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A prospective cross-sectional study to assess the correlation of placental thickness with gestational age and fetal weight among pregnant women

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***Abstract*---**Aim: The goal of the current study was to determine the average placenta thickness and foetus weight for each group of gestational age, as well as the relationship between placenta thickness and foetus weight for pregnant Indian women of various gestational ages. Methods: 202 pregnant women were included as study subjects in the current study utilising a convenient sample technique. The antenatal women underwent an ultrasound examination to measure placental thickness, gestational age, and fetus weight. The correlation between the gestational age in weeks, placental thickness in cm, and

foetal weight in gram was determined using the Pearson's Correlation (r value). Statistical significance was defined as a P value of 0.05 or lower. Results: The mean placental thickness increased significantly from first follow up (1.61±0.26 cms) to second follow up (2.62±0.07 cms) and third follow up visit (3.35±0.26 cms). The mean placental thickness increased significantly from first follow up (1.61±0.26 cms) to second follow up (2.62±0.07 cms) and third follow up visit (3.350±0.26 cms). The estimated gestational age (11–20 weeks) had a 79.9% variability (R^2) based on placental thickness (mm). Conclusion: Our research revealed a linear relationship between gestational age and mean placental thickness. We have observed that placental development initially outpaces increasing gestational age up to 18 weeks. After that, it nearly reached the gestational age at 32 weeks. Placental thickness lags behind gestational age beyond that point, or 32 weeks, which is due to the placenta's lower blood supply close to term.

***Keywords*---**gestational age, fetal weight, placenta thickness, pregnant women, pearson‘s correlation.

Introduction

The size of the placenta, which is primarily an organ of the foetus, is a reflection of the fetus's health and size. A common ultrasonographic criterion for evaluating the placenta is placental size. Although volumetric measurement is too difficult and time-consuming for practical use, total placental volume is likely the most accurate estimate of placental size [1]. It is well recognised that abnormal placental thickness can serve as a diagnostic indicator for a variety of pathologic occurrences. Management of at-risk foetuses can benefit from research on placental thickness [2]. Previous research established the placental thickness's significance in determining gestational age. Placental thickness measurements can be used to distinguish between normal and abnormal pregnancies [3]. By examining the measures of the foetus, such as the femur length, head circumference (HC), biparietal diameter (BPD), and abdominal circumference (AC), ultrasonography (USG) can be used to estimate gestational age (FL). Because it depends on the technical expertise of the observers, an ultrasonogram is vulnerable to observer bias. The accuracy of the estimated gestational age may also be affected by the foetal factors, various measurement methods, and positioning issues [2].

Studies revealed that in foetuses with an early membrane rupture, the biparietal diameter was unreliable. There have been noted shortcomings in the aforementioned parameters for calculating gestational age [3]. Therefore, a different parameter is required in order to estimate the gestational age with the least amount of inaccuracy. According to Nyberg et al., the placental thickness and gestational age are correlated [4]. Magnetic resonance imaging (MRI) and ultrasound are medical imaging modalities that can be used to estimate foetal weight, with ultrasonography being the more common modality. Estimates of foetal weight are crucial since birth weight is a major factor in a significant share

of perinatal mortality. Fetal weight estimates and measurements of placental size are both possible with the aid of obstetric ultrasonography. In fact, among the conceivable underlying mechanisms that could cause intrauterine growth limitation, placental illness has been demonstrated to be the most clinically important [5].

The health of the foetus is directly correlated with placenta thickness, which may have a significant role in perinatal outcome prediction. Large placentas are linked to severe anaemia, intrauterine foetal infections, maternal diabetes mellitus, and infant hemolytic illness [6,7]. Severe diabetic mellitus, preeclampsia, recurrent foetal infections, chromosomal abnormalities, and intrauterine growth limitation are all linked to small placentas [6,8,9]. The goal of the current study was to determine the average placenta thickness and foetus weight for each group of gestational age, as well as the relationship between placenta thickness and foetus weight for pregnant Indian women of various gestational ages. Additionally, the current study's goal is to establish whether placental thickness may be utilised as an alternative measure to estimate foetal weight and gestational age when regular foetal biometry cannot be performed.

