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Correlation of Placental Thickness with Gestational age and Other Fetal Parameters - A Cross Sectional Study

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Abstract
Introduction: *Exact determination of gestational age is crucial for appropriate antepartum care as well as successful outcome of deliveries. The exact knowledge of gestational age is also important for undertaking various diagnostic procedures that needs to be performed within a narrow range of a particular gestational age. While fetal biometry is one of the most common method of determination of gestational age and weight alternative methods such as measurement of placental thickness can also be used for determination of gestational age and other parameters in doubtful situations. We conducted this cross sectional study to find out whether placental thickness can be used for estimation of gestational age and other parameters.*

Materials and Methods: *This was a cross sectional study in which 403 pregnant women in their second and trimester were included on the basis of a predefined inclusion and exclusion criteria. Gestational age and other fetal parameters were determined on the basis of bio-physical parameters. The placental thickness was measured at the level of umbilical cord insertion and maximum thickness was determined in the cross section. Statistical analysis was done using SPSS software. P value less than 0.05 was taken as statistically significant.*

Results: *In this study of 403 women the mean age was found to be 28.36 +/- 7.6 years. In majority of the cases placenta was either anterior (42.4%) or posterior (30.5%). Placental thickness of 36.51 ±\ 4.67 was found to be corresponding to the gestational age of 37 weeks (Full-Term Gestation). The mean placental thickness was found to be having a linear relationship with gestational age and other fetal parameters and statistical association between placental thickness and gestational age as well as other fetal parameters was found to be significant.*

Conclusion: *Placental Thickness can be used for determination of gestational age and other fetal parameters in doubtful cases.*

Keywords: *Placental Thickness, Second and Third Trimester, Gestational Age, Biometry.*

Introduction

Accurate estimation of foetal maturity is one of the most common problems that an obstetrician faces. Estimation of gestation age (foetal maturity) is of critical importance in clinical practice not only to ensure appropriate management of new-

borns but also to distinguish pre-term from term infants[1]. The best antepartum care and successful deliveries of babies always revolve around the accurate knowledge of the gestational age (GA). It is also very important to differentiate between normal and growth restricted foetuses. The exact knowledge of gestational age is also important for undertaking various diagnostic procedures (Chorionic villous sampling and amniocentesis) that need to be performed within a narrow range of a particular gestational age. While fetal biometry is one of the most common method of determination of gestational age and weight alternative methods such as measurement of placental thickness can also be used for determination of gestational age and other parameters in doubtful situations[2].

Proper assignment of expected date of delivery is of utmost importance in the interpretation of biochemical tests such as screening for the expanded biochemical markers (HCG, Alfa Fetoprotein and the oestrogen and progesterone level) for the risk assessment of various foetal anomalies, to plan and execute therapeutic manoeuvres and to determine the optional management in certain difficult situations like intrauterine growth restriction, gestational diabetes and Rh disease[3]. Moreover when an anomaly is detected, the interventional modality which is used, is influenced by the gestational age. All the important clinical decisions, which include caesarean section, elective labour induction, etc., depend on the knowledge of gestational age. Hence an accurate establishment of expected date of delivery is fundamental to the management of high risk pregnancies[4].

Introduction of obstetric ultrasonography in the early 1970s led to a marked improvement in the evaluation of foetal and placental anatomy, as well as foetal growth. Now, it appears as the most effective technique to estimate gestational age (GA). Fetal biometry (Biparietal diameter, Head circumference, abdominal circumference and femur length) is routinely used to determine gestational age after 12 weeks of pregnancy[5].

It is important to know that ultrasonography is highly observer dependent investigation.

Moreover the position of the baby many times makes it difficult to accurately take biometric parameters. Many authors, such as Wolfson et al, have concluded that the bi-parietal diameter was not reliable in the foetuses which had premature rupture of membranes. So, there is a need of another parameter for supplementing the gestational age estimation with minimal error. Placental thickness is an important parameter in estimating fetal growth, the placental thickness changes with increasing growth of fetus. It is different in all 3 trimesters. So, it can be used as another parameter to estimate gestational age (GA). Various studies have reported that the placental thickness not only reflects the gestational age of the fetus but also may be useful in diagnosing conditions such as intrauterine growth restriction (placental thickness < 25mm) or gestational diabetes (Placental 10 thickness > 40mm)[6].

We conducted this cross sectional study to find out whether placental thickness can be used for estimation of gestational age and other parameters.

