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Evaluation of fetal weight with respect to placental thickness and fetal doppler indices for detection of fetal growth curve

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Abstract

Introduction: Normal development of the placenta throughout pregnancy is critical for supporting a healthy fetus. Contrarily, any impairment in its development may have a profound impact on fetal development and pregnancy outcomes.

Aim of the study: The purpose of the study was to evaluate the correlation between Evaluation of Fetal Weight (EFW) and both placental thickness and fetal doppler indices in healthy pregnant ladies. It might be used as a tool for fetal weight estimation and fetal growth curve detection.

Subjects and Methods: This study was conducted in the obstetrics and gynecology department outpatient clinic at Fayoum University Hospital and involved 50 pregnant women from January 2020 to July 2021. Using an ultrasound device, the gestational age (GA) of the fetus and fetal weight were estimated. Doppler indices were estimated for the uterine and umbilical arteries, and the thickness of the placenta was measured.

Results: The mean value of placental thickness was 38.5 (17.4–68.8) mm, and the mean EFW was 1992.2 (83–3797) g. EFW and placental thickness showed a statistically significant positive connection ($P = 0.001$). The mean value of pulsatility index (PI) was 0.92 (0.42–1.76), and there was no significant correlation between EFW and uterine artery PI ($P = 0.95$). The mean value of PI was 0.95 (0.33–1.66), and there was a statistically significant weak negative correlation between PI and the umbilical artery.

Conclusions: From the results, we found that there was a significant correlation between EFW and placental thickness. But there was no significant correlation between EFW and uterine artery PI. A weak negative correlation was found between EFW and umbilical artery PI.

Keywords: Estimated Fetal Weight; Placental Thickness; Fetal Doppler Indices.

1. Introduction

Assessment of fetal weight and growth monitoring is a vital and universal part of antenatal care, labor management, and the management of high-risk pregnancies. Fetal ultrasonography is essential for evaluating these conditions [1].

Acceptable growth of the fetus and consequent normal birth weight depend on the efficiency of nutrients delivered from the mother to the fetus through a normal functioning utero-placental organ [2]. The first imaging modality of preference for placental assessment is ultrasound with

Doppler imaging [3]. Estimating the fetal weight is the most accurate way to calculate the fetal size. This may be approached in different ways using biometric characteristics [4].

It's essential to understand the difference between fetal size at a given point in time and fetal growth. The latter is a dynamic process that necessitates at least two time-distanced ultrasound scans for evaluation. In assessing fetal growth, both size and velocity (change in size over time) have been used. Although size is a more frequent definition of "growth," growth velocity is a more rational definition. Working with growth velocities, on the other hand, necessitates serial measurements, the determination of an acceptable scan interval, and a method for collecting velocity data over a wide range of fetal ages [5].

After birth, the kidneys, gastrointestinal tract, lungs, and other endocrine glands manage the placenta's physiological activities, which are critical for embryonic development [6]. The placenta is not passive, and it does not develop only according to its genes; rather, it appears to adapt and adjust in response to the demands of the fetus as well as the supply from the mother. It regulates blood flow via the stem villi with the arterial muscles on a local level, and on a global level, it generates increased placental resistance, which is observed by Doppler testing [7].

Placental thickness linearly increases with gestational age throughout a normal pregnancy. In situations of central or near-central cord insertion, accurate measurements should be taken in the midportion of the placenta near the umbilical cord insertion and must be taken perpendicular to the uterine wall from the sub-placental veins to the amniotic fluid while excluding the myometrium [8].

Actual fetal size gives an idea of previous placental function until that point in time. Doppler flows in the maternal (uterine) or fetal (umbilical and middle cerebral arteries) arteries allow for in-vivo monitoring of placental function through vascular resistance measurements. Doppler flow measures enable the noninvasive detection of fetal hemodynamic changes caused by oxygen deprivation as well as markers of placental insufficiency [9].

