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Original research article

Placental Thickness and its Correlation to Gestational age - A Prospective Ultrasonographic Study

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Abstract

Aim: To assess the accuracy of placental thickness measurement as a new parameter for estimating gestational age of the fetus and also to assess the growth pattern of placenta with advancing gestational age.

Material & methods: The prospective cross-sectional study consisting of 200 normal antenatal women attending in the Department of Radiodiagnosis, National Institute of Medical Science and Research, NIMS University, Jaipur for the period of one year. Placental thickness was measured as a parameter for estimating gestational age of the fetus from 11 weeks to 40 weeks of gestation by using grey scale real time ultrasonographic examinations. The gestation age was determined by measuring the biparietal diameter, the abdominal circumference, the crown rump length, the head circumference and the femur length. Descriptive statistical analysis has been carried out in the present study. Correlation was inferred by Pearson's Correlation coefficient. P-value < 0.001 was taken as significant.

Results: In the present study, it is observed that mean ± SD of gestational age (weeks) by USG is 27 ± 6.97 with the range of 11-39 weeks. The mean ± SD of placental thickness is 27.595 ± 7.15 with the range of 11-38 mm. It was found that at 11-39 weeks of gestational age there is no statistical significance (t value = 0.33, p>0.001) between the mean difference of gestational age and placental thickness, which indicates that there was high positive correlation between gestational age and placental thickness (r = 0.94) which is significant i.e. P< 0.001. It was found that at 11-35 weeks of gestational age there is no statistical significance (t value = 0.083, p>0.001) between the mean difference of gestational age (25.65 ± 6.12) and placental thickness (25.59 ± 6.65), which indicates that there was high positive correlation between gestational age and placental thickness (r = 0.92) which is significant i.e. P< 0.001. It was found that at ≥35 weeks of gestational age there is statistical significance (t - value = 3.55, p<0.001) between the mean difference of gestational age (36.293 ± 1.188) and placental thickness (35.37 ± 1.22), which indicates that there was moderate positive correlation between gestational age and placental thickness (r = 0.53) which is not significant i.e. P> 0.001.

Conclusion: The relationship between the placental thickness and gestational age is linear and direct. Placental thickness (in mm) measurement can be important additional parameter for estimating gestational age along with other parameters especially from 11 to 35 weeks of gestation in the woman in whom the LMP is unreliable or is not known.
Keywords: Placental Thickness, Gestational Age.

Introduction

The biochemical and physical duet of the mother and the fetus in the formation of the placenta is one of the most carefully orchestrated phenomenon in the fetal development. The placenta is a fetal organ with important metabolic, endocrinal and immunologic functions besides being responsible for nutrition, respiration and excretion for the fetus. Lastly acting as a barrier, it has a role in protecting the fetus from various noxious agents. Placental formation begins in the later half of the 2nd month of the pregnancy and is usually completed by the 4th month. It reaches its maximum growth at term.

With the new advances in grey scale and doppler sonography, we are able to study the placental sonographic appearance and its relationship to uteroplacental blood flow measurement and intrauterine growth.

Placental evaluation by ultrasonography has been used to characterize placental position and morphologic changes as the placenta matures. Sonography has provided a safe and non-invasive means to evaluate the placenta whose normal and abnormal size, appearance and growth pattern can have significant antenatal implications.

The role of sonography in the evaluation of morphology and detection of placental abnormalities in clinical conditions such as nonimmune hydrops, gestational diabetes and intrauterine growth restriction has been well established. Placenta is primarily a fetal organ and its size is a reflection of the health and size of the fetus. One additional ultrasonographic parameter frequently used to assess the placenta is placental size.

The measurement of placental thickness is relatively simple and clinically useful. Abnormal thickness of placenta is well recognized as a diagnostic harbinger in a wide spectrum of pathologic events. Placental thickness can contribute to the management of fetus at risk. Few authors have studied the role of placental thickness as a new parameter for estimating gestational age and placental thickness nomograms in relation to gestational age have been published. Placental thickness measurement can differentiate normal from abnormal pregnancy.

The best possible ante partum care and the successful deliveries of babies always revolve around the accurate knowledge of the Gestational Age (GA). The gestational age is of utmost importance in the interpretation of biochemical tests such as the screening for the expanded maternal serum biomarkers (Human Chorionic Gonadotrophin, Alfa Fetoprotein and the oestrogen and progesterone levels) for the risk assessment of various fetal anomalies, in evaluating the fetal growth by distinguishing the normal from the pathological fetal development.

