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Original Research Article

Correlation of placental thickness with gestational age in antenatal women

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ABSTRACT

Background: Accurate estimation of gestational age and fetal wellbeing is mandatory to ensure safe pregnancy and healthy delivery. With recent development in USG, basic scan, Doppler imaging and interventional radiology helped greatly in accurate estimation of gestational age and delivering timely care. The objectives of this study was to determine the USG placental thickness at the level of insertion of cord in antenatal women from gestational age 11 to 40 weeks. To correlate placental thickness with gestational age. To calculate composite gestational age from USG parameters; CRL, BPD, HC, AC, FL. To compare the relationship of menstrual gestational age with placental thickness and composite gestational age separately

Methods: It is a comparative study of 2 years duration. Total 322 patients were included. Gestational age was determined from LMP. Patient's routine obstetric USG was done and composite gestational age was calculated from fetal parameters like BPD, HC, AC and FL (CRL in 11 to 14 weeks). At the same time placental thickness was determined at the level of insertion of umbilical cord. The plane of USG image was adjusted so that the thickness measured from cord insertion is perpendicular to the margin of uterine wall.

Results: The following parameters were noted: correlation of period of gestation (weeks) with composite gestational age (weeks) correlation of period of gestation (weeks) with gestational age calculated by placental thickness (weeks).

Conclusions: Placental thickness can give an estimation of gestational age. The linear correlation and statistical compatibility of placental thickness makes it an alternate parameter for gestational age. Knowledge of correct gestational age helps in delivering proper antenatal care, assessing fetal wellbeing, identifying pathology at the earliest and timely decision of termination and providing safe motherhood.

Keywords: Fetal parameters, Gestational age, Obstetrics ultrasound, Placental thickness

INTRODUCTION

Placenta is a fetal organ with important metabolic, endocrine and immunologic functions besides being responsible for nutrition, respiration and excretion for the fetus. It provides physiologic link between a pregnant woman and the fetus. The placenta develops from the chorionic villi at the implantation site at about the fifth week of gestation and by the 9th or 10th week, the diffuse

granular echo texture of the placenta is clearly apparent at sonography.^{1,2} Although certain placental functions are better understood these days, there are parameters need to be established in relation to pregnancy and fetal growth.³

The role of ultrasonography in obstetric has been immense. With advances in gray scale from 2 D to 3D and Doppler sonography, it is possible to study sonographic appearance of placenta and its relation to

uteroplacental blood flow measurement and intrauterine growth. Several studies have reported an increase “Gestational (menstrual) age is the measure of the age of a pregnancy where the origin is the woman’s last normal menstrual period (LMP), or the corresponding age as estimated by other methods”.

According to American Congress of Obstetrician and Gynecologist, main methods to calculate gestational age are:

- Calculating from LMP, Neagle’s formula.
- Early obstetric ultrasound
- In case of IVF, calculating days since oocyte retrieval or co-incubation and adding 14 days. In placental thickness with gestational age.^{4,5}

In present study, placental thickness at the level of insertion of umbilical cord is measured sonographically and is correlated to gestational age. The study is undertaken to first calculate the placental thickness at the level of insertion of umbilical cord and correlate it with gestational age, thereby establishing a nomogram for placental thickness at different gestations and secondly to compare placental thickness with other established fetal parameters in determining the gestational age.

METHODS

From November 2013 to November 2015 (2 years). After obtaining all the ethical permissions from the College Ethical Committee, a comparative study on correlation of placental thickness with gestational age in antenatal women was done. The study was conducted on 322 patients who were admitted at a tertiary care center for a period of 2 years at Department of Obstetrics and Gynaecology. All pregnant patients (11 - 40 weeks of gestation) attending the OPD or admitted as in-patients who were included. Antenatal women of gestational age between 11 to 40 weeks who are ready to participate in the study were advised routine obstetric ultrasonography.

Inclusion criteria

All pregnant women of gestational age between 11 to 40 weeks attending OPD or admitted as inpatients with

- Known last menstrual period (LMP)
- Regular periods
- Viable singleton pregnancy.

Exclusion criteria

- Multiple gestation
- Diabetes
- Rh negative, fetal hydrops
- PIH, Pre-eclampsia, chronic hypertension
- Hydramnios
- Congenital anomalies

- IUGR
- Uterine or adnexal mass
- Abnormal placental insertion
- Intra uterine death
- Ovulatory dysfunction.