Uterine artery Doppler has been thought of as a possible screening tool for the development of pre-eclampsia, fetal growth restriction, placental abruption, and stillbirth. It has proven a viable approach for indirectly monitoring uteroplacental circulation from early gestation. The predictive value in individuals with pregnancy-induced hypertension, or small for gestational age (SGA) babies, is the most significant [10].

The uterine artery can be demonstrated by color Doppler velocimetry as it originates from the anterior division of the internal iliac artery just before it enters the uterus at the uterine-cervical junction. The uterine artery pulsed Doppler velocimetry should be carried out as soon as the artery passes the iliac vessels and before it divides into the uterine and cervical branches [11].

Umbilical artery Doppler was the usual fetal vessel to undergo Doppler velocimetry evaluation. A free-floating portion of the cord is identified, and the Doppler sample volume is placed over the artery and vein. The impedance indices at the fetal end of the cord are much higher than those at the placental end [12].

The study aimed to look at the relationship between Evaluation of Fetal Weight (EFW) and both placental thickness and fetal Doppler indices in healthy pregnant women. It might be used to estimate fetal weight and detect fetal growth curves.

2. Subjects and methods

2.1. Subjects

The current cross-sectional study involved 50 pregnant females in an obstetrical outpatient clinic at Fayoum University Hospital from January 2020 to July 2021. Using an ultrasound device, fetal gestational age (GA) and weight were estimated by detecting and measuring biparietal diameter (BPD), femur length (FL), head circumference (HC), and abdominal circumference (AC).

The thickness of the placenta was measured in millimeters at the cord insertion site, and the uterine and umbilical arteries' Doppler indices were evaluated to evaluate the correlation between EFW and both placental thickness and fetal doppler indices in healthy pregnant ladies.

Inclusion criteria

The pregnant ladies between the ages of 18 and 40 years, singleton pregnancy, 13 to 40 weeks of gestation, reliable last menstrual period (LMP), and a normal body mass index (BMI), were recruited.

Exclusion criteria

Patients with any disorder that might affect the size of the placenta were excluded from the study. These comorbidities included hypertension (HTN), diabetes mellitus (DM), unreliable LMP, multiple pregnancies, intrauterine growth restriction (IUGR), hydrops fetalis, congenital malformations, polyhydramnios, placental abnormalities, poorly visualized placentas, low-lying placentas, placenta previa, and placentas with umbilical cord insertion variants.

2.2. Methods

Women's medical and obstetrical histories were collected in addition to age, parity, and past medical occurrences. As part of the regular transabdominal ultrasound scan, all pregnant ladies had their BPD, HC, FL, and AC measured in order to determine EFW. This scan was done with a Philips ultrasound machine, model no. MCMD02AA (Philips, Amsterdam, Netherlands).

At the point where the cord is inserted, the thickness of the placenta is measured in millimeters. As a tangential scan can distort measurements of placenta thickness, the transducer was positioned on the skin surface and angled to scan perpendicular to the chorionic and basal plates. To acquire accurate measurements, the cord insertion point must be identified. This point is usually central, but a slightly eccentric position may be normal. Cord placental insertion could be discovered by ultrasound as hypoechoic patches near the chorionic plate with a V shape or as linear echo’s radiating from the placental surface at right angles.

In the mid-placental region, measurements were made from the chorionic plate to the placental-myometrial interface. We eliminated myometrium and the sub-placental veins from placental measurements.

During the relaxed period of the uterus, all measurements of the placenta were made, as contractions can falsely raise the placental thickness. To calculate placental thickness in millimeters, the best data for each case were averaged.

For all pregnant ladies, a color Doppler examination was performed. Doppler waveforms were obtained throughout three sequential cardiac cycles:

It was possible to locate the uterine artery where it crosses over with the iliac artery by using color Doppler mode.

We detected the umbilical artery Doppler velocity waveforms during fetal calmness from the middle free-floating loop of the cord. Doppler PI was calculated from the Doppler velocity waveform.

