Original research article

Gestational age accuracy based on various ultrasonographic parameters: among healthy pregnant women at a tertiary care center

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 Abstract

Background: Determination of gestational age and expected date of delivery are important for maternal and fetal well-being. Most commonly used method is last menstrual period (LMP). To overcome the limitations of the LMP, ultrasonographic parameters are used.

Objective: To study the correlation of gestational age based on LMP with various ultrasonographic parameters among healthy pregnant women.

Methods: Hospital based cross-sectional study was carried out among 285 healthy pregnant women. LMP was determined by asking the women their last menstrual period and also cross-checked from the available records. The ultrasonographic parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) and transverse cerebellar diameter (TCD) were studied.

Results: Majority of the women belonged to the age of 18-24 years (49.5%). Majority (41.4%) were primi. BPD, AC and TCD were positively correlated with gestational age by LMP ($p<0.05$). FL and HC were also positively correlated with gestational age by LMP but their coefficient of determination was not significant ($p>0.05$). For all parameters, as gestational age increased, their values also increased. Scatter plots of TCD, BPD and AC showed that there is a linear relation with the gestational age by LMP. But, the scatter plot of the HC and FL had no linear relation between the gestational age by LMP.

Conclusion: The biparietal diameter, transverse cerebellar diameter and abdominal circumference showed a strong linear relationship with the gestational age by LMP. The FL and AC had no linear relation with it.

Keywords: Biparietal diameter, head circumference, abdominal circumference, femur length, transverse cerebellar diameter

Introduction

Appropriate determination of gestational age is important to prevent the maternal and perinatal morbidity and mortality [1]. It is also used for determination of the time for labor induction. Well-being of the fetus, development of the fetus is also determined by the use of correct gestational age. The probable decision on mode of delivery can also be taken with its help. History of last menstrual period (LMP) is usually used to decide the expected date of delivery (EDD). In case of a woman with normal menstrual cycles of about 28 days, the EDD is about 280 days or 40 weeks [2].

In various parts, usually the LMP is used to estimate the EDD. This method depends on many factors like accurate recall of date of LMP by the woman, regularities of the menstrual cycle, timing of the ovulation etc. Most of the time, only half of the women are able to recall the correct date of LMP. Hence, the obstetricians prefer to use the range for EDD rather than single date. The standard deviation for the gestational age determined based on the LMP is 16 days and it is 14 days when it is determined using the ultrasound in the first trimester [3,4].

Therefore, compared to LMP, ultrasonography may be better when combined with the clinical methods. There are different ultrasonographic fetal biometry parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) which are commonly used to estimate the gestational age. But, some of them are not so specific. They depend on certain factors like the fetal growth should be normal, menstrual cycle should be regular etc. In those fetuses where there is uteroplacental insufficiency, these parameters get affected [5]. BPD is not reliable after 26 weeks of gestation if the fetus is having the brachycephaly and dolichocephaly. In those fetuses with the achondroplasia, the FL is shortened. It is also affected by the abnormal liquor volume [6].

The transverse cerebellar diameter (TCD) is one which is thought to be more reliable than the above mentioned parameters. It has a linear relationship with the gestational age [1]. In conditions of intra-uterine growth retardation, the size of the cerebellum is not affected [7].

With this background present study was carried out to study the correlation of gestational age based on LMP with various ultrasonographic parameters among healthy pregnant women

Methods

This was a single center, hospital based cross sectional study conducted at Department of Obstetrics and Gynecology, Mallareddy Narayana Multispecialty hospital from August 2017 to December 2019.

Institutional Ethics Committee permission was obtained. Written informed consent was taken from all participating mothers. Confidentiality in terms of their identity was ensured. All mothers were given appropriate medical care as per the standard treatment guidelines.

All pregnant women in the age group of 18 to 32 years of age and willing to participate in the present study were included. Those not willing, high risk pregnancies, with systemic disorders were excluded from the present study.