Materials and Methods

Between July 22, 2021, and July 22, 2022, the Department of Anatomy at Santosh Medical College and Hospital in Ghaziabad, Uttar Pradesh, India, worked with the Departments of Radiology and Obstetrics & Gynecology on this prospective cross-sectional study. The institutional ethical and review committee provided the ethical approval. The pregnant women with gestational ages between 11 and 20 weeks who were referred by the Obstetrics and Gynecology department to the Radiology department for routine prenatal ultrasonography were included in the study. The study excluded women who were pregnant and had irregular menstrual cycles, thyroid disease, multiple pregnancies, gestational diabetes, placental abnormalities, hypertension, placenta previa, anaemia, and poor placental visualisation.

The study subjects were enrolled using a convenient sampling technique, and during the first five months, ANC subjects with gestational ages between 11 and 20 weeks were considered as the study subjects. They were then monitored (during the intervals between 21 and 30 weeks and 31 and 40 weeks) during routine ANC check-ups. In total, 254 participants aged 11 to 20 weeks were enrolled; however, only 202 of them underwent the three planned follow-ups, and 52 were lost to follow over the course of the trial.

After taking a thorough medical history, the antenatal women underwent an ultrasound examination using a GE Voluson E6 ultrasound machine with a convex probe and a 3-5 Mhz frequency array transducer to measure placental thickness, gestational age, and foetus weight. The subjects were scanned in the supine posture with a moderately distended bladder (Figure 1). Following the coupling agent application, the transducer was positioned on the skin's surface. At the point where the cord was inserted, the placental thickness in cm was measured. Due to the fact that a tangential scan would have affected the measurement of placenta thickness, the transducer was positioned to scan

perpendicular to both the chorionic and basal plates. All measurements of the placenta were made when the uterus was relaxed because contractions can artificially increase the thickness of the placenta.

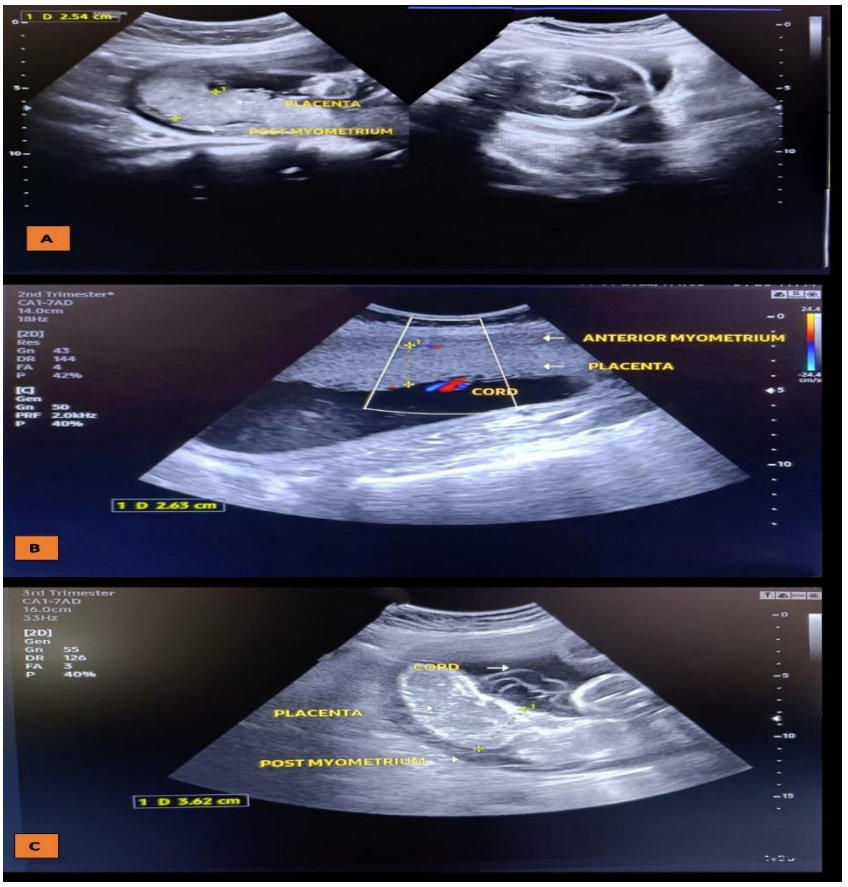

Figure 1. Sonogram at various gestational age. A: Sonogram showing placenta for 11-20 weeks gestational age (Placenta thickness=2.54 cm, Gestational age=19 weeks and 5 days; and weight of fetus=314 gm). B: Sonogram showing placenta for 21-30 weeks gestational age (Placenta thickness=2.63 cm, Gestational age=23 weeks and 6 days; and weight of fetus=642 gm). C: Sonogram showing placenta for 31-40 weeks gestational age (Placenta thickness=3.62 cm, Gestational age=35 weeks and 2 days; and weight of fetus=2460 gm).