This allows obstetrician to institute measures that will optimize the fetal outcome. When an anomaly is detected, the interventional modality which is used, is influenced by the gestational age. Virtually, all the important clinical decisions, which include caesarean section, elective

labour induction etc. depend on the knowledge of the gestational age. The gestational age is approximately 280 days, which is calculated from the first day of the last menstrual period and so, the dating of the pregnancy starts even before the fertilization. The determination of the gestational age is a common clinical problem. Ultrasonography (USG) is commonly used to estimate the gestational age by measuring the fetal dimensions like the Biparietal Diameter (BPD), the abdominal circumference (AC), the Head Circumference (HC) and the Femur Length (FL). An ultrasonograph is prone to observer bias, as it depends on the observers technical skills. Also, the fetal parameters, the different techniques of measurement and the positional problems may diminish the accuracy of the gestational age estimation. Wolfson et al, showed that the biparietal diameter was not reliable in the fetuses which had a premature rupture of the membranes. There are some drawbacks in those above said parameters in estimating the gestational age. So, there is a need of another parameter for supplementing the gestational age estimation with minimal error. Nyberg and Finberg reported that the placental thickness parallels the gestational age.[1]

Accurate assessment of gestational age is an important part of any obstetric examination and presently the most effective way to date pregnancy is by the use of ultrasound. Several investigations have demonstrated that an estimated gestational age determined sonographically is more accurate than one based on last menstrual period. Several sonographically derived fetal parameters are used to date pregnancy. They are fetal crown-rump length (CRL), biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC). Placental thickness measurement can be used as a new parameter to estimate gestational age.

The purpose of the present study of measuring placental thickness at the level of umbilical cord insertion site was to assess the relationship of placental thickness with gestational age and also to assess the growth pattern of placenta with advancing gestational age.

Material and Methods

The prospective cross-sectional study consisting of 200 normal antenatal women attending in the Department of Radiodiagnosis, National Institute of Medical Science and Research, NIMS University, Jaipur for the period of one year.

Placental thickness was measured at the insertion of the umbilical cord as a parameter for estimating gestational age of the fetus. The study was performed from 11 weeks to 40 weeks of gestation. The grey scale real time ultrasonographic examinations was performed using a ultrasonographic machine Volusion S 6 with a 3 – 5 MHz convex array transducer.

The gestation age was determined by measuring the biparietal diameter, the abdominal circumference, the crown rump length, the head circumference and the femur length. The placental thickness was measured at the level of the umbilical cord insertion; the maximum thickness was noted in the cross section. Each placenta was measured to a 1 mm precision, at its greatest thickness, which is perpendicular to the uterine wall. The uterine myometrium and the retroplacental veins were excluded. The subjects were in the supine position with a full urinary bladder while they underwent the ultrasonography.

Inclusion criteria

1. Singleton pregnancies, 11- 40 weeks
2. The known last menstrual period
3. A history of regular menstruation

Exclusion Criteria

1. Maternal disease
a. Gestational diabetes
b. Hypertension (Systemic hypertension and pregnancy induced hypertension)
c. Anemia
2. Fetal anomalies
3. Placenta previa, placental anomalies and poor visualization of the placenta.
4. Multiple pregnancies
5. Last menstrual period not known or irregular menstrual periods.

Cord Insertion

The identification of cord insertion site is vitally important for obtaining correct measurements. The site is usually central, but slightly eccentric position may be normal (as shown in figure 1). The ultrasonic appearance of cord insertion appears either as hypoechoic areas closest to the chorionic plate in the thickest portion of the placenta with a V- shape or as linear echoes emanating at right angles from the placental surface.

