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Correlation between Late Second and Third Trimester Placental Thickness Detected by Ultrasound and Gestational Age in Normal and IUGR Pregnancies

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Ultrasonography has played a significant part in obstetric care. This has progressed from basic 2-D imaging to Doppler imaging to monitor foetal and maternal circulation, as well as 3-D imaging of foetal anatomy ..(Obstetrical ultrasound has proven crucial in a variety of ways, two in particular being more accurate pregnancy dating and detection of fetal anomalies. The aim of this study is determine to Correlation between late second and third trimester placental thickness detected by ultrasound and gestational age in normal and IUGR pregnancies.
Methods: This study was a prospective study that was conducted on100 pregnant women who attended the outpatient clinics or admitted at inpatients wards of Obstetrics and Gynecology department, Tanta University during the period from December 2019 to December 2020.
Results In the majority of gestational age groups, the mean placental thickness was lower in group I than that detected in group II ($P<0.01$) except that detected between 28 and 29 weeks and 29 and 30 weeks, where there was no significant difference between two studied groups regarding placental thickness ($P>0.05$). In addition, the present study indicated that 26 out of 50 (52%) of newborns in group I had a birth weight below the fifth percentile and 24% of them had a birth weight ranged between 5 th -10 th percentile for gestational age and sex at the time of birth whereas all newborns of group II had a birth weight >10th percentile for gestational age and sex. A

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comparison of neonates' birth characteristics and outcomes between two groups showed a statistically significant difference in the birth weight among both studied groups
Conclusions: The mean placental thickness was steadily increased with increased gestational age both IUGR and normal fetal weight cases. in addition, In the majority of gestational age groups, the mean placental thickness was lower in IUGR than that their normal weight conterparts .

Keywords: Trimester; placental thickness; ultrasound; IUGR pregnancies.

1. INTRODUCTION

Ultrasonography has played a significant part in obstetric care. Over time, this has progressed from basic 2-D imaging to Doppler imaging to measure foetal and maternal circulation, and finally to 3-D imaging of foetal anatomy [1].

Obstetric ultrasound has proven useful in a variety of ways, the most important of which are more accurate pregnancy dating and the detection of foetal anomalies [2]. Several studies have shown that an estimated gestational age determined sonographically was more accurate than one based on the last menstrual period. Accurate dating can also change how a pregnancy is terminated. Various formulas and nomograms are used to accurately determine gestational age and characterise typical foetal structural growth [3].

The performance and interpretation of fetal biometry was an important component of obstetric ultrasound practice. Serial sonographic assessment of fetal size over time can provide useful information about growth, with the possibility of improving the prediction of small for gestational age (SGA) infants, particularly those at risk for morbidity. However, errors and approximations that may occur at each step of such a process greatly impede the ability to detect abnormal growth, and most importantly fetal growth restriction (FGR) [4].

The impairment of foetal growth has gained prominence in recent years. A growing body of evidence suggested that long-term health outcomes could still be managed during pregnancy. Fetal growth restriction (FGR; or intrauterine growth restriction, IUGR), which occurs when a foetus does not reach its "optimal" growth potential, may be the underlying condition of future epidemiological burden of noncommunicable chronic diseases (NCDs) [5]. Therefore, Early detection of intrauterine growth restriction (IUGR) was of core importance for maternal and child health [6].

Despite careful antenatal surveillance involving scrupulous examination, an issue of considerable disappointment is that a majority of low birth weight infants are not diagnosed until delivery [2].

Fetal dimensions like the Biparietal Diameter (BPD), the Abdominal Circumference (AC), the Head Circumference (HC) and the Femur Length (FL) are prone to observer bias, as it depends on the observers' technical skills. Also, the positional problems may diminish the accuracy of the gestational age estimation. Thus, there are some drawbacks in those above said parameters in estimating the gestational age. Accordingly, there is a need of another parameter for supplementing the gestational age estimation with minimal error [7].

Placental thickness appears to be a promising parameter for estimation of gestational age of the fetus because of increase in placental thickness with gestational age [8].

Placental thickness is very much related to fetal development and may be a key in perinatal outcome. At term placenta is approximately 3 cm thick and measures 15-25 cm in diameter. A 'warning limit' of placental diameter of 18 cm and placental thickness of 2 cm at 36 weeks predicts low birth weight neonates [9].