Therefore, during the study period, it was possible to include the 285 healthy pregnant women. The age of the mother was noted from her identity card. Parity was determined based on the history. The history was taken from the woman about the last menstrual period and the expected date of delivery (EDD) was determined. All efforts were taken to remove the recall bias. For that, even the antenatal cards given at the time of booking were checked to ensure the correctness of the LMP if available.

The radiologist expert in the obstetric cases did the ultrasonography for these pregnant women. The standard machine for the ultrasound was used. All the fetal parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) and transverse cerebellar diameter (TCD) were studied.

The data was entered in the Microsoft Excel worksheet and analyzed using the SPSS version 22. Descriptive statistics like proportions and means with standard deviation and range, minimum and maximum values were used. To study the correlation, the correlation coefficient, the coefficient of determination was used. P value less than 0.05 was taken as statistically significant. Scatter plots were also used to study the relation between the gestational age using LMP with different ultrasonographic parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) and transverse cerebellar diameter (TCD).

Results

Table 1: Maternal characteristics of the study population

Maternal characteristics		Number	Percentage
Age (years)	18-24	140	49.5
	25-29	121	42.5
	30-34	24	8.4
Parity	Primi	129	45.3
	1	118	41.4
	2	35	12.3
	3	3	1.1
	Mean ± SD	Min-Max	Range
Gestational age based on LMP (weeks)	30.61 ± 5.70	19-40	21
Maternal age (years)	24.83 ± 3.24	18-32	14

Table 1 shows maternal characteristics of the study population. Majority of women belonged to the age group of 18-24 years (49.5%) followed by the 25-29 years (42.5%). Majority i.e. 41.4% were primi. The mean Gestational age based on LMP was 30.61±5.70 with a range of 21. The mean maternal age was 24.83 ± 3.24 with a range of 14.

Table 2: Correlation of gestational age by LMP with various ultrasonographic characteristics

| Gestational age by LMP (weeks)	BPD (cm)	AC (cm)	FL (cm)	HC (cm)	TCD (mm)
Correlation coefficient (r)	0.957	0.937	0.733	0.933	0.939
Coefficient of determination (R^2)	0.916	0.877	0.537	0.870	0.882
p	0.0001	0.0001	> 0.05	> 0.05	0.0001

Table 2 shows correlation of gestational age by LMP with various ultrasonographic characteristics. The BPD, AC and TCD were highly and positively correlated with the gestational age by LMP. This correlation was found to be statistically significant ($p<0.05$). FL and HC were also positively correlated with the gestational age by LMP but their coefficient of determination was not found to be statistically significant (p>0.05).

Table 3: Mean values of various ultrasonographic parameters across the gestational age

Gestational age by LMP (weeks)	N	TCD (mm) Mean ± SD	BPD (cm) Mean ± SD	AC (cm) Mean ± SD	FL (cm) Mean ± SD	HC (cm) Mean ± SD
19.0	1	20.00	4.30	13.60	2.80	15.70
20.0	7	21.14±0.69	4.90±0.21	15.45±0.75	3.62±0.26	18.20±0.41
21.0	10	21.70±1.25	4.93±0.23	16.32±1.37	3.66±0.31	18.61±0.56
22.0	21	22.71±2.57	5.45±0.61	17.17±2.41	3.91±0.47	20.11±2.12
23.0	15	23.07±1.16	5.57±0.15	17.47±1.10	4.97±4.21	19.20±4.36
24.0	10	25.00±1.69	5.89±0.22	19.44±1.01	4.50±0.45	21.84±1.34
25.0	8	25.38±1.30	6.30±0.31	19.46±0.94	4.41±0.22	22.47±0.85
26.0	10	27.00±2.75	6.58±0.24	21.18±1.43	4.70±0.33	23.56±0.99
27.0	2	28.00±2.83	6.60±0.56	22.56±3.48	5.18±0.54	25.43±0.09
28.0	11	26.18±3.31	6.42±1.03	21.19±3.84	4.77±0.91	23.48±3.79
29.0	14	29.36±2.02	7.32±0.28	24.59±1.98	5.36±0.33	26.59±1.42
30.0	14	31.14±2.54	7.55±0.29	25.69±1.36	5.69±0.36	27.76±1.01
31.0	10	30.90±1.91	7.40±0.53	26.23±1.54	5.85±0.31	27.90±1.37
32.0	23	33.52±1.47	7.89±0.28	27.33±1.37	6.06±0.36	29.01±1.01
33.0	15	34.60±2.64	8.19±0.41	26.82±4.68	6.24±0.48	29.59±1.49
34.0	20	34.55±2.64	8.33±0.58	28.96±2.66	6.46±0.65	30.30±2.10
35.0	25	35.40±1.97	8.64±0.28	30.70±1.77	6.71±0.34	31.33±1.03
36.0	27	36.70±2.07	8.85±0.24	30.78±1.34	6.87±0.23	32.11±1.51
37.0	19	37.00±1.05	8.90±0.15	31.83±1.59	6.96±0.23	32.10±0.59
38.0	12	39.50±1.17	9.30±0.16	33.29±0.88	7.26±0.23	33.15±0.74
39.0	6	39.17±0.98	9.06±0.16	32.95±2.35	7.11±0.31	32.44±0.53
40.0	5	39.60±1.67	9.39±0.22	33.41±1.52	7.11±0.26	32.99±0.81