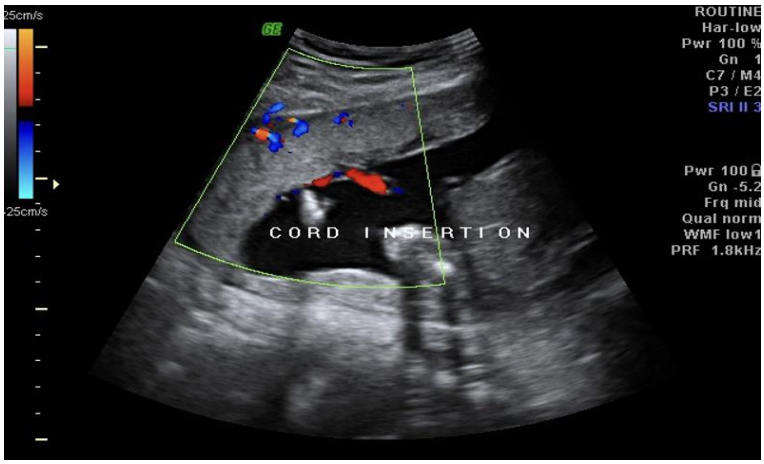

Figure 1: Cord insertion

Placental thickness was calculated from the echogenic chorionic plate to placental myometrial interface. The myometrium and sub placental veins were excluded in the measurements. All placental measurements were taken during the relaxed phase of the uterus as contractions can spuriously increase the placental thickness. The thickness increases during uterine contractions due to distention of intervillous space by maternal blood. The length and surface of placenta can also increase due to distension of intervillous space[2].Placental thickness depends on the amount of fetal blood, maternal blood and placental tissue[2].

Placental myometrial interface

Correct identification of placental myometrial interface is important for proper measurements of placenta. Focal myometrial thickening due to contractions or myomata may spuriously suggest placental thickening but attention to the placental myometrial echogenicity difference should confirm that the placenta drapes over these regions of myometrial thickening[3].
Placental thickness value, in mm, was calculated by averaging the three best measurements for each case.

Calculation of gestational age

The gestational age in first trimester from 11 to 13 weeks of pregnancy was determined by measuring CRL and calculations using Hadlock tables[4]. Additional measurements are not more accurate than the CRL length in predicting age from 11 to 13 weeks and their use in conjunction with CRL does not further improve age estimation[5].

The gestational age in second and third trimesters from 14 to 40 weeks of pregnancy was determined by composite fetal measurements of BPD, HC, AC and FL[6]. Gestational age was computed by the ultrasound machine based on Hadlock tables by using regression equations from combination of measurements (computation software package). Four parameter method used in second and third trimester results in lowest variability estimates. Multiple variables do reduce uncertainty of the prediction, especially when measurements are made for the first time in the third trimester[7-8].

The dissertation studies the relationship of placental thickness, in mm, measured at the level of insertion of the umbilical cord with advancing gestational age in weeks. We obtained the correlation of mean placental thickness with calculated gestational age from 11 weeks to 40 weeks.

Statistical Analysis

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). 95% Confidence Interval has been developed for placental thickness according to estimated GA in weeks. Correlation was inferred by Pearson's Correlation coefficient. P-value < 0.001 was taken as significant.

RESULTS

In the total study group of 200 normal antenatal women more than 18 years, mean age was 25 years. Majority of antenatal women were in age group of 20-25 years **(Table-1, Fig 2)**. Anterior placenta was noted in 107 cases, posterior 62 cases, fundal and lateral in 17 and 14 cases respectively **(Table-2, Fig 3)**.

It was observed that the placental thickness gradually increased from 11.00 mm at 11 weeks to 37.33 mm at 39 weeks. From 11-35 weeks of gestation, the placental thickness (mm) almost matched the gestational age in weeks. Thereafter for ≥35 weeks placental thickness was lowered by 1-2 mm. At no stage of pregnancy normal placenta was greater than 38mm **(Table-3, Fig 4,5,6)**. .

In the present study, it is observed that mean ± SD of gestational age (weeks) by USG is 27 ± 6.97 with the range of 11-39 weeks. The mean ± SD of placental thickness is 27.595 ± 7.15 with the range of 11-38 mm. It was found that at 11-39 weeks of gestational age there is no statistical significance (t value = 0.33, p>0.001) between the mean difference of gestational age and placental thickness, which indicates that there was high positive correlation between gestational age and placental thickness (r = 0.94) which is significant i.e. P< 0.001 **(Table-4, Fig 7).** It was found that at 11-35 weeks of gestational age there is no statistical significance (t value = 0.083, p>0.001) between the mean difference of gestational age (25.65 ± 6.12) and placental thickness (25.59 ±6.65), which indicates that there was high positive correlation between gestational age and placental thickness (r = 0.92) which is significant i.e. P< 0.001**(Table-5, Fig 8)**.