Statistical Analysis

The data was analysed using the SPSS 26.0 version software. The data was presented using univariate and bivariate tables. The correlation between the gestational age in weeks, placental thickness in cm, and foetal weight in gram was determined using the Pearson's Correlation (r value). For the gestational age in weeks, placental thickness in cm, and foetal weight in gram, three gestational age groups (11-20 weeks, 21-30 weeks, and 31-40 weeks) were compared using analysis of variance (ANOVA). For gestational ages between 11 and 20 weeks, 21 to 30 weeks, and 31 to 40 weeks, a correlation between

gestational age and placenta thickness and gestational age and estimated birth weight was calculated independently. On the scattered diagrams, the relevant data was shown, and a straight line was used to represent the best fit or trend. Statistical significance was defined as a P value of 0.05 or lower.

Results

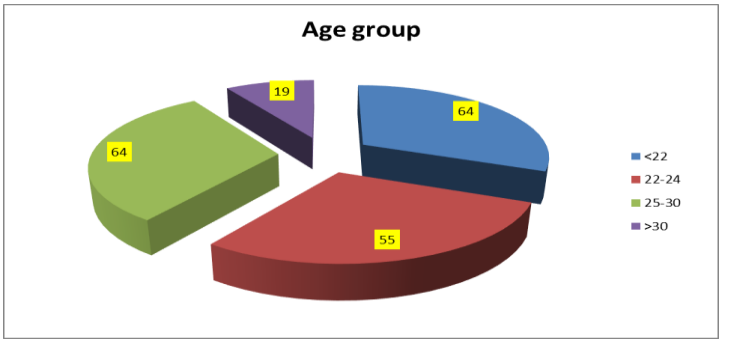

Figure 2. Maternal age groups (in years) of the respondents (N=202)

Figure 2 depicts the respondents' percentage distribution by age. The majority of participants (31.6 percent, 64/202) were under 22 years old, and a similar percentage was seen among participants in the 25–30 age range (31.6 percent, 64/202). The mean gestational age during first follows up at 11-20 weeks for the subjects was 16.58±2.20 weeks and during follow up visits means gestational age was 24.49±3.01 weeks at 21-30 weeks and 35.12±2.33 weeks at 31-40 weeks during 3rd follow up visit. The mean placental thickness increased significantly from first follow up (1.61±0.26 cms) to second follow up (2.62±0.07 cms) and third follow up visit (3.35±0.26 cms). The mean placental thickness increased significantly from first follow up (1.61±0.26 cms) to second follow up (2.62±0.07 cms) and third follow up visit (3.350±0.26 cms). The mean fetus weight increased significantly from first follow up (169.05±83.93 gms) to second follow up (875.93±405.47 gms) and third follow up visit (2674.33±482.31 gms) (Table1).

Table 1. Descriptive statistics of fetal measurement and gestational ages of the respondents (n=202)

Variable	Gestational age group	Minimum	Maximum	Mean	SD
Gestation age (weeks)*	11-20 weeks	12.14	21.00	16.58	2.20
	21-30 weeks	20.14	30.43	24.49	3.01
	31-40 weeks	30.57	40.50	35.12	2.33
Placenta thickness (cms)*	11-20 weeks	1.20	2.45	1.61	0.26
	21-30 weeks	2.00	3.50	2.62	0.07
	31-40 weeks	2.92	3.80	3.35	0.26
Fetus weight (grams)*	11-20 weeks	54.00	412.00	169.05	83.93
	21-30 weeks	357.00	1723.00	875.93	405.47
	31-40 weeks	1655.00	4101.00	2674.33	482.31

*ANOVA analysis was statistically significant

A very significant association (r=0.894) was found between gestational age and placenta thickness in the Pearson correlation analysis of participants between 11 and 20 weeks of gestation. Similar to this, a very significant correlation (r=0.971) was found between gestational age and foetus weight. Additionally, a highly significant correlation (r=0.882) between foetus weight and placenta thickness was found (Table 2).