The peak systolic and end diastolic velocities of the UtA and UA were measured. The computation of PI came after that.

Study subjects were classified into four groups according to their GA to determine whether the relationship was affected by GA progress or not:

- Group A: from 13 weeks to 19 weeks + 6 days, including three pregnant women.
- Group B: from 20 weeks to 26 weeks + 6 days, including eight pregnant women.
- Group C: from 27 weeks to 33 weeks + 6 days, including 17 pregnant women.
- Group D: from 34 to 40 weeks, including 22 pregnant women.

2.3. Statistical Methods

The experimental design was cross-sectional, and SPSS was used for the statistical analysis (Social Science version 26.00) at a significance level of 0.05. Quantitative analyses were obtained using the LSD ANOVA for the comparison of continuous variables in cases of normal distribution. Otherwise, non-parametric tests were used for Kruskal-Walli's variance analysis with the parametric distribution of Levene's study. In qualitative analyses, associations between categorical variables were compared with chi-square. The interval of confidence was set at 95%, and the agreed error margin was set at 5%. Spearman correlations between variables were done.

3. Results

In a comparison between groups as regarding placental site, Table 1 didn't reveal any statistically significant variation in the placental site between the groups (*P = 0.892*).

Table 1: Comparison between groups as regarding placental site.

Placental site	Groups				Chi-square	*P-value*
	A (n=3)	B (n=8)	C (n= 17)	D (n=22)		
Anterior	1 (33.3%)	2 (25%)	6 (35.3%)	6 (27.3%)	2.282	0.892
Posterior	2 (66.7%)	5 (62.5%)	8 (47.1%)	10 (45.5%)		
Fundal	0 (0%)	1 (12.5%)	3 (17.6%)	6 (27.3%)		

Table 2 and Figure 1 show the correlation between placental thickness and EFW. The mean value of placental thickness was 38.5 (17.4–68.8) mm, and the mean EFW was 1992.2 (83–3797) g. By applying Spearman's correlation test, there was a statistically significant positive correlation between placental thickness and EFW. This relationship is more apparent in group D, which has a higher gestational age.

Table 2: Relationship between placental thickness and EFW.

	Group				r-value#	*P-value*
	A	B	C	D		
EFW	200±106.1	819.1±348	1789.7±450.6	2819.6±438.6	0.482	<0.001*
Placental thickness	30.4±10.7	28.5±6.03	39±7.8	42.8±12.1		

** Significant at P <0.05. #Prearson correlation test.*

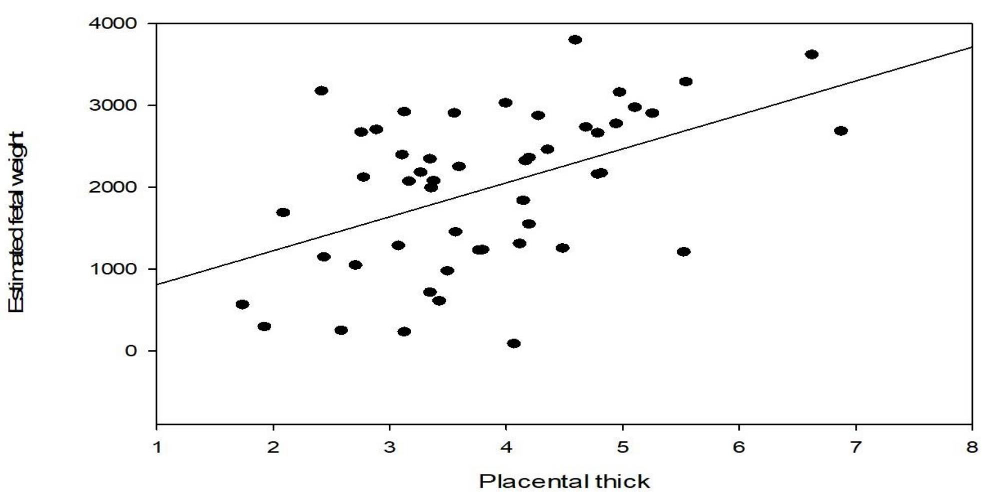

Figure 1: Linear regression shows statistically significant correlation between placental thickness and EFW.