It was found that at ≥35 weeks of gestational age there is statistical significance (t - value = 3.55, p<0.001) between the mean difference of gestational age (36.293 ± 1.188) and placental thickness (35.37 ± 1.22), which indicates that there was moderate positive correlation between gestational age and placental thickness (r = 0.53) which is not significant i.e. P> 0.001. **(Table-6, Fig 9)**.In the present study it was observed that there was high positive correlation between the gestational age and placental thickness at 11- 35 weeks. After 35 weeks moderate correlation occurs between the gestational age and placental thickness **(Table-7)**.

Table 1: **Maternal Age Distribution**

AGE IN YEARS	NUMBER OF CASES	PERCENTAGE
<20	Nil	Nil
20-25	127	63.5
26-30	56	28
>30	17	8.5
Total	**200**	**100.0**

Mean ± SD: 24.7±3.88

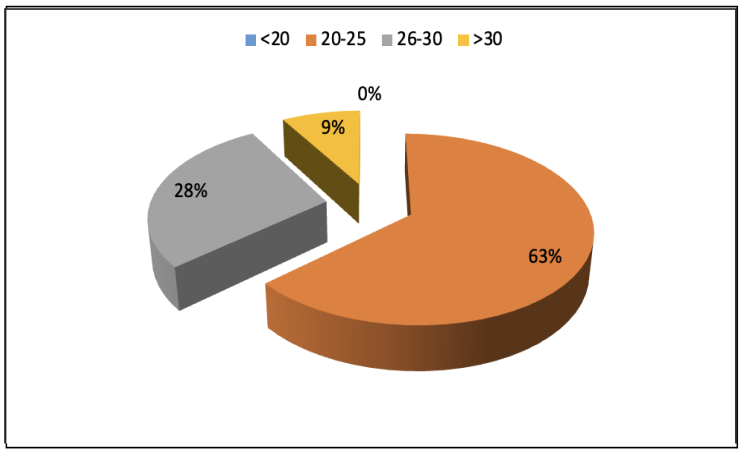

Figure 2: Maternal Age Distribution

Table 2: Distribution of Placental Position

PLACENTA	NUMBER	PERCENTAGE
ANTERIOR	107	53.5
POSTERIOR	62	31
FUNDAL	17	8.5
LATERAL	14	7
TOTAL	**200**	**100.0**

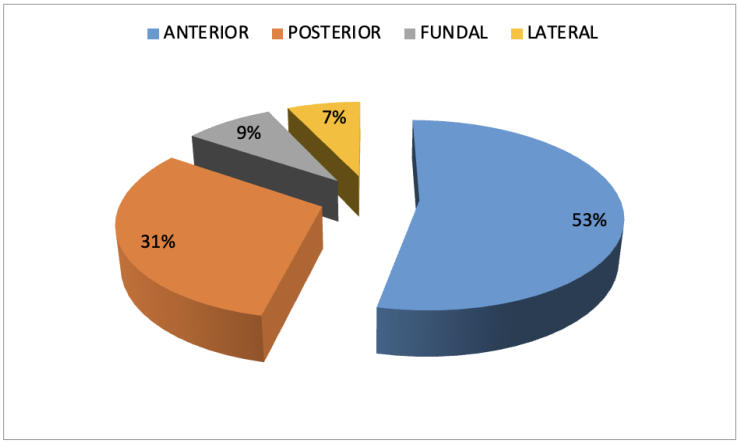

Figure 3: Distribution of Placental Position

Table 3: Relationships Between Gestational Age (Weeks) By USG and Placental Thickness (MM)