Table 3 shows mean values of various ultrasonographic parameters across the gestational age. For all parameters, as the gestational age increased, their values also increased.
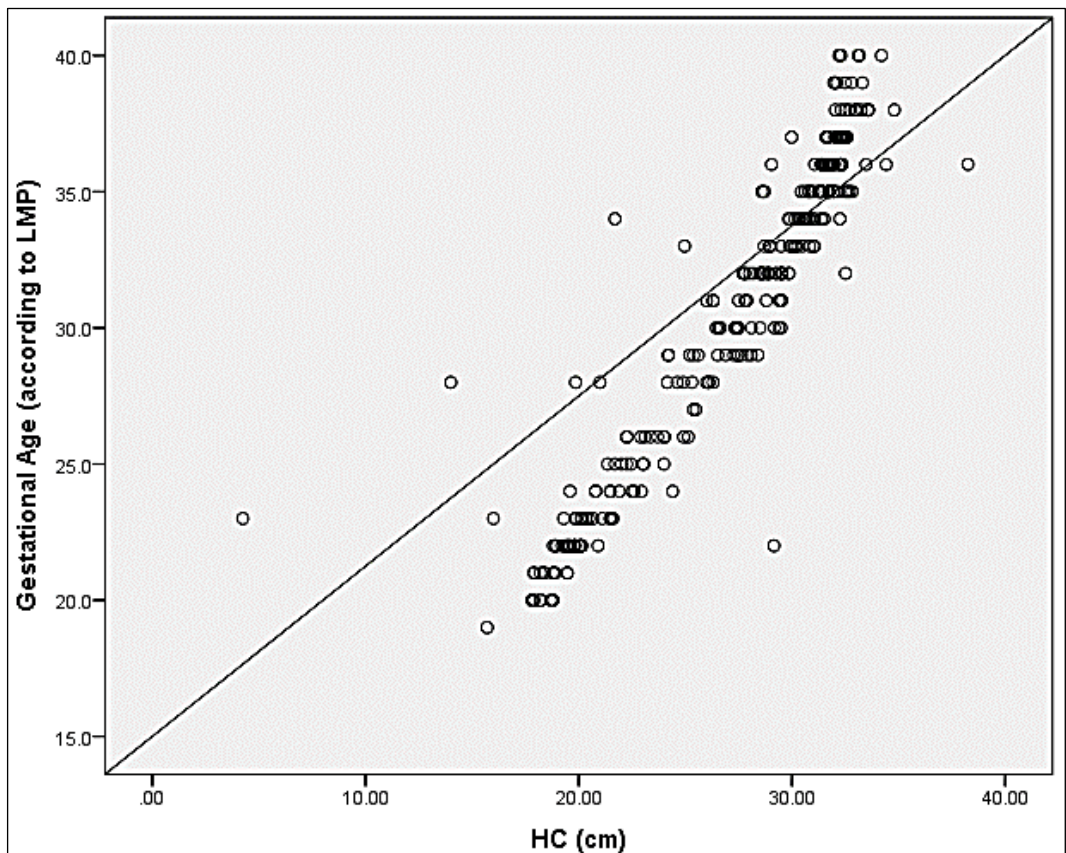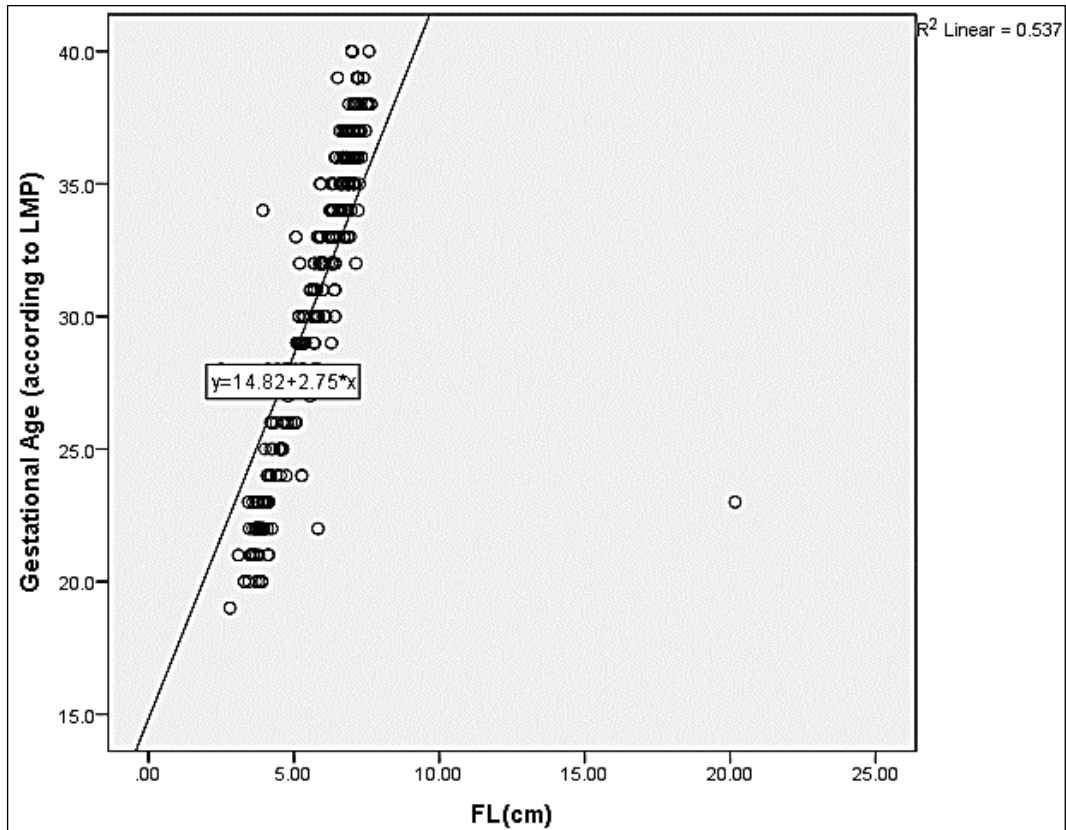