Small placentas are associated with preeclampsia, chromosomal abnormalities, severe maternal diabetes mellitus, chronicfetal infections and intrauterine growth restriction he placentas over 4 cm thick at term have been observed in conditions like diabetes mellitus, perinatal infections, hydrops fetalis (both immune & non immune) [10].

The aim of this study is determine Correlation between late second and third trimester placental thickness detected by ultrasound and gestational age in normal and IUGR pregnancies.

2. PATIENTS AND METHODS

This study was a prospective study that was conducted on100 pregnant women who attended the outpatient clinics or admitted at inpatients

wards of Obstetrics and Gynecology department, Tanta University during the period from December 2019 to December 2020.

2.1 Inclusion Criteria

Pregnant women (≥24 weaks of gestation),
With singleton pregnancy,
Who are attended the outpatient department admitted as inpatients.

2.2 Exclusion Criteria

- Diabetes mellitus.
- Fetal hydrops.
- Fetal congenital anomalies.
- Intrauterine fetal death.
- Preterm labour.

All patients were subjected to the following:

2.3 Methods

Then Cases fulfilling the inclusion criteria which were included in this study subjected at admission to the following:

Complete history was taken with special emphasis on:

- Personal history.
- Menstrual history, date of last menstrual period (LMP) for confirming of gestational age.
- Past history for Diabetes Mellitus, hypertension, cardiac problems, bleeding tendency, blood disease, bronchial asthma, allergy …..etc.
- Previous operations (especially previous uterine scar as cesarean scar).
- Past obstetric history: especially details of previous pregnancies (Date, outcome, onset& mode of delivery, gestational age at delivery and any associated complication).
- History of drug intake.
- Patient complaint.
- History of the current pregnancy and history of satisfaction of fetal kicks were asked about as a method to estimate fetal wellbeing.

Then clinical examinations were done including:

- General examination especially :
  - - Measurement of weight, height and body mass index (BMI) using the formula: BMI= weight (kg) / [height (m)]2 .
  - Assessment of vital signs (body temperature, pulse and blood pressure) to assess the hemodynamic status.
- Cardiac and chest examination.
- Abdominal examination was done: (fundal level, lie and presentation of the fetus, auscultation of fetal heart rate (FHR), presence of scar of previous laparotomy).

2.4 Ultrasound Examination

The Equipment:

The ultrasound equipment used was (MINDRAY DC-30, China) using a 3.5- 5-MHz transabdominal at the ultrasound unit of the Obstetrics and Gynecology department at Tanta University Hospitals, Egypt.

All cases underwent for:

Transabdominal ultrasound examination at admission for assessment of:

Gross anatomical defects
Fetal viability
Fetal biometry [biparietal diameter (BPD) - femur length (FL) - abdominal circumference (AC)]:

2.5 Method of Estimation

The BPD was calculated as the distance between the outer edge of the cranium nearest to the transducer and the inner edge of the cranium distal to the transducer at the level of the paired hypoechoic thalami and cavum septum pellucidum. The HC was measured using the elliptical calipers over the four points of BPD and occipital frontal diameter in the same plane as BPD, between the leading edge of the frontal bone and the outer edge of the occiput. The AC was measured as the length of the outer perimeter of fetal abdomen at the level of umbilical vein junction with the portal vein in a transverse plane perpendicular to the spine, and the FL was measured as the length of the ossified diaphysis of the fetal femur from the greater trochanter to the femoral condyles. The

mean of three different values for each measurement was recorded.

Follow up of placental thickness every (4-6ws) till delivery was done.

2.6 Fetal Outcome

Findings were correlated by neonatal weight.

Thus, cases were categorized into 2 groups:

Group A: (birth weight less than 2500 gm).
Group B: (birth weight more than 2500 gm)

2.7 Statistical Analysis

In the present study, statistical analyses of data were carried out using SPSS version 23. Shapiro –Wilks test was used to test normal distribution of variables. Numerical data were expressed as mean ± standard deviation or median and range. Categorical data were summarized as percentages. The significance for the difference between groups was determined by using two-tailed Student's t test and one way ANOVA (analysis of variance) test or for quantitative data as appropriate. Also Qualitative variables were assessed by chi-squared χ2test.

- Probability (P-value)

- P-value >0.05 was considered insignificant.
- *P-value <0.05 was considered significant.
- **P-value <0.001 was considered as highly significant.

Moreover, correlations between placental thickness and various outcome was evaluated using Pearson and spearman's correlation coefficient as appropriate.