EGA By USG (Weeks)	Number of Cases	% of Cases	Placental Thickness (mm)	95% Confidence Interval (Lower - Upper)
11	2	1	11.00 ± 0.00	11.00 – 11.00
12	1	0.5	12.00 ± 0.00	12.00 – 12.00
13	1	0.5	14.00 ± 0.00	14.00 – 14.00
14	3	1.5	14.67 ± 0.67	14.00 - 15.34
15	3	1.5	15.00 ± 0.00	15.00 – 15.00
16	3	1.5	16.00 ± 0.00	16.00 – 16.00
17	5	2.5	17.60 ± 0.76	16.84 - 18.36
18	6	3	17.83 ± 0.94	16.89 - 18.77
19	6	3	19.67 ± 0.65	19.02 - 20.32
20	6	3	20.17 ± 0.61	19.56 - 20.78
21	10	5	21.10 ± 0.35	20.75 - 21.45
22	5	2.5	22.40 ± 0.47	21.93 - 22.87
23	4	2	23.25 ± 0.48	22.77 - 23.73
24	7	3.5	24.29 ± 0.37	24.12 - 24.66
25	14	7	25.21 ± 0.29	24.92 - 25.50
26	8	4	25.75 ± 0.80	24.95 - 26.55
27	7	3.5	26.86 ± 0.51	26.35 - 27.37
28	8	4	27.63 ± 0.51	27.12 - 28.14
29	4	2	29.50 ± 0.57	28.93 – 30.07
30	9	4.5	30.40 ± 0.47	29.93 – 31.87
31	10	5	31.30 ± 0.51	30.79 - 31.81
32	10	5	32.60 ± 0.59	32.01 – 33.19
33	16	8	33.56 ± 0.44	33.12 – 34.00
34	11	5.5	33.18 ± 0.36	33.82 – 34.54
35	13	6.5	34.69 ± 0.87	33.82 - 35.56
36	11	5.5	35.36 ± 0.48	34.88 – 35.84
37	12	6	35.50 ± 0.29	35.21 - 35.79
38	2	1	36.00 ± 0.00	36.00 – 36.00
39	3	1.5	37.33 ± 0.65	36.68 - 37.98

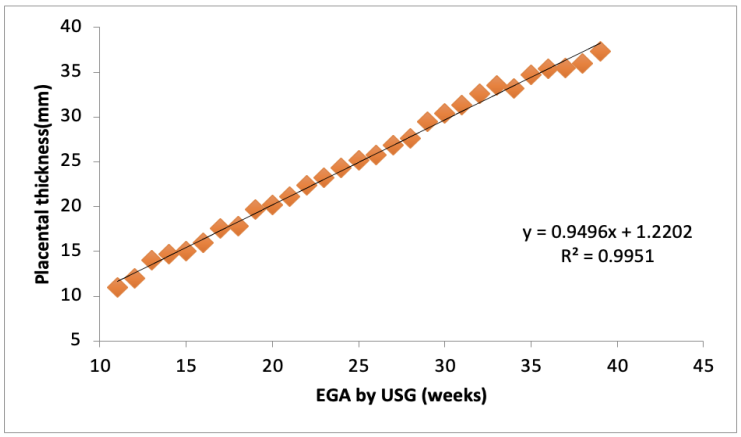

Figure 4: Relationship of Mean Placental Thickness (MM) With Increasing EGA By USG (Weeks) From 11-39 Weeks

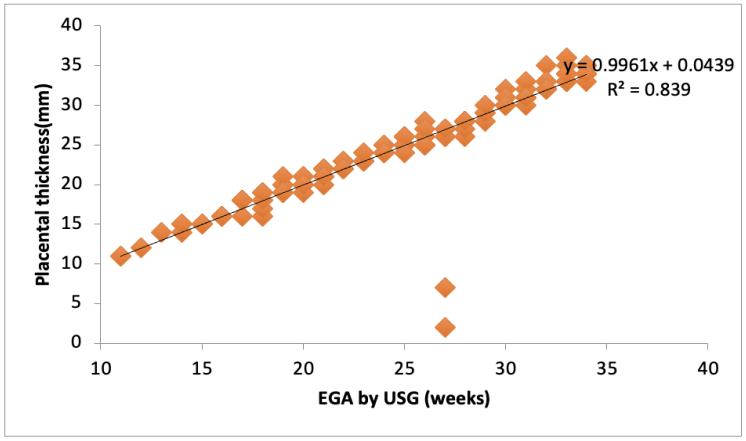

Figure 5: Relationship of Mean Placental Thickness (MM) With Increasing EGA By USG (Weeks) From 11-35 Weeks

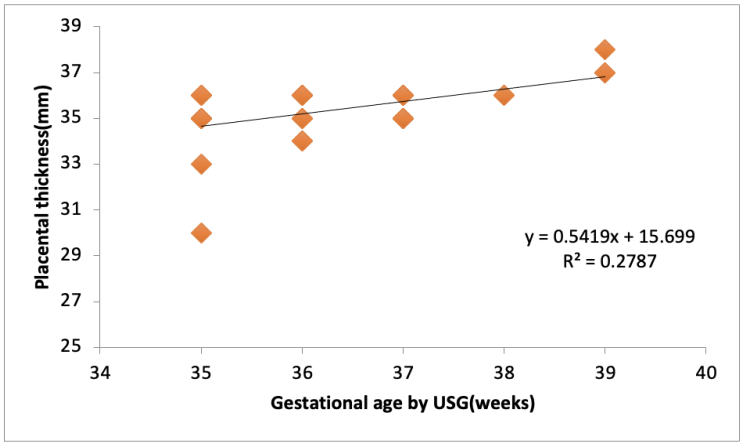

Figure 6: Relationship of Mean Placental Thickness (MM) With Increasing EGA By USG (Weeks) From ⩾35 Weeks