The ultrasound machine used for an obstetric scan is of Voluson make ‘S6 Pro’ model. Abdominal transducer with convex array having frequency of 4 - 6 MHz was used. The women were asked to lie in a supine position with full bladder for ultrasonography scan as full bladder provides better acoustic contrast for localization of placenta, its margins and level of cord insertion. The ultrasonographic (composite gestational) age was determined by standard fetal biometric measurements; biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and Femur Length (FL). Placenta is localized whether anterior, posterior, lateral or fundal. The insertion of umbilical cord is located either by 2-D scan or in case where loops of cord interfere, the insertion of cord is located by Color Doppler on the margin of the placenta.

Once the insertion is localized, sonographic probe is kept perpendicular to the abdominal wall. Placental thickness was measured perpendicular to the uterine wall at the site of umbilical cord insertion. The measurement line is from inner margin of uterine wall to the level of insertion of placenta. The placental thickness with menstrual age and composite gestational age were then correlated separately.

Statistical analysis

The mean values of the placental thickness for gestational age along with the respective standard deviations were calculated for the different gestational ages from 11th to 40th week for both menstrual as well as composite gestational age.

Coefficient of correlation was calculated to look for the relationship between placental thickness and gestational age. After this, correlation was sought categorically to see the variations in placental thickness with changing gestational age. The aim was to seek the duration of pregnancy where placental thickness almost equaled the period of gestation.

Placental thickness is then correlated with gestational age on a simple linear regression analysis model and coefficient of correlation was computed. R² value i.e. percentage variability in gestational age calculation from placental thickness was determined. β 1 value i.e. change in gestational age per unit change in placental thickness is calculated. Finally linear equation was formulated for calculation of gestational age from placental thickness at any gestation from 11 to 40 weeks.

Similar simple regression models were used to determine correlation coefficient (r) and percentage variability and

per unit change (R^2 and β_1) between gestational age and other fetal biometric parameters; BPD, HC, AC, FL. As these are already established sonographic fetal parameters for determining gestational age, values of correlation coefficient and percentage variability of placental thickness can be compared with those of other fetal parameters and to that of composite gestational age.

RESULTS

A total of 322 patients were included in this study. Routine ultrasonography was done and placental thickness at the insertion of the cord was calculated and correlated with gestational age. The observations of our study are as follows:

Table 1: Age distribution of study population (n= 322).

Characteristics (n=322)	
Age groups	n (%)
< 20 years	12 (3.73)
20-30 years	289 (89.75)
> 30 years	21 (6.52)
Mean±SD (years)	24.27 ± 3.79

Range = 18 - 36years

The age range among the population was from 18 to 36 years. The mean age of study population was 24.27 with standard deviation of 3.79. Majority (90%) of study participants belonged to the reproductive age group of 20 - 30 years (Table 1).

Table 2: Parity distribution and correlation between parity and placental thickness (mm).

Parity	n = %	Placental thickness (mm) Mean±SD	Correlation coefficient (Spearman's rho)	P Value
0 (n=167)	167 (51.86)	26.95±6.60	0.079 No or negligible relationship	0.159 (>0.05) Not significant
1 (n=107)	107 (33.23)	25.94±6.72		
2 (n=38)	38 (11.80)	26.21±6.17		
3 (n=10)	10 (03.11)	25.29±5.28		

In this study about half (52%) of the study participants were primiparas followed by second paras (34%). The mean placental thickness was compared with the parity in the study population. It was observed that mean placental thickness at a particular gestation has no correlation with the parity. The correlation coefficient showed no relationship between the two ($r = 0.079$) and the p value is non-significant (0.159) (Table 2).

There was a linear correlation between mean placental thickness and menstrual gestational age as described earlier. When correlation was assessed categorically, it was found:

From 12 to 18 weeks

The mean placental thickness (mm) > 2 to 3 mm than the menstrual gestational age (weeks). It has a strong positive correlation ($r = 0.531$, P value = 0.000) (Table 3).

From 19 to 32 weeks

It almost coincided, i.e. mean placental thickness (mm) = Menstrual gestational age (weeks). It has a very strong positive correlation ($r = 0.792$, P value = 0.000) (Table 3).

Table 3: Correlation between placental thickness (mm) and different period of gestation (POG, weeks).