3. RESULTS

This study was carried out on 100 pregnant women who attended the outpatient clinics or the inpatients wards at Obstetrics and Gynecology department, Tanta University Hospital from December 2019 to December 2020.

All women had a singleton pregnancy with gestational age ≥24 weeks. The subjects were divided into 2 groups: Group I: 50 women had neonatal birth weight <2,500 g

Group II: 50 women had outcome fetal weight ≥2500 g

Table 1. The Demographic data of the studied cases

		Group I N=50	**Group II N=50**	**P-value**
Age (years)				
	Range	18 – 33	18 – 35	0.731
	Mean ± SD	24.94± 3.16	25.16 ± 3.22	
≤30 years	N	47	47	1
	%	94%	94%	
>30 years	N	3	3	
	%	6%	6%	
Parity				
0	N	12	13	0.983
	%	24%	26%	
1	N	18	18	
	%	36%	36%	
2	N	13	11	
	%	26%	22%	
3	N	6	7	
	%	12%	14%	
4	N	1	1	
	%	2%	2%	
Body mass index (BMI) (kg/m^2)				
	Range	19.1-33.02	18-32.2	0.363
	Mean ± SD	27.5±4.73	28.4±5.11	

It has been showed that 47 cases (94%) of each group had an age ≤30 years, whereas 3 (6%) had an age more than 30 years old. This results revealed that there is no difference in number of studied females with increased maternal age between both studied groups (P=1.000) (Table 1).

According to history of previous IUGR, Table 2 shows that 28 out of 50 cases (56%) in group I and 16 cases (32%) in group II had a growth-restricted fetus in a prior pregnancy. There was significant difference between both studied groups [P=0.001] regarding the history of previous IUGR (Fig. 1)

The results showed that ten mothers (20%) in group I developed pregnancy induced hypertension while all women in group II had normal blood pressure (Fig. 2).

This table shows the number of cases with their mean estimated placental thickness at each gestational week in both studied groups. The mean placental thickness was steadily increased with increased gestational age in the 2 groups.

