 0.447, p = 0.02), AC (r = 0.445, p = 0.02), HC (r = 0.323, p = 0.08)and was least with BPD (r = 0.161, p = 0.3). Ravindernath ML et al21 observed that in IUGR pregnancy the gestational age predicted by transverse cerebellar diameter measurements closely correlated with gestational age predicted by last menstrual period. Singh et al28 in their study showed that in IUGR pregnancy TCD showed best correlation with gestational age (r = 0.942, p = <0.001). The correlation of gestational age was least with AC (r =0.845, p = <0.001)

Present study showed a significant linear correlation between TCD and gestational by LMP (R2 =0.97, p=<0.001), BPD (R2 =0.88, p=<0.001), HC (R2 =0.93, p=<0.001), AC (R2 =0.87, p=<0.001) and FL (R2 =0.88, p=<0.001). The correlation was the highest with GA by LMP (r = 0.985, followed by HC (0.965), FL (0.938), BPD (0.938).and was the least with AC (0.933). The results of present study was consistent with results of Uikey PA et al1. They showed that there was a strong correlation between TCD and GA by LMP (r = 0.972), BPD (r = 0.960), HC (r = 0.979), AC (r = 0.980) and with FL (r = 0.976). In their study correlation was the highest with AC followed by HC, FL, TCD and least with BPD. Results of present studies were also in line with studies done by Eze et al6, Mathur Y et al22, and S. Iram et al29. All of them showed a strong positive correlation between TCD and gestational age by LMP (r = 0.9893, 0.933 and 0.976 respectively).

This study showed a strong linear correlation between foetal TCD and gestational age (by LMP) in normal and in IUGR pregnancies. Afshan et al30 in their study showed that the mean transverse cerebellar diameter of the foetus showing normal growth was not statistically different from the mean transverse cerebellar diameter of the foetus with reduced growth. They concluded that foetal TCD measurements seem to correlate well with gestational age in both normal and growth-restricted foetuses so reliable measurement of transverse cerebellar diameter may be used for accurate calculation of gestational age in growth-restricted foetuses. Prssad and Likhitha31 detected a good correlation between the GA and TCD throughout the third trimester and even in the case of Intrauterine growth retardation (IUGR).

Conclusion

Transverse cerebellar diameter shows a good linear relationship with gestational age in this study. A significant relationship was found between transverse cerebellar diameter, and other foetal biometric parameters like femur length, biparietal diameter, head circumference, and abdominal circumference. Transverse cerebellar diameter is more reliable method of gestational age determination in third trimester of pregnancy compared to BPD and FL. TCD measurement is not affected by IUGR pregnancies and easily accessible. Measurement of TCD is easy to learn so it should be

incorporated in routine foetal biometry to improve the accuracy of gestational age estimation by sonography.

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Legends Tables and Figures

Variables	Number	Percentage
Age (Years)		
18 – 25 26 – 30 ≥31	57 31 12	57 31 12
Religion		
Hindu Muslim	70 30	70 30
Socio-economic Status		
Upper Middle Lower	18 65 17	18 65 17
Gravida		
G1 G2 G≥3	33 37 30	33 37 30
IUGR		
Present Absent	11 89	11 89

Table 1: Socio-demographic Profile of the women

G. Age (weeks)	Mean TCD (mm)	Mean BPD (mm)	Mean HC (mm)	Mean AC (mm)	Mean FL (mm)
28	33.50 ± 0.71	71.00 ± 1.41	261.25 ± 6.01	231.50 ± 7.78	48.00 ± 2.83
29	34.43 ± 10.92	75.14 ± 2.04	267.34 ± 4.60	245.57 ± 3.55	54.57 ± 1.13
30	36.73 ± 1.03	76.15 ± 2.23	278.99 ± 14.38	259.25 ± 6.96	57.63 ± 1.69
31	38.47 ± 2.83	78.83 ± 2.14	292.57 ± 8.44	268.00 ± 8.44	61.50 ± 4.23
32	39.30 ± 1.57	80.10 ± 3.35	296.10 ± 26.13	274.90 ± 20.01	60.50 ± 3.24
33	43.20 ± 1.30	81.60 ± 1.82	320.28 ± 25.41	282.60 ± 16.20	61.60 ± 3.36
34	43.30 ± 1.16	84.20 ± 2.86	320.02 ± 16.20	290.50 ± 23.90	63.00 ± 3.86
35	45.46 ± 1.85	85.70 ± 2.58	321.08 ± 15.15	305.10 ± 11.35	66.60 ± 2.50
36	47.06 ± 1.14	86.42 ± 4.10	322.55 ± 31.58	304.83 ± 20.59	67.50 ± 3.45
37	50.96 ± 2.39	88.00 ± 4.17	325.63 ± 4.57	319.13 ± 22.20	69.88 ± 2.64
38	51.46 ± 3.36	87.77 ± 3.98	323.35 ± 4.26	317.92 ± 20.95	69.00 ± 4.42
39	53.00 ± 6.16	91.80 ± 2.39	319.72 ± 17.53	331.20 ± 12.17	71.80 ± 1.79
40	55.25 ± 3.77	88.50 ± 3.42	325.00 ± 4.62	324.50 ± 18.57	71.50 ± 3.32