Period of gestation (weeks)	r (Correlation coefficient)	P value
12 th to 18 th weeks	0.531 Strong positive relationship	0.000 (<0.001), Significant correlation
19 th to 32 weeks	0.792 Very strong positive relationship	0.000 (<0.001), Significant correlation
33 rd to 40 th weeks	0.386 Moderate positive relationship	0.000 (<0.001), Significant correlation
12 th to 40 th week (overall)	0.918 Very strong positive relationship	0.000 (<0.001), Significant correlation

From 33 to 40 weeks

The mean placental thickness (mm) <3 to 4 mm than the menstrual gestational age (weeks).

It has a moderate positive correlation ($r = 0.386$, p value= 0.000) (Table 3).

Overall correlation, i.e. from 12 to 40 weeks

- Mean placental thickness correlated with menstrual gestational age by a very strong positive correlation ($r = 0.918$, p value 0.000) (Table 3).

When simple linear regression analysis was performed using placental thickness (mm) as independent variable and gestational age (weeks) as dependent variable, it showed statistically significant very strong positive relationship between these two variables ($r = 0.844$, p

<0.001). Percentage of variability in the gestational age (weeks) estimation (R^2) by Placental thickness (mm) was 84.4%. β_1 was 1.118, which indicates that change in 1 mm of Placental thickness will lead to 1.118 week change in gestational age (Table 4).

Table 4: Simple linear regression analysis using period of gestation/POG age (weeks) as dependent variable and ultrasonic parameters as independent variable.

Ultrasonic parameters	r (Correlation coefficient)	R ² *	β_0 (Constant)	β_1 *	P Value
Placental thickness (mm)	0.918 Very strong positive relationship	0.844	-2.994	1.118	0.000 (<0.001) Significant
CRL (mm)	0.212 Weak positive relationship	0.045	13.315	- 0.008	0.430 (>0.05) Not Significant
BPD (mm)	0.966 Very strong positive relationship	0.933	4.442	0.353	0.000 (<0.001) Significant
HC (mm)	0.940 Very strong positive relationship	0.884	5.009	0.095	0.000 (<0.001) Significant
AC (mm)	0.843 Very strong positive relationship	0.710	11.278	0.072	0.000 (<0.001) Significant
FL (mm)	0.850 Very strong positive relationship	0.723	12.533	0.302	0.000 (<0.001) Significant

*R²: % variability in the gestational age (weeks) estimation by each ultrasonic parameter; * β_1 : Value tells about change in gestational age (weeks) value for per unit change in each ultrasonic parameter.

Table 5: Multiple linear regression analysis using period of gestation (weeks) as dependent variable and ultrasonic parameters as independent variable.

Ultrasonic parameters	β	P Value
(Constant)	2.412	0.000 (<0.001), Significant
Placental thickness (PT, mm)	0.205	0.000 (<0.001), Significant
BPD (mm)	0.214	0.000 (<0.001), Significant
HC (mm)	0.017	0.001 (<0.01), Significant
AC (mm)	0.005	0.047 (<0.05), Significant
FL (mm)	0.011	0.271 (>0.05), Not significant

*R²= 0.938 (93.8%).

Table 6: Correlation of period of gestation (weeks) with composite gestational age (weeks) and gestational age calculated by placental thickness (weeks).

Correlation	r (Correlation coefficient)	P value
Period of gestation (weeks) and composite gestational age (weeks)	0.982 Very strong positive relationship	0.000 (<0.001), Significant correlation
Period of gestation (weeks) and gestational age calculated by placental thickness (weeks)	0.918 Very strong positive relationship	0.000 (<0.001), Significant correlation

From the analysis of linear regression model considering all ultrasonic variables, linear equations can be derived for calculation of gestational age. FL was not associated with gestational age in multiple linear regression analysis, hence excluded in derivation of Regression equation (Table 5).

Both composite gestational age and gestational age calculated by Placental thickness has correlation coefficient values (r) above 0.9. It indicates that both are

good predictor for gestational age. However based on correlation coefficient values (r) Composite gestational age is a better indicator than Gestational age calculated by Placental thickness alone (Table 6).