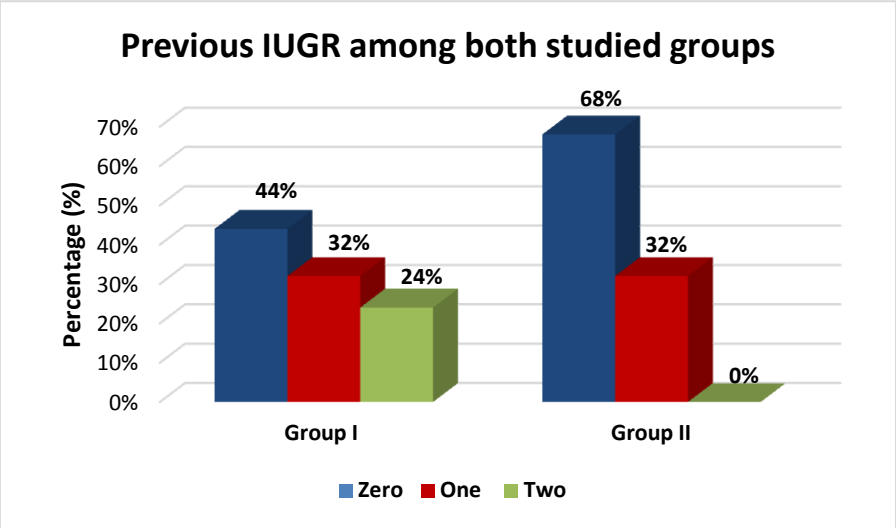

Fig. 1. History of previous IUGR in group I and group II

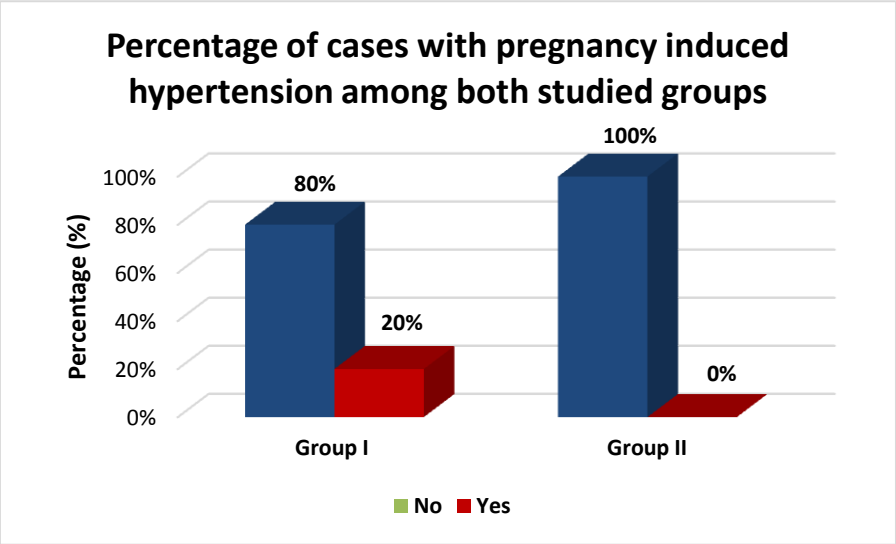

Fig. 2. Percentages of hypertensive patients among group I and group II

Table 2. The mean placental thickness in both groups according to the gestational age

USG gestational age (weeks group)	Group I	Mean placental thickness (cm)	Group II	Mean placental thickness (cm)	P-value
24-25 weeks	3	2.32±0.07	4	2.58±0.07	0.006**
25–26 weeks	6	2.47±0.1	8	2.89±0.08	<0.001**
26–27 weeks	6	2.76±0.16	8	3.02±0.09	0.002**
27–28 weeks	10	2.9±0.12	10	3.14±0.05	<0.001**
28–29 weeks	13	2.89±0.15	13	2.99±0.15	0.120
29–30 weeks	3	2.86±0.05	4	3.00±0.09	0.056
31–32 weeks	10	3.17±0.09	17	3.34±0.09	<0.001**
32–33 weeks	14	3.23±0.11	14	3.42±0.05	<0.001**
33–34 weeks	13	3.33±0.04	8	3.46±0.05	<0.001**
34–35 weeks	28	3.42±0.06	28	3.52±0.05	<0.001**
35–36 weeks	26	3.55±0.05	25	3.65±0.07	<0.001**
36–37 weeks	16	3.74±0.06	22	3.92±0.09	<0.001**
37–38 weeks	8	3.84±0.04	14	4.01±0.06	<0.001**
38–39 weeks	2	4.01±0.04	6	4.17±0.05	0.006**

**: statistically significant P value (P≤0.05)*

Table 3. Comparison between group I and group II regarding gestational age at delivery

		Group I N=50			Group II N=50			P-value
Gestational age at delivery (weeks)	Range	32	–	39	33	–	39	0.177
	Mean ± S. D	35.84	±	1.65	36.32	±	1.88	

Table 4. Distribution of birth weight (percentile) in group I and group II

Birth weight		Group I (N= 50)	Group II (N= 50)	Total
<5th percentile	N	26	0	26
	%	52%	0%	26%
5-10 percentile	N	12	0	12
	%	24%	0%	12%
>10 percentile	N	12	50	62
	%	24%	100%	62%
P-value		<0.001*		

**: statistically significant P value (P≤0.05)*

In the majority of gestational age groups, the mean placental thickness was lower in group I than that detected in group II (P<0.01) except that detected between 28 and 29 weeks and 29 and 30 weeks, where there was no significant difference between two studied groups regarding placental thickness (P>0.05). Table 2.

Table 1 and Fig. 3 show that the mean gestational age at the time of delivery was (35.84±1.65 weeks) in group I while it was (36.32±1.88 weeks) in group II. These results revealed that there was no statistically significant difference in the mean gestational age between both studied groups (P =0.177) Table 3.

In addition, the present study indicated that 26 out of 50 (52%) of newborns in group I had a birth weight below the fifth percentile and 24% of them had a birth weight ranged between 5th-10th percentile for gestational age and sex at the time of birth whereas all newborns of group II had a birth weight >10th percentile for gestational age and sex. A comparison of neonates' birth characteristics and outcomes between two groups showed a statistically significant difference in the birth weight among both studied groups Table 4.

Table 5 shows the best cut-off points for prediction of low birth weight for all gestational age.