Table 4: Comparison Between Gestational Age (11-39 Weeks) and Placental Thickness (MM)

Parameter	Number of Subject	Range	Mean	Standard Deviation	T - Value	P – Value
Gestational age by USG	200	11 – 39	27.83	6.97	0.33	P>0.001 (NS)
Placental Thickness (mm)	200	11 – 38	27.595	7.15		

***NS= Not Significant, T value is obtained using student's T – test

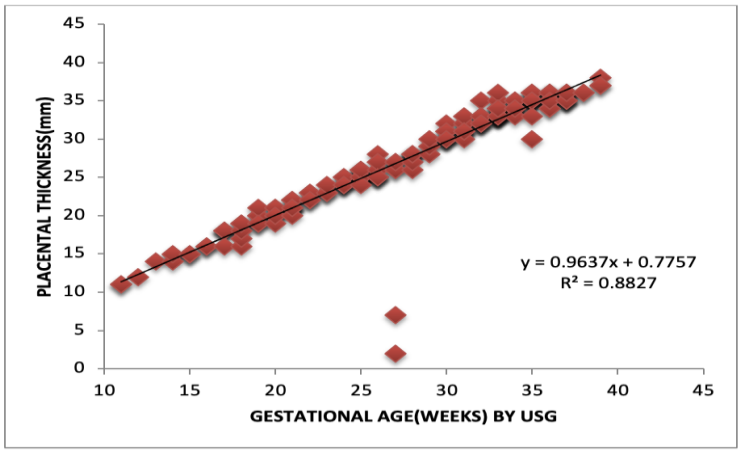

Figure 7: Gestational Age (11-39 Weeks) by USG and Placental Thickness (mm)

Table 5: Comparison Between Gestational Age (11 - 35 Weeks) and Placental Thickness (mm)

Parameter	No. of Subject	Range	Mean	Standard Deviation	T – Value	P – Value
Gestational age by USG	159	11 – 35	25.65	6.12	0.083	P>0.001 (NS)
Placental Thickness (mm)	159	11 – 36	25.59	6.65		

***NS= Not Significant, T value is obtained using student's T – test

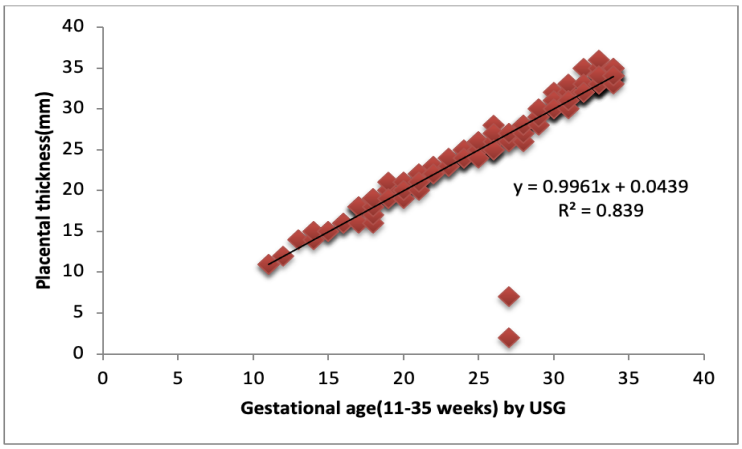

Figure 8: **Gestational Age (11-35 Weeks) by USG and Placental Thickness (mm)**

Table 6: Comparison Between Gestational Age (≥ 35 Weeks) and Placental Thickness (mm)

Parameter	No. of Subject	Range	Mean	Standard Deviation	T – Value	P – Value
Gestational age(weeks) by USG	41	36 – 39	35.293	1.188	3.55	P<0.001 (S)
Placental Thickness (mm)	41	34 - 38	35.37	1.22		