Materials and Methods

This was a Cross sectional study with an analytical design carried out amongst pregnant women referred to radio-diagnosis department of a tertiary care medical college situated in an urban area. 403 Pregnant women who were referred for Level II obstetric ultrasound scan (in their 2nd and 3rd trimester) were included in this study on the basis of a predefined inclusion and exclusion criteria. Informed consent was obtained from all the women. Previous scans, if already done, were analysed and if any abnormality was detected in previous scan it was noted down.

Study Protocol

After taking a detailed history, the antenatal women were examined for placental thickness, gestational age, Biparietal Diameter (BPD), the Abdominal Circumference (AC), the Head

Circumference (HC), the Femur length (FL) by USG using 1-5 MHZ convex array transducer.

Subjects were scanned with moderately distended bladder in supine position. The transducer was placed on the skin surface after applying the coupling agent. Placental thickness in mm was measured at the site of cord insertion. The transducer was oriented to scan perpendicular to both the chorionic and basal plates, as tangential scan would have distorted the measurement of thickness of placenta. All placental measurements were taken during the relaxed phase of uterus as contractions can spuriously increase the placental thickness.

Collected data (Annexure I) was entered in the MS Excel spread sheet, coded appropriately and will be cleaned for any possible errors. Analysis was carried out using Statistical package for social sciences (SPSS) for Windows version 17.0, Released 2008 (SPSS Inc., Chicago, IL). Normally distributed data was presented as means and standard deviation, or 95% confidence intervals (CI). Placental thickness was measured in mm along with their respective standard deviation (SD) were computed for each gestational age from 12 to 40 weeks. The 95 % C.I was calculated. Correlational analysis including Pearson's and Spearman's analysis was used for the multiple variables to establish the degree of relationship between PT, FL, HC, AC & BPD. The level of significance was determined and p value of <0.05 was taken as statistically significant.

Inclusion Criteria
1. Singleton pregnancies, 12-40 weeks.
2. The known last menstrual period.
3. A history of regular menstruation.
4. No known maternal and fetal chromosomal /structural abnormalities.

Exclusion Criteria
1. Pregnant females not knowing their LMP.
2. Patients with irregular menstrual cycle.
3. First trimester gestations
4. Multiple pregnancies.
5. Known cases of Eclampsia, PIH, gestational diabetes or maternal systemic diseases.

Results
In this study of 403 women the most common age group was found to be between 26- 30 years (47.9%) followed by 20-25 years (30.8%) and more than 30 years (20.6%). Only 3 patients (0.7%) were found to be below 20 years of age.

	<20	20-25	26-30	>30
No. of cases	3	124	193	83
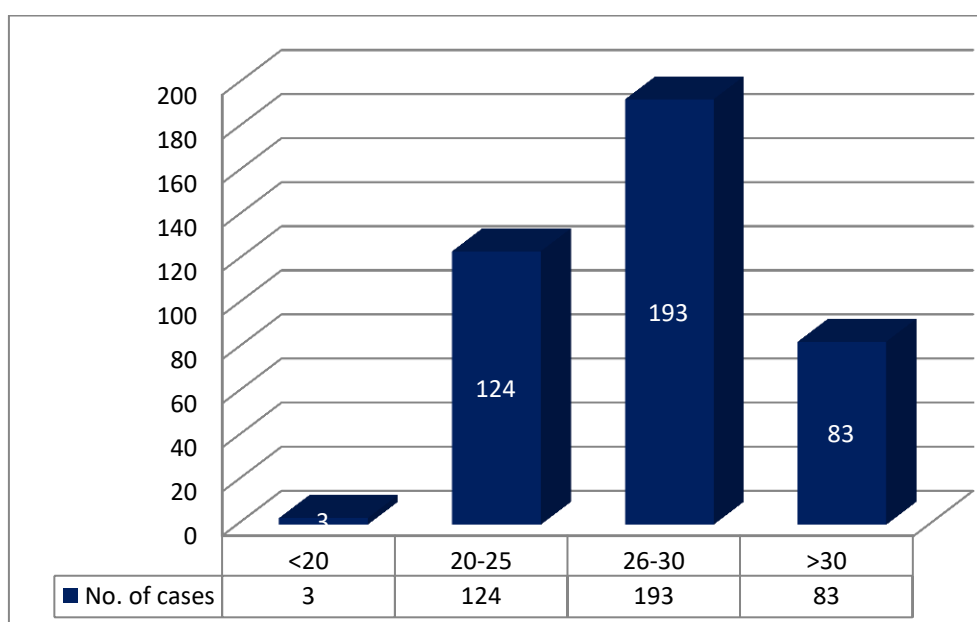
Figure 1: Age distribution of the studied cases