DISCUSSION

Correlation of gestational age with placental thickness and gestational age

We have found that the mean placental thickness increased in proportion to the advancing gestational age and has linear correlation with gestational age from 11 to 40 weeks. Ohagwu C et al conducted similar study on Nigerian antenatal population. They seeked the relation between placental thickness and gestational age. In their study fairly linear correlation was obtained between placental thickness and gestational age.⁶

Although correlation was linear, placental thickness equaled gestational age at only 10 and 11 weeks. At other gestations, the mean placental thicknesses exceeded the gestational age. Author explains it to be the racial difference between Nigerian women and others and recommends the conclusion that placentas more than 40 mm thick have an association with maternal diabetes mellitus, fetal hydrops and intrauterine infections has to be regarded with caution in Negroes.⁷

Early reports of studies done for placental localization by ultrasound examination were published by Donald, Kobayashi and Gottesfield.⁸⁻¹⁰ Nyberg and Finberg also reported that placental thickness in millimeter parallel gestational age in weeks.¹¹

Mital et al, also found a direct proportion in the values of mean placental thickness (in mm) with increase in gestational age (in weeks) and found that the placenta thickness (in mm) coincides almost exactly with the gestational age in weeks, and recommends that more studies are required to establish this new parameter in calculating gestational age or confirming the fetal age using this parameter.¹² Similar study conducted by Anupama et al, reported that placental thickness can be used to estimate the gestational age of the fetus.¹³ Our study observation is supported by Ahmed A et al, in their study in Sudan in 2014 who found significant positive correlation between placental thickness and gestational age.¹⁴

Placental thickness in direct proportion with gestational age

In our study, the mean placental thickness gradually increased with gestational age, from 15 mm at 12 weeks to 35.75 mm at 40 weeks which almost matched with the observations of the study conducted by Dudley et al, where placental thickness gradually increased from 15 mm at 11 weeks of gestation to 37.5 mm at 39 weeks. In a similar study conducted by Jauniaux et al, Placental thickness increased progressively from a mean value of 20 mm at 16 weeks of gestation to 30 mm at 28 weeks.^{15,16}

In another study by Ohagwu et al, in Nigeria obtained the maximum placental thickness of 45.1 ± 6.4 mm at 39 weeks gestation.¹⁷ The higher value of placental thickness might be due to racial difference of women.

Clinical implications of measuring placental thickness and correlating it with gestational age

Significant positive correlations between placental thickness and estimated fetal weight in the second and third trimesters ($p < 0.05$) in a non-IUGR group were demonstrated.¹⁸ A positive correlation, between increasing placental volume with increasing gestational age was observed, but it remained reduced in the growth-restricted fetuses.¹⁹ The usefulness of this relationship between placental thickness and growth parameters is that subnormal placental thickness for a gestational age may be the earliest indication of fetal growth retardation.

There is an association found by Dombrowski et al, and Jauniaux et al, around mid-gestation between an increase in placental thickness and subsequent slow fetal growth and/or hypertensive disorders of pregnancy.^{20,21} It has been suggested by Ko et al, that an increased placental thickness in the second trimester is a highly sensitive marker of the subsequent development of fetal hydrops related to a-thalassaemia in high risk populations.²²

These studies emphasize the importance of measuring Placental Thickness at routine ultrasonography to follow fetal well being and to identify at the earliest the developing pathology. Once the fetal pathology is developed, timely intervention and termination is decided considering fetal maturity. For that exact knowledge of gestational age and assessment of maturity provides guidance for management and to ensure safe motherhood.

Placental thickness being an important feto-maternal component and easily accessible, serves as a marker for identification of both maternal and fetal complications at the earliest before they become clinically evident. The study derives a nomogram for placental thickness as a reference. It will act as a screening tool as deviation in thickness at any gestation will serve as a clue to subject the women for further investigations and level 2/3 scans. With evolution of placentography, other placental parameters and their patterns with increasing gestational age will serve to both obstetric and fetal care and aid in safe maternal and neonatal outcomes.

CONCLUSION

Present study shows a linear correlation between mean placental thickness and gestational age. We have noticed that initially up to 18 weeks, placental growth exceeds advancing gestational age. Placental thickness was higher by 2-3 mm. Then up to 32 wks, it almost equaled the gestational age. After that i.e. 32 week onwards, Placental thickness lags behind gestational age which is attributed to reduced blood supply to placenta near term. Percentage variability of other sonographic parameters in estimating gestational age was comparable to that of placental thickness.

To conclude, placental thickness can give an estimation of gestational age. Knowledge of correct gestational age is important in delivering proper antenatal care, assessing fetal well-being, identifying pathology at the earliest and timely decision of termination and providing safe motherhood.

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