R^2 Linear = 0.882

$y = 3.11 + 0.88 \cdot x$
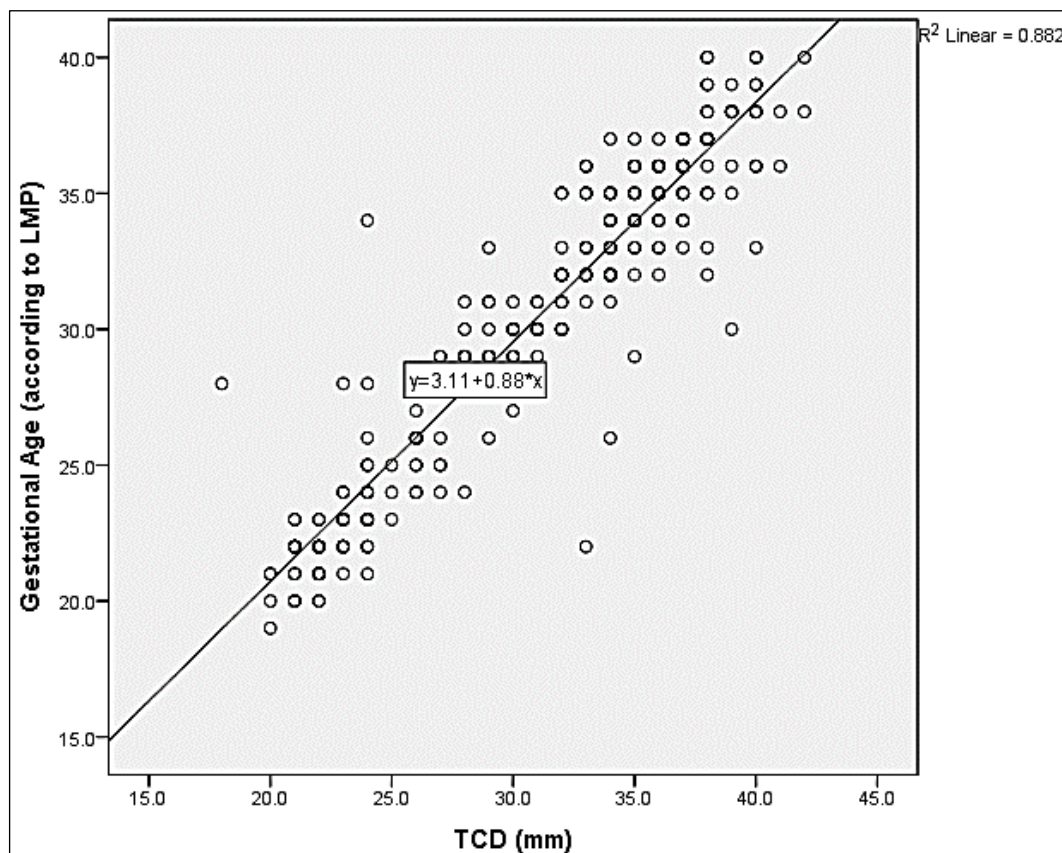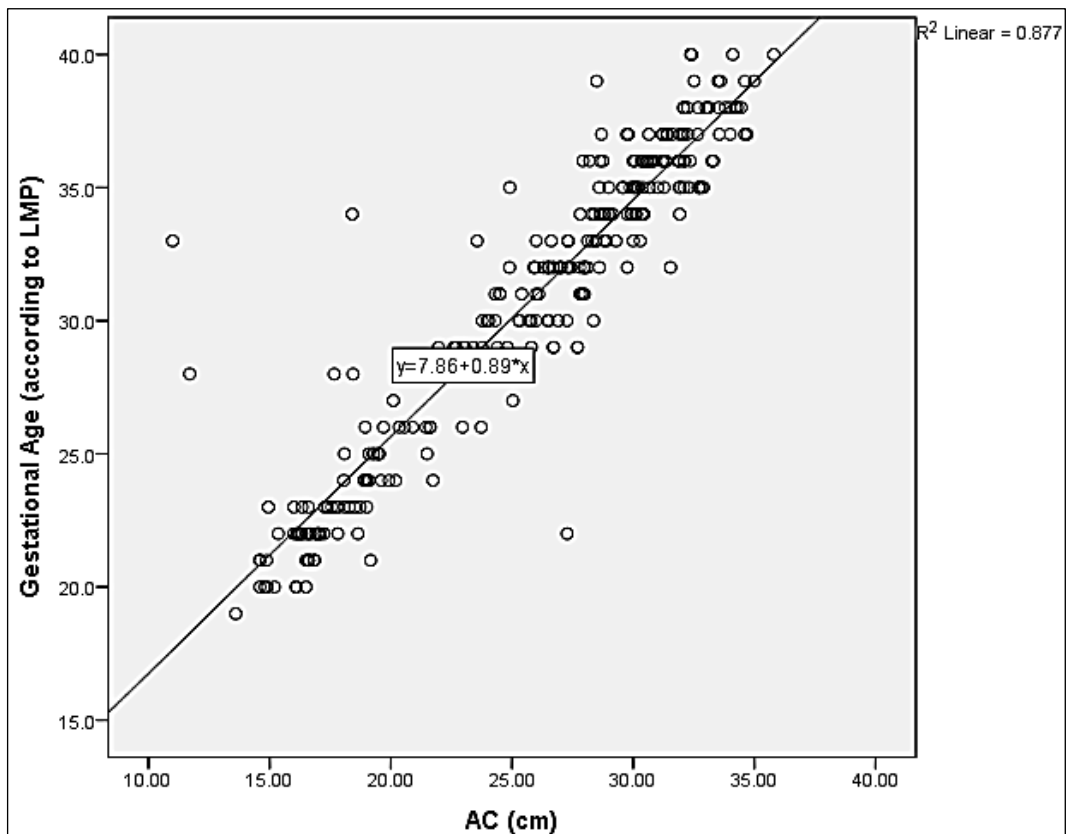