It was observed that in majority of the pregnant females (42%), the placenta was attached anteriorly to the uterus. This pattern was followed by posterior attachment (30%), and fundal posterior (14%) attachments as the most frequent types. Fundal attachment (1.9%) was observed to be the least common type.
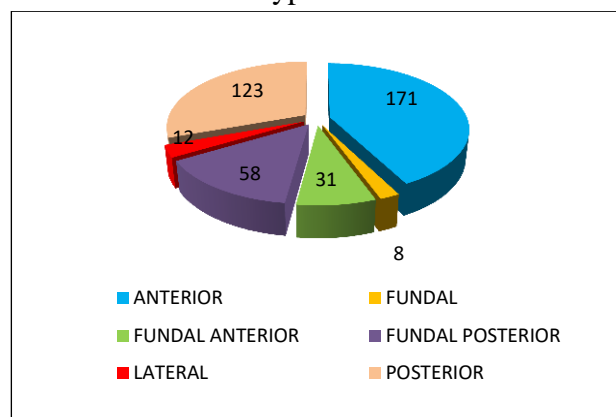
**Figure 2:** Location of attachment of the placenta

Pearson's analysis was used to depict correlation between the gestational age and placental thickness. The two variables depicted strong positive correlation (r= 0.967) & p-value :< 0.001 between the gestational age of 14-35 weeks whereas the placental thickness depicted statistically significant but a weak positive correlation with gestational age of >35 weeks. The range of placental thickness varied between 11-38 mm during the gestational age 14-35 weeks. The thickness of placenta varied between 30-43 mms and the mean value was about 35.35 mm when it was measured between 35-39 weeks period of gestation.

Table 1: Correlation of gestation age14-35 weeks and >35 weeks by ultrasonography and placenta thickness (mm)

	Range	Mean	SD	r	P-value
Gestational Age (weeks) by USG	14-35	25.60	6.29	0.967	<0.001 (HS)
Placenta thickness (mm)	11-38	25.34	6.26		
Gestational Age (weeks) by USG	35-39	36.19	1.17	0.432	<0.001 (HS)
Placenta thickness (mm)	30-43	35.35	3.77		

The analysis of placental thickness and gestational age showed that the mean placental thickness increases with each passing gestational week, till 37 weeks period of gestation but then a decrease in thickness was observed after 38 weeks period of gestation.
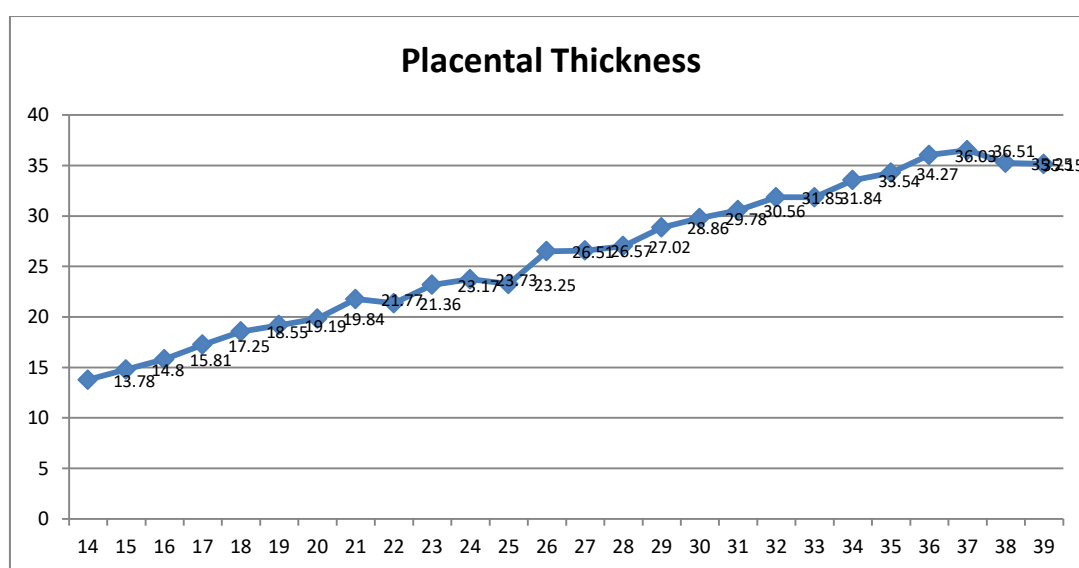
Figure 3: Variations in the placental thickness with increasing gestational age

The analysis of the variations in the placental thickness with increase in the period of gestation showed that the difference in the placental thickness with time were statistically significant with a p-value<0.001.