Table 5. Receiver-operating characteristic curve for detection of placental thickness in different gestational age with regard to low-birth weight

USG gestational age (weeks group)	Cutoff (cm)	Sensitivity	Specificity	PPV	NPV	Accuracy
24-25 weeks	2.45	100%	100%	100%	100%	100%
25–26 weeks	2.72	100%	100%	100%	100%	100%
26–27 weeks	2.87	83.3%	100%	100%	88.9%	92.9%
27–28 weeks	3.03	90%	100%	100%	90.9%	95%
28–29 weeks	2.92	69.2%	69.2%	69.2%	69.2%	69.2%
29–30 weeks	2.91	100%	100%	100%	100%	100%
30–32 weeks	3.26	90%	88.2%	81.8%	93.8%	88.9%
32–33 weeks	3.35	100%	92.9%	93.3%	100%	96.4%
33–34 weeks	3.39	92.3%	100%	100%	88.9%	95.2%
34–35 weeks	3.455	75%	92.9%	91.3%	78.8%	83.9%
35–36 weeks	3.585	76.9%	92%	90.9%	79.3%	84.3%
36–37 weeks	3.785	75%	100%	100%	84.6%	89.5%
37–38 weeks	3.93	100%	92.9%	88.9%	100%	95.45%
38–39 weeks	4.06	100%	100%	100%	100%	100%

CASES

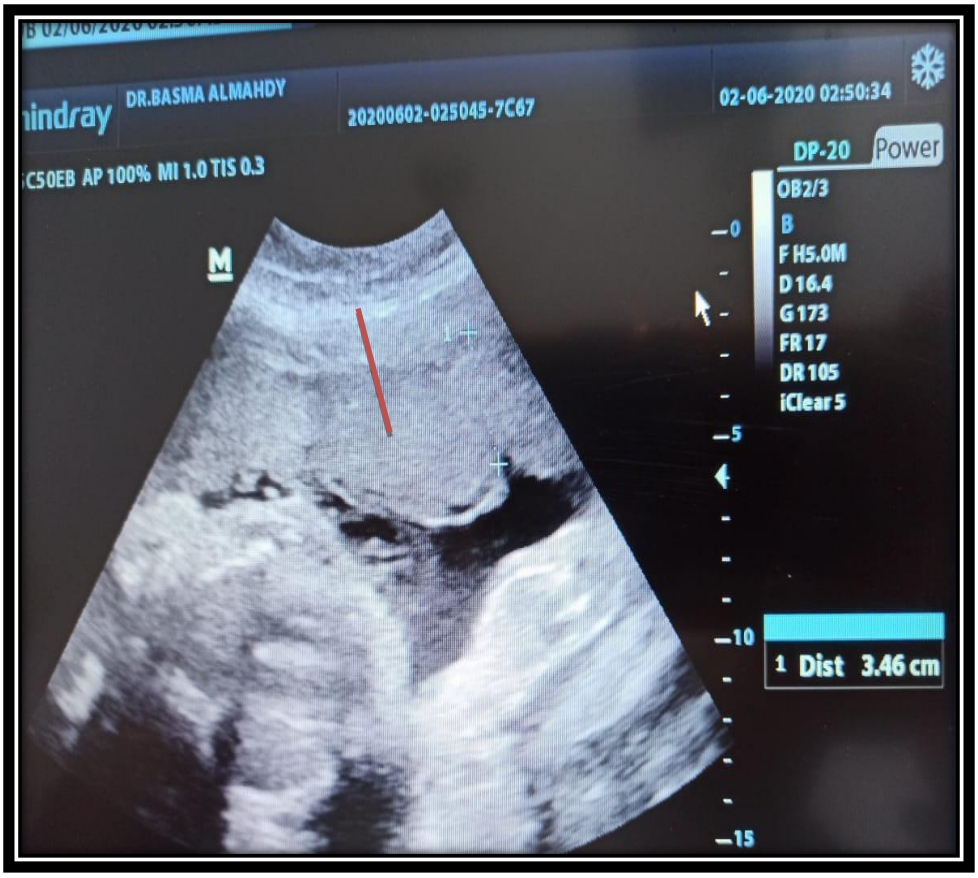

Fig. 3. This figure shows Placental thickness measurement that was 3.46cm at 34 week