Table 2: Mean Foetal TCD, BPD, FC, AC and FL according to gestational age (by LMP)

Parameters compared	**r**	**R^2**	**P value**
GA vs BPD	0.921	0.85	<0.001
GA vs HC	0.954	0.91	<0.001
GA vs AC	0.921	0.85	<0.001
GA vs FL	0.933	0.88	<0.001
GA vs TCD	0.985	0.97	<0.001

Table 3: Correlation of GA by LMP with BPD, HC, AC, FL and TCD in Normal Pregnancy

Table 4: Correlation of GA by LMP with BPD, HC, AC, FL and TCD in Pregnancy with IUGR

Parameters Compared	r	R^2	P value
GA by LMP vs TCD	0.954	0.91	<0.001
GA by LMP vs BPD	0.583	0.34	0.141
GA by LMP vs HC	0.860	0.74	0.003
GA by LMP vs AC	0.693	0.48	0.059
GA by LMP vs FL	0.728	0.53	0.03

Table 5: Correlation of TCD with GA by LMP, BPD, HC, AC and FL in Normal Pregnancy

Parameters compared	r	R^2	P value
TCD vs GA by LMP	0.985	0.97	<0.001
TCD vs BPD	0.938	0.88	<0.001
TCD vs HC	0.965	0.93	<0.001
TCD vs AC	0.933	0.87	<0.001
TCD vs FL	0.938	0.88	<0.001

Figure 1: Scatter line diagram to show mean BPD, TCD, FL, HC and AC with gestational Age (by LMP)

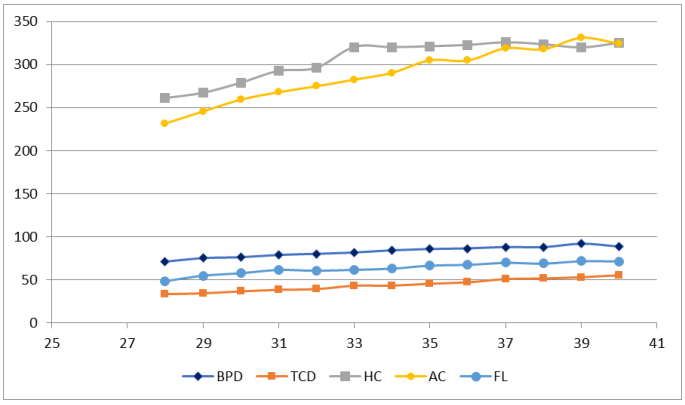

Figure 2: Correlation of GA (LMP in weeks) with TCD, BPD, HC, AC and FL (mm) in normal pregnancy

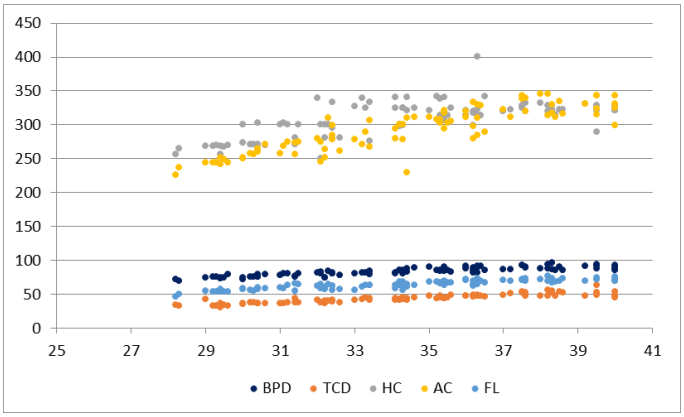

Figure 3: Correlation of GA (LMP in weeks) with TCD, BPD, HC, AC and FL (mm) in pregnancy with IUGR

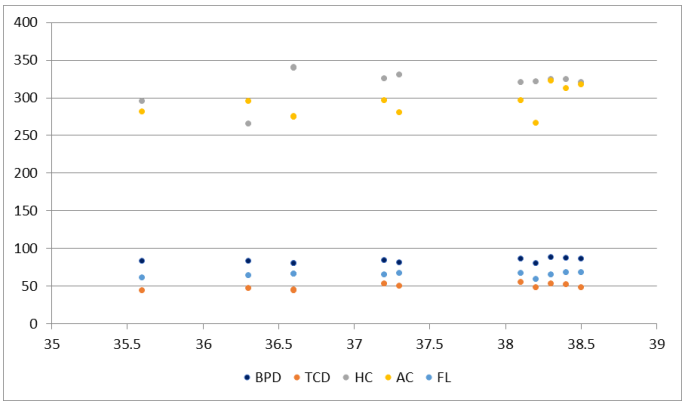

Figure 4: Correlation between POG (Weeks) (LMP) and TCD (mm)