Table 2: Comparison of the placental thickness with gestational age

Gestational Age (Weeks)	Number Of Cases	Placental Thickness + SD (mm)
14-20	88	17.63 ± 2.58
21-27	73	23.87 ± 2.94
28-32	91	29.87 ± 2.22
33-40	151	34.50 ± 3.42
Total	403	27.85 ± 7.19

The changes in placental thickness and other anthropometric parameters with increase in gestational age. The maximum mean placental thickness achieved was 36.51 mm at 37 weeks period of gestation. Other parameters also increased steadily and corresponded well with the actual gestational age.

Table 3: Relationships between placental thickness, gestational age, bi-parietal diameter, head circumference, abdominal circumference and femur length

Gestational Age (Weeks)	PT (mm)	BPD (Weeks)	HC (Weeks)	AC (Weeks)	FL (Weeks)
14	13.78	14.23	14.00	14.23	14.08
15	14.80	15.20	15.00	15.10	14.90
16	15.81	16.13	15.63	16.13	15.75
17	17.25	18.00	17.00	17.50	16.50
18	18.55	17.90	17.80	18.60	18.70
19	19.19	19.09	18.86	18.86	19.18
20	19.84	20.09	19.91	19.83	19.78
21	21.77	20.83	20.75	21.25	21.00
22	21.36	22.17	22.17	22.33	38.58
23	23.17	24.00	23.75	23.75	23.75
24	23.73	24.30	23.40	23.50	23.80
25	23.25	25.00	24.00	25.00	24.00
26	26.51	25.89	25.67	37.11	26.33
27	26.57	27.06	26.94	27.13	27.13
28	27.02	27.40	27.40	27.67	27.53
29	28.86	29.17	28.94	28.83	29.17
30	29.78	30.42	29.92	30.42	30.17
31	30.56	30.95	31.00	31.23	31.14
32	31.85	32.33	31.79	32.00	32.17
33	31.84	32.95	33.05	33.00	33.09
34	33.54	33.79	34.18	33.54	33.86
35	34.27	34.76	35.30	34.68	35.43
36	36.03	35.93	36.21	36.00	36.54
37	36.51	36.75	36.70	36.75	37.20
38	35.25	37.92	38.00	38.08	38.17
39	35.15	38.00	38.50	38.25	38.50

The comparison of the bi-parietal diameter, head circumference, abdominal circumference and femur lengthduring different periods of gestation was done. It was observed that the difference in these variables with time were statistically significant with a p-value<0.001.

Table 4: Comparison of the bi-parietal diameter, head circumference, abdominal circumference and femur length with gestational age

Gestational Age (Weeks)	Number Of Cases	BPD (Weeks)	HC (Weeks)	AC (Weeks)	FL (Weeks)
14-20	88	17.76+2.33	17.52 +2.30	17.69+ 2.22	17.67+ 2.38
21-27	73	24.15+2.62	23.89 +2.60	25.49+ 12.19	26.81+ 23.32
28-32	91	30.31+2.10	30.07 +2.08	30.26+ 1.99	30.30 + 2.03
33-40	151	35.13+1.83	35.42 +1.79	35.11+ 1.97	35.54 + 1.99
Total	403	28.26+7.11	28.21 +7.29	28.47+ 8.62	28.87 + 12.10
P-Value		<0.001	<0.001	<0.001	<0.001

In the second trimester of the pregnancy Placental thickness depicted maximum correlation with the gestational age($r = 0.916$; $p<0.001$), followed by bi-parietal diameter($r = 0.907$; $p<0.001$) and head circumference ($r = 0.898$; $p<0.001$). It depicted weak and poor correlation with abdominal circumference ($r = 0.482$; $p<0.001$) and femur length ($r = 0.236$; $p<0.001$). Femur length also depicted weakest correlation ($r = 0.267$; $p<0.001$) with the gestational age. Overall, weakest correlation was seen between femur length and abdominal circumference ($r=0.149$; p-value :> 0.05).