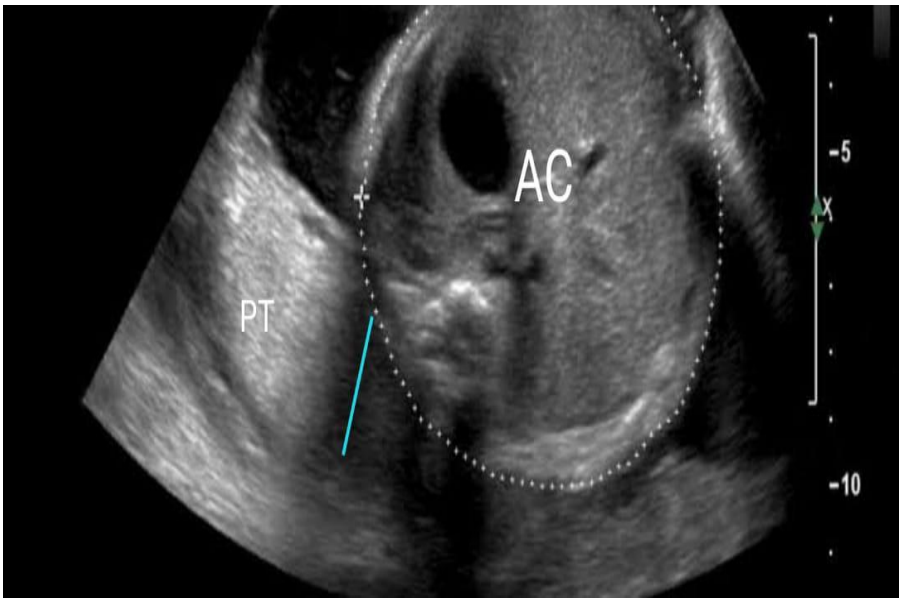

Fig. 4. This figure shows IUGR case.PT: Placental thickness, AC: abdominal circumference at 37 week

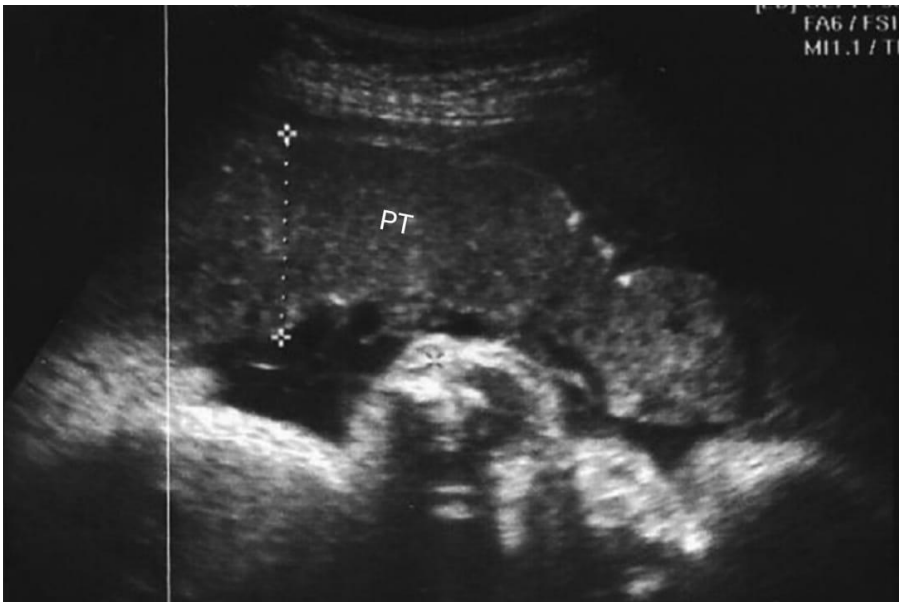

Fig. 5. This figure shows normal Placental thickness at full term fetus

4. DISCUSSION

An emerging body of literature indicates that abnormal fetal growth is associated with increased risk of perinatal morbidity and mortality. More specifically, intrauterine growth restriction (IUGR) is associated with chronic hypoxia and stress, leading to adverse endocrine axis reprogramming [11].

In light of that, the aim of this work was to study the correlation of placental thickness, measured at the level of the umbilical cord insertion, with the ultrasonographic gestational age in normal and IUGR pregnancies in the late second and third trimester .

In line to our reults , Abdelhamid et al. [12] who set pthier study to evaluate the correlation between placental thickness in the second and third trimesters with gestational age, weight, and fetal outcome. reported that the mean age of their included women was 28.4 years, and the mean BMI was 27.8 kg/m^2.