Table 2. Correlation between Gestational age, thickness of Placenta and weight of fetus [11-20 weeks] (N=202)

Gestational age (11-20 weeks)		Gestational age	Thickness of Placenta	Weight of fetus
Gestation age	Pearson Correlation	1	0.894*	0.971*
	Sig. (2-tailed)		0.000	0.000
Thickness of Placenta	Pearson Correlation	0.894*	1	0.882*
	Sig. (2-tailed)	0.000		0.000
Weight of fetus	Pearson Correlation	0.971*	0.882*	1
	Sig. (2-tailed)	0.000	0.000	

* Correlation is significant at the 0.01 level (2-tailed).

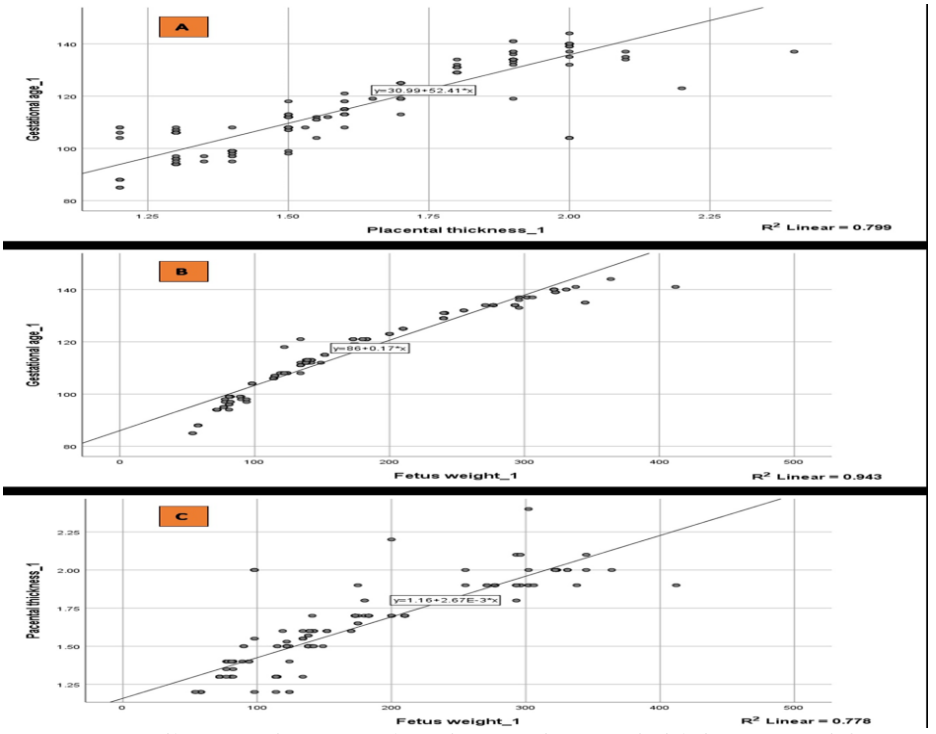

Figure 3. Scatter diagram for gestational age, placental thickness and fetus weight at 11-20 weeks. A: Scatter plot between gestational Age on Y-axis and thickness of placenta on X -axis. B: Scatter plot between gestational Age on Y-axis and fetus weight on X -axis. C: Scatter plot between placental thickness on Y-axis and fetus weight on X -axis

The estimated gestational age (11–20 weeks) had a 79.9% variability (R^2) based on placental thickness (mm). The value of beta 1 was 52.41, indicating that a change in placental thickness of 1 cm will result in a change in gestational age of 52.41 days (Figure 3). A very significant association (r=0.760) was found between gestational age and placenta thickness in the Pearson correlation analysis of participants between 21 and 30 weeks of gestation. Similar to this, a very significant correlation (r=0.967) was found between gestational age and foetus weight. Additionally, a highly significant correlation (r=0.773) between foetus weight and placenta thickness was found (Table 3).