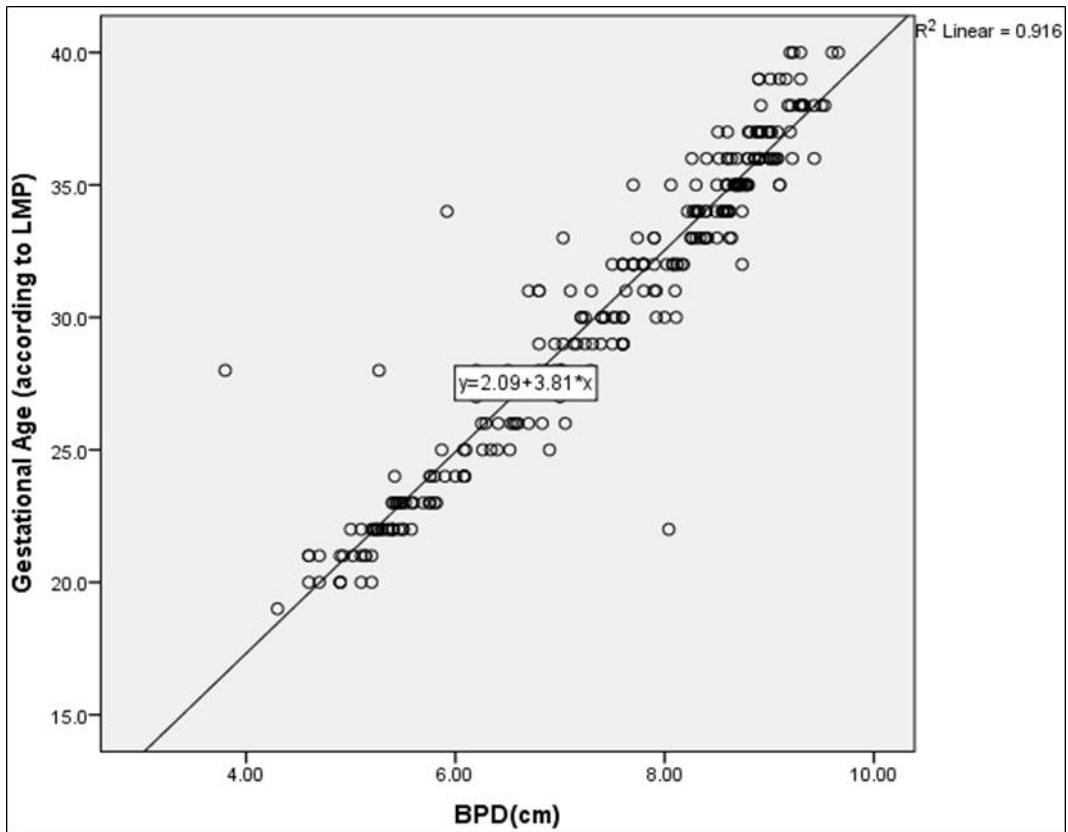
Fig 1: Scatter plots of various ultrasonographic parameters with gestational age