***S= Significant, T value is obtained using student's T - test

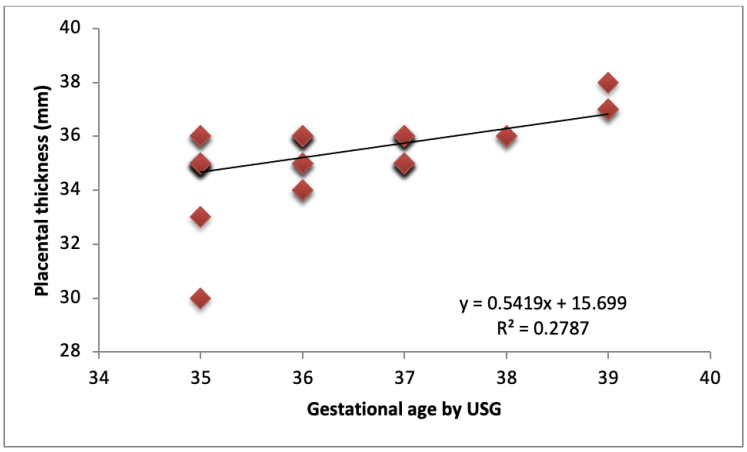

Figure 9: Gestational Age (≥35 Weeks) By Usg And Placental Thickness (Mm)

Table 7: Correlation Between Gestational Age (Weeks) and Placental Thickness (mm)

Correlation Between	Karl Pearson's Coefficient (R)	Nature of Correlation	P – Value
Gestational age (11 – 35 weeks) and Placental Thickness(mm)	0.92	High Positive correlation **(0.75< r <1)**	P<0.001 (S)
Gestational age (≥ 35 weeks) and Placental Thickness(mm)	0.53	Moderate Positive correlation **(0.5 < r < 1)**	P>0.001 (NS)
Gestational age (11-39 weeks) and Placental Thickness(mm)	0.94	**High Positive correlation (0.75< r <1)**	P<0.001 (S)

Discussion

Before the advent of prenatal investigation techniques morphological examination of the placenta was limited to retrospective information and had little influence on pregnancy management. With the improvement of ultrasound equipment, it is now possible to examine the placenta in detail from the beginning of first trimester of pregnancy.

Donald introduced placental localization by ultrasound in 1965.[9] This method of ultrasound placentography was found to be highly accurate for localization of placenta. Until recently, the placenta was evaluated purely to determine its position or to ascertain premature separation.

A more detailed USG evaluation of the placenta has led to the understanding of possible morphologic changes as the placenta matures.

For many years ultrasonologists have approached the placenta as a 'static' feature in a dynamic system. While all measurements of fetus were related to menstrual age, the placental thickness was judged as normal or abnormal based on a single "cut off" point. The present study data confirm that placental thickness is a function of age. Abnormal thickening or thinning must be correlated with estimates of pregnancy duration.
Sonographic measurements of the placenta during pregnancy have been described previously.

To determine whether a given placental thickness is normal or abnormal, normal placental thickness must be defined for each week of gestational age throughout pregnancy.

The present study assessed the relationship of placenta thickness (in mm) with sonographic gestational age (in weeks) and also the growth pattern with advancing gestational age. The study showed that the placental thickness (in mm) increases steadily with increasing gestational age in (in weeks) in a linear fashion and almost matching the gestational age from 11-35 weeks of gestation. The rate of increase of placental thickness gradually diminished from 36-40 weeks and was less by 1-2 mm compared to gestational age (in weeks). Placental Thickness is a Gestational age dependent variable. The results of the present study are in accordance with several other previous studies in this regard.
Hoddick et al (1985) found average placental thickness (in mm) to be roughly equivalent to gestational age (in weeks).[3] Mital P and Hooja N also found an increasing trend in the values of mean placental thickness (in mm) with increase in gestational age (in weeks) and the placental thickness (in mm) coincides almost exactly with the gestational age in weeks.[10] Anupama Jain et al reported similar correlations between placental thickness and gestational age. They found placental thickness (in mm) almost matched gestational age (in weeks) from 27 weeks to 33 weeks of gestation.[11]

Grannum et al reported that placental thickness would increase linearly until 33 weeks of pregnancy, after which there was gradual thinning.[12] Other authors reported similar findings. Berkowitz et al reported gradual decrease in placental size after 32 weeks until term.[13]