Table 3. Correlation between Gestational age, thickness of Placenta and weight of fetus [21-30 weeks] (N=202)

Gestational Age (21-30 weeks)		Gestational age	Thickness of Placenta	Weight of fetus
Gestation age	Pearson Correlation	1	0.760*	0.967*
	Sig. (2-tailed)		0.000	0.000
Thickness of Placenta	Pearson Correlation	0.760*	1	0.773*
	Sig. (2-tailed)	0.000		0.000
Weight of fetus	Pearson Correlation	0.976*	0.773*	1
	Sig. (2-tailed)	0.000	0.000	

* Correlation is significant at the 0.01 level (2-tailed).

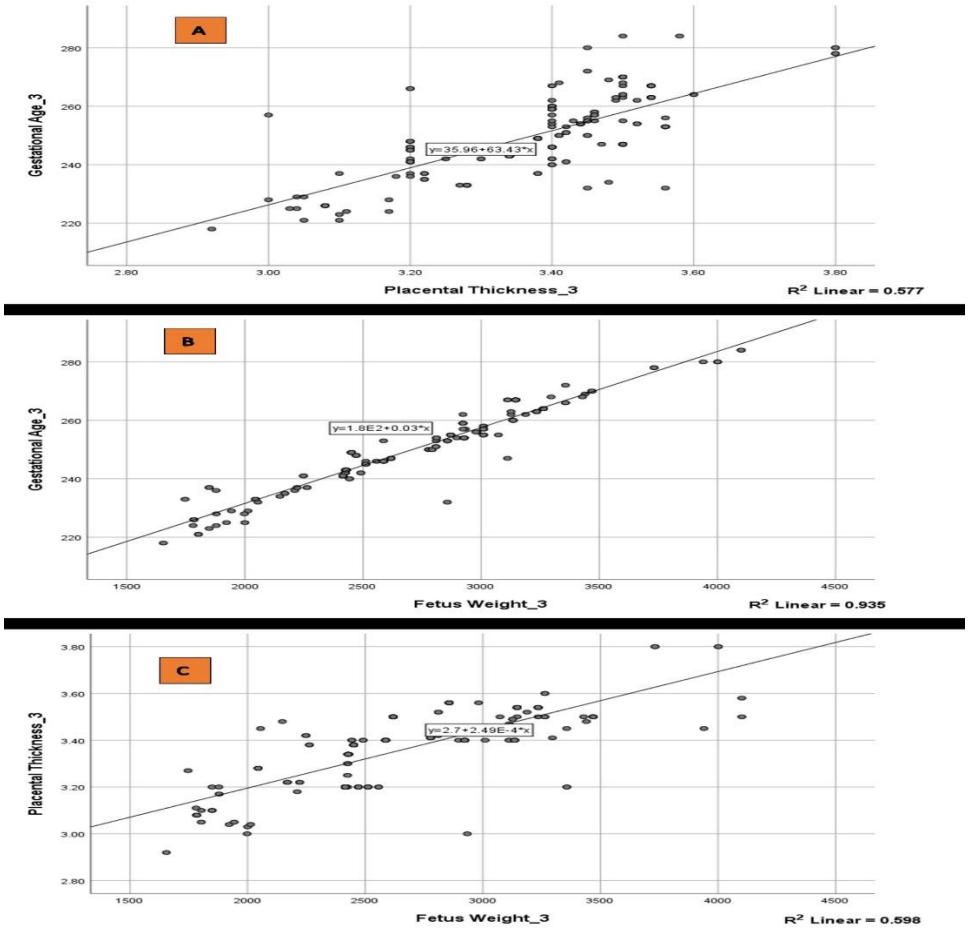

Figure 4. Scatter diagram for gestational age, placental thickness and fetus weight at 21-30 weeks. A: Scatter plot between gestational Age on Y-axis and thickness of placenta on X -axis. B: Scatter plot between gestational Age on Y-axis and fetus weight on X -axis. C: Scatter plot between placental thickness on Y-axis and fetus weight on X -axis.

The assessment of gestational age (21–30 weeks) by placental thickness (mm) has a 42.6% variability (R^2). The value of beta 1 was 58.46, indicating that a change in placental thickness of 1 cm will result in a change in gestational age of 58.46 days (Figure 4). A very significant association (r=0.746) was found between gestational age and placenta thickness in the Pearson correlation analysis of participants between 31 and 40 weeks of gestation. Similar to this, a very significant correlation (r=0.965) was found between gestational age and foetus weight. Additionally, a highly significant correlation (r=0.759) between foetus weight and placenta thickness was found (Table 4).