In addition, Hamdy and his co-workers, 2020 [13] who assessed the role of measurement of placental thickness and diameter in the third trimester using two-dimensional ultrasound for the determination of low birth weight also had thier patients divided into Group A (outcome fetal weight≤2500 g, n = 33) and Group B (fetal weight>2500 g, n = 376), they also reported that the mean age of group A&B cases was 25.9±2.6& 25.7±2.3 years in order with no statistically significant differences between both groups according to the mean age (P=0.513) and also regarding parity (p= 0.195).

Furthermore, Patole and his colleges in 2018 [14] in their work, who reported that 14% of the women were less than 20 years, 76% were between 21-30 years while 10% were more than 30 years.

Our results also were in agreement with similar study of Adeyekun & Ikubor, [15] as they reported that the mean age of their study subjects were 29.1 ± 4.9 years and the mean maternal weight was 71.4 ± 13.6 kg and mean height was 1.6 ± 0.5m.

Also in concordance to our reslts, Manandhar et al. [16] in assessing risk factors of IUGR on a total of 87 pregnant women suspected of having IUGR reported that maximum number of cases (38.3%) belonged to age group between 26 to 30 years followed by age group of 20-25 years. There were only 15(25%) cases of teenage pregnancy. Out of 60 cases, they reported that 45 (75%) of the patients were multigavida and mostly were in the group Gradiva 2 toGravida 3 (58.3%).

Nagpal et al. [17] found that, mean age of their study population was 23.1 ± 3.02 years. Majority of women were in age group of 19–23 years.

Sananpanichkul and Rujirabanjerd, [18] who tried to found the ssociation between maternal body mass index and weight gain with low birth weight in eastern Thailand on Two thousand twelve pregnant wom¬en found that the mean maternal age was 26.8 ± 7.1 years. Sixty-three point four percent of participants were multiparous.

Liu and his colleuges in 2019 [19] in their meta-analysis, thirty-four articles investigated the link between maternal BMI on infant birth weight. A total of 313,569 subjects were included in this meta-analysis. Fifteen studies evaluated the connection between maternal BMI and LBW. Using mothers with normal BMI as the reference category, they found that pre-pregnancy underweight increased the risk of LBW . No relationship was found between LBW infants and overweight/obese mothers aas reported by our results.

Moreover, on assessing risk actors of IUGR;, 28 out of 50 cases (56%) in group I and 16 cases (32%) in group II had a growth-restricted fetus in a prior pregnancy. History of prior IUGR had significantly more in LBW cases [P=0.001] . Added to that, ten mothers (20%) in patients group developed pregnancy induced hypertension while all women in control group had normal blood pressure.

Also in concordance to our reslts, Manandhar et al. [20] in assessing risk factors of IUGR on a total of 87 pregnant women reported that most significant Maternal risk factor observed was Hypertension complicating pregnancy in 7 (28%) in which 3 (42.85%) were because of severe preeclampsia and 2 (28.57%) were because of chronic HTN and gestational HTN one each. Previous history of IUGR was reported in in 3 (12%) cases.

Various maternal factors has been attributed for IUGR. Several studies had shown that women who had an IUGR infant in a previous pregnancy had an increased risk of delivering an IUGR infant in the next pregnancy. The rate of recurrence was believed to be nearly 20 percent [21].

Muhammad et al. [22] showed that Growth restriction in previous pregnancies was also identified as a risk factor in thier study (21%) compared to only 4. 5% in thier normal growth feti and also PIH was also found in 25% of SGA babiesversus only 6% in their normal ones .

Recurrent IUGR may be due to the persistence of unknown factors causing IUGR as reported by the literature [23].

A positive history for risk factors of IUGR can raise the problem of an increased surveillance with the specific goal of an early detection of growth insufficiency [24].

In singleton pregnancies, there is evidence to support that the 2 conditions stem from the failure of the developing extravillous trophoblast cells to invade the decidualized endometrium and properly remodel the uterine spiral arteries

from muscular into distended, thin-walled vessels. The inadequately modified spiral arteries can lead to high pressure flow and damage the placenta because of changes in pressure or oxygen delivery, which then leads to fetal growth restriction and preeclampsia [25]. Aberrations in placental function provide a primary clinical indicator that transfer of oxygen and nutrients is suboptimal, and fetal growth may be adversely affected [26]. In fact, biopsies of placental beds from patients with FGR and preeclampsia show similar changes [27]. Postdelivery pathologic examination of placentas also shows a strong correlation between preeclampsia and IUGR. This has led to the term "ischemic placental disease," which refers to a disease process of the placenta that manifests clinically as preeclampsia, IUGR, abruption, or a combination of these disorders [28].