Table 5: Correlation between placental thickness, gestational age and other growth parameters; bi-parietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC) in the second trimester of pregnancy (13-27 weeks

	Gestational Age By USG (weeks)	Placental Thickness (mm)	BPD (Weeks)	HC (Weeks)	AC (Weeks)	FL (Weeks)
Gestational Age By USG(weeks)	1					
Placental Thickness (mm)	.916[**]	1				
BPD (Weeks)	**.955[**]**	.907[**]	1			
HC (Weeks)	**.959[**]**	.898[**]	.953[**]	1		
AC (Weeks)	.512[**]	.482[**]	.500[**]	.510[**]	1	
FL (Weeks)	.267[**]	.236[**]	.281[**]	.269[**]	.149	1

In the third trimester of the pregnancy only good positive correlation was seen between the placental thickness and Bi-parietal diameter ($r = 0.705$; $p<0.001$), gestational age ($r = 0.702$; $p<0.001$), femur length ($r = 0.699$; $p<0.001$), head circumference ($r = 0.696$; $p<0.001$) and abdominal circumference ($r = 0.693$; $p<0.001$) that were depicted in weeks. Overall, excellent correlation was seen between gestational age and the head circumference in weeks ($r = 0.931$; $p<0.001$) and femur length ($r = 0.931$; $p<0.001$) and only good correlation was seen with placental thickness ($r = 0.702$; $p<0.001$)

Table 6: Correlation between placental thickness and the growth parameters; bi-parietal diameter (BPD) and abdominal circumference (AC) in the third trimester of pregnancy (28-40 weeks)

	Gestational Age By USG (weeks)	Placental Thickness (mm)	BPD (Weeks)	HC (Weeks)	AC (Weeks)	FL (Weeks)
Gestational Age By USG(weeks)	1					
Placental Thickness (mm)	.702[**]	1				
BPD (Weeks)	**.929[**]**	.705[**]	1			
HC (Weeks)	**.931[**]**	.696[**]	.898[**]	1		
AC (Weeks)	.925[**]	.693[**]	.876[**]	.892[**]	1	
FL (Weeks)	**.931[**]**	.699[**]	.890[**]	.898[**]	.904	1

The correlational analysis of the different fetal growth parameters and gestational age (GA) showed that GA depicted strong positive correlation with all the parameters except FL

(femur length, weeks) where it depicted week positive correlation. Femur length depicted

Table 7: Correlation matrix showing the correlation coefficient 'r' values between gestational age, Placental Thickness, Bi-parietal Diameter, Head Circumference, Abdominal Circumference and Femur Length.

	GA by USG (Weeks)	Placental Thickness (mm)	BPD (Weeks)	HC (Weeks)	AC (Weeks)	FL (Weeks)
GA by USG (Weeks)	1					
Placental Thickness (mm)	0.946	1				
BPD (Weeks)	0.987	0.945	1			
HC (Weeks)	0.987	0.942	0.982	1		
AC (Weeks)	0.805	0.771	0.799	0.802	1	
FL (Weeks)	0.560	0.531	0.563	0.559	0.464	1

The age of the pregnant females ranged between 15-46 years (mean value: 27.29 + 4.97 years). Mean gestational age of the fetuses ranged between 14-39 weeks (mean value: 28.25 + 7.15 years). (Table 12) Similarly, the Placental Thickness, Bi-parietal Diameter, Head Circumference, Abdominal Circumference and Femur Length ranged between 11-43 weeks (mean value: 27.85 + 7.19 weeks), 14-40 weeks (mean value: 28.26 + 7.11 weeks), 13-40 weeks (mean value: 28.21 + 7.30 weeks), 13-126 weeks (mean value: 28.47 + 8.62 weeks) and 13-222 weeks (mean value: 28.87 + 12.10 weeks) respectively.