Table 4. Correlation between Gestational age, thickness of Placenta and weight of fetus [31-40 weeks] (N=202)

Gestational Age (31-40 weeks)		Gestational age	Thickness of Placenta	Weight of fetus
Gestation age	Pearson Correlation	1	0.746*	0.965*
	Sig. (2-tailed)		0.000	0.000
Thickness of Placenta	Pearson Correlation	0.746*	1	0.759*
	Sig. (2-tailed)	0.000		0.000
Weight of fetus	Pearson Correlation	0.965*	0.759*	1
	Sig. (2-tailed)	0.000	0.000	

* Correlation is significant at the 0.01 level (2-tailed).

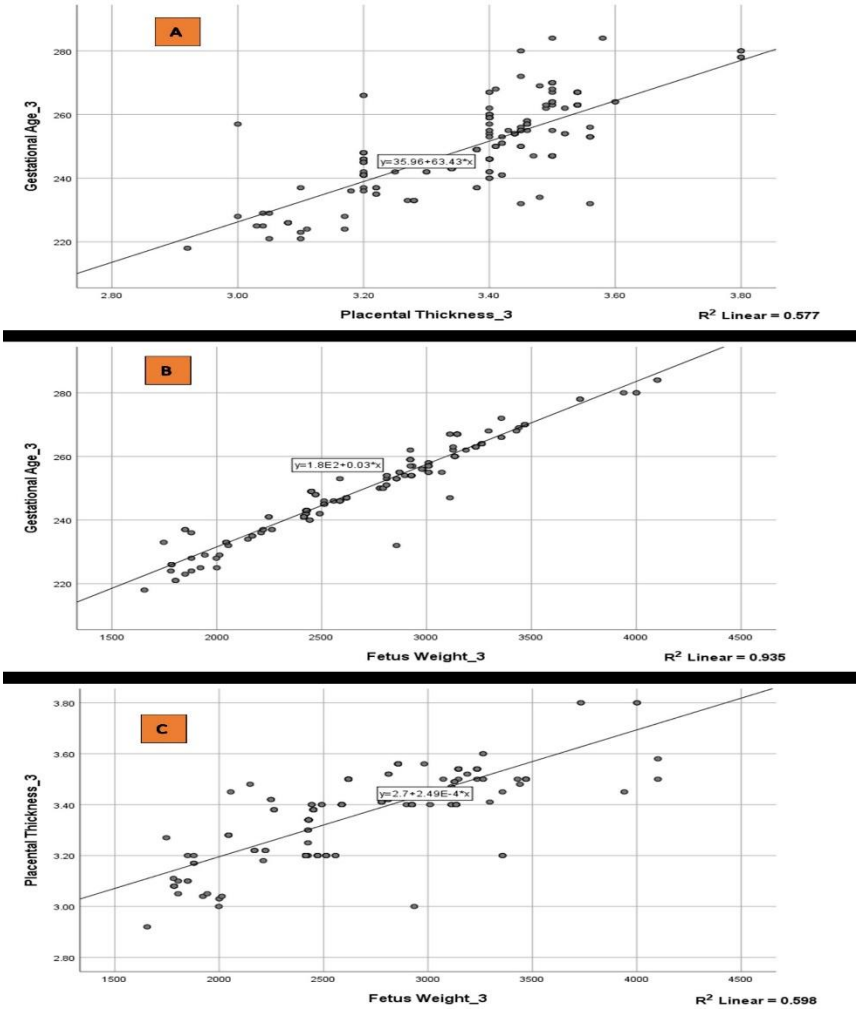

Figure 5. Scatter diagram for gestational age, placental thickness and fetus weight at 31-40 weeks. A: Scatter plot between gestational Age on Y-axis and thickness of placenta on X -axis. B: Scatter plot between gestational Age on Y-axis and fetus

weight on X -axis. C: Scatter plot between placental thickness on Y-axis and fetus weight on X -axis.

The estimated gestational age (31–40 weeks) had a 57.7% variability (R^2) based on placental thickness (mm). The value of beta 1 was 63.43, indicating that a change in placental thickness of 1 cm will result in a change in gestational age of 63.43 days (Figure 5).