Figure 1 shows scatter plots of various ultrasonographic parameters with gestational age. The scatter plots of the TCD, BPD and AC shows that there is a liner relation between the gestational age by LMP. But, the scatter plot of the HC and FL had not linear relation between the gestational age by LMP.

Discussion

Majority of women belonged to the age group of 18-24 years (49.5%) followed by the 25-29 years (42.5%). Majority i.e. 41.4% were primi. The mean Gestational age based on LMP was 30.61±5.70 with a range of 21. The mean maternal age was 24.83±3.24 with a range of 14. The BPD, AC and TCD were highly and positively correlated with the gestational age by LMP. This correlation was found to be statistically significant ($p<0.05$). FL and HC were also positively correlated with the gestational age by LMP but their coefficient of determination was not found to be statistically significant (p>0.05). For all parameters, as the gestational age increased, their values also increased. The scatter plots of the TCD, BPD and AC shows that there is a liner relation between the gestational age by LMP. But, the scatter plot of the HC and FL had not linear relation between the gestational age by LMP.

Eze CU et al. [8] examined 257 healthy pregnant women with gestational age of 16-40 weeks. They used the LMP to calculate the gestational age. In the present study the gestational age varied from 19-40 weeks. They also used the various ultrasonographic parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) and TCD. They found that the mean TCD was 32.0 mm which is similar to the present study of 31.22 mm. They observed that the TCD and gestational age were related linearly which was statistically significant. We also observed similar findings.

Orji MO et al. [9] studied 450 healthy pregnant women. They found that the minimum value of TCD was 11.9 mm while the maximum value was 59.3 mm. It ranged from 18-42 in the present study implying that the variation in TCD in the present study was lesser compared to this study. They mean TCD was also little more at 34.2 mm compared to present study mean TCD of 31.22 mm. They also observed that the TCD was significantly correlated with the gestational age by LMP which we also observed. They found that the predictive accuracy of TCD was 96.9%.

Bavini S et al. [10] carried out a study to study the accuracy of TCD measurements in the estimation of the gestational age. They observed that the among the BPD, AC, HC, FL the TCD had the highest correlation of 0.979 and the AC had the lowest correlation for the estimation of the gestational age. We found that the highest correlation was by BPD at 0.959 followed by TCD of 0.939 and least by the FL at 0.733.

Mishra S et al. [11] measured fetal parameters using ultrasonography in 300 singleton pregnant women. Their coefficient of determination was 0.92 for TCD which was almost similar to what we found in the present study at 0.882. They stated that TCD in combination with other parameters can be used to predict the gestational age.

Ali MA et al. [12] carried out an observational prospective study among 275 singleton pregnant women. Their range of gestational age based on LMP was 32-37 weeks. In the present study, the gestational age based on the LMP ranged from 19 to 40 weeks. They found that there was a very good positive correlation between TCD and gestational age based on LMP. We also observed similar results of positive correlation between TCD and gestational age based on LMP.

Adeyekun AA [13] studied 450 healthy singleton pregnant women. They noted that the values of TCD ranged from 11.9 to 59.7 mm. This variation was little low in the present study with a range of 18 to 42 weeks. They also observed that the correlation of TCD was more with the menstrual age compared to other parameters like BPD, FL, AC and HC. We also found that after BPD, the correlation of the TCD with the gestational age by LMP was more.

Singh J et al. [14] carried out a cross sectional study among 500 antenatal women. The gestational age ranged from 14 to 39 weeks. In the present study the gestational age ranged from the 19 to 40 weeks. They noted that there was strong positive correlation between TCD with the gestational age. We also found that there was strong positive correlation between TCD with the gestational age.

Conclusion

In this present study the biparietal diameter, transverse cerebellar diameter and abdominal circumference showed a strong linear relationship with the gestational age by LMP. The FL and AC had no linear relation with it.

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