Table 7: Mean values of mother's age, gestational age, Placental Thickness, Bi-parietal Diameter, Head Circumference, Abdominal Circumference and Femur Length observed during the ultrasonography

	Range	Mean+ SD
Age of pregnant Females (yrs.)	15-46	27.29 +4.97
Gestational Age By USG (Weeks)	14-39	28.25+7.15
Placental Thickness (mm)	11-43	27.85+7.19
BPD (Weeks)	14-40	28.26+7.11
HC (Weeks)	13-40	28.21+7.30
AC (Weeks)	13-126	28.47+8.62
FL (Weeks)	13-222	28.87+12.10

Discussion

The current study presented data based on 403 mothers enrolled as study participants according to their age. Distribution of the pregnant mothers by age as well as position of the placenta was observed to be similar to several studies conducted by other researchers in the region[7].

weakest positive correlation with most of the other parameters ranging from r=0.464 to 0.531.

In this study, data has been generated and analyzed for different gestational ages in the different trimesters of pregnancy. The mean PT was 23.8 (2.94) mm and 34.5 (3.42) mm in the second and third trimester, respectively. In the present study, a mean PT was 35.15 mm at 39 weeks of gestation. This was lower than to the value reported by researchers from Nigeria who reported a mean PT of 45 (6.4) mm and 42 (2.9) mm at 39 weeks of gestation[8,9]. The reason for difference can be difference in genetic structure of two populations. However, PT at 39 weeks' gestation was closer to that reported by Mital *et al.* (37.5 mm) who conducted similar work in India[10]. Further studies exploring the genetic differences in placental thickness can explain the extent and reason for differences.

Placental thickness and estimated fetal birth weight have a significantly high positive correlation in both the trimesters as noted by other researchers also[11]. The usefulness of this relationship between placental thickness and estimated fetal weight is that subnormal placental thickness for a gestational age may be the earliest indicator of fetal growth retardation.

In an Indian study, mid pregnancy placental volume was suggested to be significantly related to placental weight at birth and also the birth weight of new born independent of maternal size.

Further Clapp et al evaluated placental growth and reported second-trimester placental volumes and growth rates as good predictors of size at birth in

healthy, active women. As found in other studies, a significant correlation between placental growth rate and gestational age was reported in this study as well. Significant positive correlations between placental thickness and estimated gestational in the second and third trimesters ($p < 0.05$) was also demonstrated[12].

Placental thickness was depicted to increase proportionally with each passing week of gestation. The placental thickness depicted statistically significant but a weak positive correlation with gestational age of >35 weeks. The overall thickness varied between 13.7- 36.5 mm which is lower than that reported by Noor et al[13]. The thickness of placenta varied between 34.2-35.15 mms and the mean value was about 35.4 mm when it was measured between 35-39 weeks period of gestation.

The variations in the placental thickness with increasing gestational age in 403 pregnant females evaluated during different period of gestation was observed which demonstrated an increase in mean placental thickness with each passing gestational week, till 37 weeks period of gestation followed by a decrease in thickness after 38 weeks period of gestation. This implies that PT increases linearly and attains its maximum thickness at 39 weeks of gestation. The maximum PT obtained during this study was less than the value of 47 mm reported by a Nigerian study[9]. A few previous reports from non- Indian populations reported normal placenta to be lower than <40 mm in thickness at any stage of pregnancy[14,15]. This implies that placenta of the Indian population is normally thinner than Nigerian populations and is similar to Caucasian populations.

The results of the present study are consistent with the observations made by authors of previous studies[16]. Average placental thickness was reported to be roughly equivalent to gestational age (in weeks). (23, 34) They reported that the mean thickness of the placenta was 3.90±1.1cm which increased till 38 weeks of gestation, thereafter decreased. This finding is consistent with our findings. Mital et al. also found similar

trends in the values of mean placental thickness (in mm) and increasing in gestational age (in weeks). The placental thickness coincided almost exactly with the gestational age in weeks in two studies from India[17]. Baghel et al. reported that placental thickness in millimeters almost coincides with gestational age in weeks at 24 weeks (24.5 mm at 24 weeks), 32 (31.8 mm at 32 weeks) and 36 weeks (35.5 mm at 36 weeks)[18]. Nyberg and Finberg also reported that as a rule of thumb, placental thickness parallels gestational age (in weeks)[19]. Similarly in a recent study by Karthikeyan et alhad reported that placental thickness can be used as a predictor of the gestational age, and additionally suggested that subnormal PT for the corresponding GA should be evaluated for any disease condition[20].

Conclusion

There is a strong linear relationship between placental thickness and gestational age and other fetal parameters in second and third trimester pregnancy. The relation was found to be statistically significant. Placental Thickness can be used for determination of gestational age and other fetal parameters in doubtful cases.

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