Discussion

Our investigation revealed a linear relationship between the mean placental thickness and gestational age from 11 to 40 weeks, with an increase in placental thickness proportional to advancing gestational age. A comparable study by Ohagwu C et al. among pregnant women in Nigeria sought to determine the relationship between placental thickness and gestational age. They found a fairly linear connection between placental thickness and gestational age [10]. Even though the association was linear, the gestational age and placental thickness did not coincide until weeks 10 and 11. The mean placental thicknesses at other gestations were greater than the gestational age. Benirschke et al. explain it to be the racial difference between Nigerian women and others and advise that placentas greater than 40 mm thick have an association with intrauterine infections, foetal hydrops, and maternal diabetes mellitus, has to be considered with care in Negroes [7].

Donald et al., Kobayashi et al., and Gottesfield et al. presented the first reports of research for placental localisation by ultrasound examination [11,12,13]. The placental thickness in millimetres and the gestational age in weeks are correlated, according to Nyberg et al. [4]. A direct correlation between the values of mean placental thickness (in mm) and gestational age (in weeks) was also discovered by Mital et al. They also discovered that the placenta thickness (in mm) matches almost identically with the gestational age (in weeks), and they advise further research be done to establish this new parameter in calculating gestational age or to confirm the foetal age using this parameter [14].

Similar research by Anupama et al. revealed that placental thickness might be used to calculate the foetus' gestational age [15]. In the Sudanese study by Ahmed A et al., a substantial positive association between placental thickness and gestational age was found [16], and this relationship between gestational age and placenta thickness was also noted in our study ($r>0.7$). In our investigation, the mean placental thickness rose with gestational age, from 1.61±0.26 cm at 11-20 weeks to 3.35±0.26 cm at 31-40 weeks, which nearly mirrored the findings of Dudley et al., who found that placental thickness grew from 15 mm at 11 weeks to 37.5 mm at 39 weeks [17]. The placental thickness increased gradually from a mean value of 20 mm at 16 weeks of gestation to 30 mm at 28 weeks in a research of a similar nature done by Jauniaux et al. [18].

The highest placental thickness of 45.1±6.4mm was measured in Nigeria for another study by Ohagwu et al., at 39 weeks of gestation [10]. The racial differences among the women may be the cause of the increased placental thickness value. In a study by Abu et al., [19], it was shown that there were

significant positive associations between placental thickness and estimated foetal weight in the second and third trimesters (p less than 0.05) in a non-IUGR group. Damodaram et al. found a link between placental volume growth and gestational age, although this correlation was diminished in the foetuses with growth restrictions [20]. Because subnormal placental thickness for a gestational age may be the early sign of foetal growth retardation, this link between placental thickness and growth metrics is useful. Jauniaux et al. and Dombrowski et al. established a correlation between an increase in placental thickness and hypertensive problems of pregnancy and/ or subsequent sluggish foetal growth, around mid-gestation [18,21]. According to Ko et al., a second trimester increase in placental thickness is a highly sensitive indicator of the development of foetal hydrops associated with alpha-thalassemia in high-risk groups [22].

These findings highlight the need of evaluating placental thickness during routine ultrasonography to monitor foetal health and detect emerging disease early. As soon as foetal pathology is identified, a decision regarding prompt intervention or termination is made taking into account foetal maturity. In order to ensure safe motherhood, management guidance is provided by precise knowledge of gestational age and maturity evaluation. Given its significance as a feto-maternal component and accessibility, placental thickness can be used as a diagnostic to detect maternal and foetal problems before they manifest clinically. As a reference, our study derives a nomogram for placental thickness. As any deviation in thickness at any gestation will serve as a sign to subject the women to more investigations and level 2/3 scans, it will serve as a screening tool. Other placental characteristics and their patterns with growing gestational age will help with obstetric and foetal care as well as ensure safe maternal and neonatal outcomes as placentography advances.

Conclusion

Our research revealed a linear relationship between gestational age and mean placental thickness. We have observed that placental development initially outpaces rising gestational age up to 18 weeks. The placental thickness was 0.2–0.3 cm higher. After that, it nearly reached the gestational age at 32 weeks. Placental thickness falls behind gestational age beyond that point, or 32 weeks, which is due to the placenta's lower blood supply close to term. Placental thickness' percentage fluctuation was comparable to that of other sonographic markers in determining gestational age.

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