Significance of placental size
Placental thickness changes are an expression of normal growth of the fetoplacental unit amenable to measurement with USG and of value in describing normal physiology.
Some diseases or abnormalities of the fetus can be detected through measurement of placental thickness.[14] The measurements relative to gestational age should serve to facilitate recognition of altered placental thickness induced by pathologic processes.
Thin placenta is often a marker for a small for dates fetuses and a sign of growth restriction. Placental thinning is also seen in patients with placenta membranacae, pre-eclampsia, chromosomal abnormalities and severe intra –uterine infection.
Thick placentas are associated with hydrops fetalis, diabetes mellitus, maternal anemia and intrauterine infections. Sonographically thick placenta is associated with increased perinatal risk with increased mortality related to fetal anomalies and higher rates of both small for gestational age and large for gestational age infants at term.

Accuracy of placental thickness measurements
To obtain an accurate placental measurement, it is important to identify the placental-myometrial interface. When placenta is posterior, identification of this region is facilitated by

the acquisition of images as free from acoustic shadowing from the fetus as possible.
When the placenta is anterior, proper transducer position and gain settings are important to minimize near field and reverberation artifacts.[3]

Correct identification of the placental-myometrial interface should also preclude the illusion of placental thickening induced by focal myometrial thickening. Since the placenta is a passive structure lacking the capacity to expand focally, measurements of placental thickness at any point yields similar results. Placental thickness may appear focally increased over uterine contractions or myomata, attention to the placental-myometrial echogenicity difference should confirm that the placenta drapes over these regions of myometrial thickening.
Thoughtful attention to technical details and correlation with gestational age should facilitate the detection of abnormal placental thickness and normal growth pattern in prenatal sonographic evaluation.

Limitations of the study

- The present study is a cross sectional study design, which is made up of observations on different individuals. It is not a true placental growth curve as these can only be obtained from serial measurements taken on the same patient throughout gestation.[15] So, it may not provide a clear understanding in individual growth patterns. However, it is a reasonable approximation of a true placental growth curve. Longitudinal placental growth curves can be constructed from serial measurements taken on the same patient throughout pregnancy.
- Accuracy of placental measurements depends on making a perpendicular scan of the placenta and care should be taken in acquisition and interpretation of the images to prevent spurious measurements. For e.g. imaging obliquely through the placenta leads to images incorrectly suggesting placental thickening. Images were always acquired at the level of cord insertion as images obtained too near the periphery of the placenta may spuriously suggest thinning. All examinations were performed using the same equipment and by the same examiner to minimize these measurement errors.
- A method to estimate the thickness of the in-situ placenta from USG images in a single dimension has its own limitations. Placental volume measurement using 3-D USG may be more accurately assess placental size than placental thickness measurements. However, 3-D sonography is expensive, time consuming and not widely available.
- The parameter of placental thickness may vary among different population groups. Population specific monograms may be needed derived from large sample sizes. The placental growth curves may be different for different population groups.
- Short placental insertion site may spuriously suggest placental thickening in a normal placenta.
- Cord insertion site on the placenta was difficult to image in normal term pregnancies, especially in posterior locations.

Conclusion

The relationship between the placental thickness and gestational age is linear and direct. Placental thickness (in mm) measurement can be important additional parameter for estimating gestational age along with other parameters especially from 11 to 35 weeks of gestation. Placental thickness (in mm) increase with increasing gestational age (in weeks) and almost matching it from 11 to 35 weeks of gestation. The relationship of placental thickness with gestational age falls marginally and the rate of growth of placental thickness decreased after ≥ 35 weeks of gestation and was lower by 1-2 mm.

Normal placental thickness nomograms have been established in the present study to determine whether a given placental thickness is normal or abnormal for a particular gestational age.

Thoughtful attention to technical detail and correlation of placental thickness with gestational age should facilitate the detection of abnormal placental thickness associated with IUGR, hydrops fetalis and diabetes mellitus in early stages.

Thus, it can be concluded that placental thickness can be used as a predictor of the gestational age in the woman in whom the LMP is unreliable or is not known. The substitution of any abnormal foetal parameter like BPD in hydrocephalus with placental thickness in USG in the gestational age estimation can be ventured into. In abnormal placental thickness for the corresponding gestational age, the diverse conditions which cause an increased or decreased placental thickness should be addressed. The regression equation can be used to calculate the gestational age from the other foetal parameters with minimal error.

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