As regard gestational age at delivery,the mean gestational age at the time of delivery in our research was lower (35.84±1.65 weeks) in group I than (36.32±1.88 weeks) in group II but without statistically significant difference (P =0.177). 78% of cases in group I and 60% of included cases in group II were delivered by caesarean section while the remaining 22% and 40% of cases in group I & II respectively were delivered via vaginal delivery with statistically significant different in between both studied groups (P= 0.05). urthermore, we noted that patients with previous caesarean delivery had overall very high rates of caesarean delivery (>50%) irrespective of IUGR status.

In agreement to or findings, amultitude of research work was present. In addition to the routine fetal biometry parameters, various studies were done trying to deduce a relationship between the placental thickness and gestational age and the estimated fetal weight (29). They reported that 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. Zeid et al., [30] reported a significant positive correlation is seen between placental thickness and the ultra sonographic gestational age. Placental thickness in their study ranged between 25.0 – 43.0 mm with a mean thickness of 36.03 ± 3.29 and a maximum placental thickness of 39.26 ± 5.69 mm at 40 weeks. That was nearly similar to our results.

This value is similar also to that of Ville and Bault, [31] in the United States who reported that normal placenta never exceeded 40 mm in thickness throughout pregnancy.

A slightly lower value of 37.5 mm at 39 weeks was reported by Ali, . This shows that race apparently has no influence on placenta measurements [32].

A fairly linear improve in mean placental thickness with gestational age was also noticed in correlation analysis studies carried out to determine the link between placental thickness and gestational age [33] they observed that the range for thickness of placenta measured between 12–41 weeks was 1.3–3.9 cm and the mean placental thickness was 2.748 cm.

According to Kakumanu et al. [34] the mean placental thickness increased with advancing gestational age, nearly matching from the 22nd to the 35th week and 27 to 33 weeks and significant positive correlations between placental thickness and estimated fetal weight in the second and third trimesters (p<0. 05) were found.

Krishna and Bhalerao, [35] reported . There was also a positive link between rising placental volume and increasing gestational age, although it was reduced in the growth-restricted fetuses. Emam and his colleuges in 2020 [36] showed that mean of Placental thickness 2nd trimester was 20.5±2.5 with range of [16.9-29.7], mean of placental thickness 3rd trimester was 30.27±2.1 with range of [27.3-55.1] cm. In their research, there was high significant relation between placental thickness second trimester and Fetal weight 2nd trimester, also there was high significant relation between placental thickness third trimester and fetal birth weight. They reported that, mean placental thickness was 24.5 mm at 24 weeks, 31.8 mm at 32 weeks and 35.5 mm at 36 weeks. So, their results were highly analogous to ours.

Our results were as well supported by study of Adeyekun & Ikubor [37] in 2015 as they reported that the mean values of placental thickness [PT] was 35.5 ± 7.0 mm. Nagpal et al. [38] reported that, at 32 and 36 weeks, mean placental thickness were 33.45 ± 1.62 and 35.7 ± 2.08 mm respectively. They demonstrated that, placental thickness < 3.0cm at 32 weeks and 3.1 cm at 36 weeks gestations were associated with low-birthweight babies and poor fetal outcome.

This was in agreement with most literature for example Visentin et al. [39] & Quinn et al. [40]

who declared that lower gestational age,lower birth weight,delivery by caesarean section were statistically significant risk factors for NICU admission.

From all of the above , the hypothesis that decreased placental size precedes the onset of IUGR, makes placental thickness abnormalities with the corresponding GA, one of the early warning signs for development of IUGR. Therefore, using two-dimensional (2D) ultrasound (US) for assessment of placental health and measurements could reflect the health and nutritional status of the fetus and could predict pregnancy outcome. Placental thickness is the simplest measure, reflecting placental size.

5. CONCLUSION

The mean placental thickness was steadily increased with increased gestational age both IUGR and normal fetal weight cases. in addition, In the majority of gestational age groups, the mean placental thickness was lower in IUGR than that their normal weight conterparts.

Thus, it can be used as asupplementary accurate sonographic indicator in gestational age assessment in singleton pregnancies owing to its linear correlation. especially in cases where LMP cannot be recalled and in detecting patients developing IUGR.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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