Table 3 shows the mean and SD of uterine artery PI in different gestational age groups. The mean value of the uterine artery PI was 0.92 (0.42–1.76), and the mean EFW was 1992.2 (83–3797) g. By applying Spearman's correlation test, there was no statistically significant correlation between PI of the uterine artery and EFW.

Table 3: Relationship between uterine arteries PI and EFW.

	Group				r-value#	*P-value*
	A	**B**	**C**	**D**		
EFW	200±106.1	819.1±348	1789.7±450.6	2819.6±438.6	- 0.01	0.946
PI	1.27±0.38	0.74±0.34	0.89±0.41	0.96±0.39		

Table 4 and Figure 2 show the mean and SD of umbilical artery PI from the free loop of the cord in different gestational age groups. The mean value of the umbilical artery PI was 0.95 (0.33–1.66), and the mean EFW was 1992.2 (83–3797) g. By applying Spearman's correlation test, there was a statistically significant weak negative correlation between the PI of the umbilical artery and the EFW. This relationship was not affected by gestational age progression in different groups.

Table 4: Relationship between umbilical artery PI and EFW.

	Group				r-value#	*P-value*
	A	**B**	**C**	**D**		
EFW	200±106.1	819.1±348	1789.7±450	2819.6±438.6	-0.294	0.037*
PI	1.31±0.12	0.95±0.34	0.95±0.27	0.91±0.31		

** Significant at P <0.05. #Prearson correlation test.*

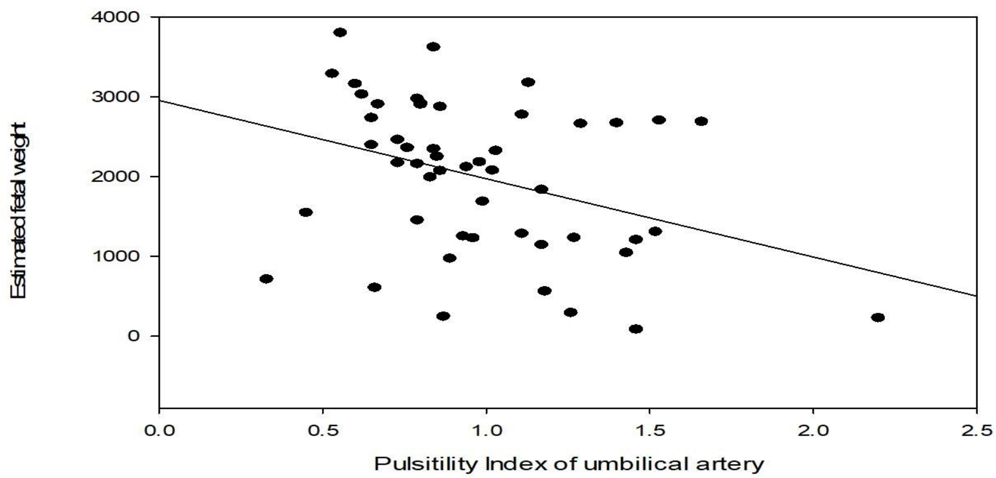

Figure 2: Linear regression shows statistically significant negative correlation between umbilical artery PI and EFW.

4. Discussion

In this study, changes in placental thickness and EFW were observed in 50 cases. The mean value of placental thickness was 38.5 (17.4–68.8) mm, the mean gestational age at measurements was 31 (13–40) weeks, and the mean EFW was 1992.2 (83–3797) g. The study's findings provide evidence in favor of the theory that in low-risk pregnancies, there is a connection between the thickness of the placenta and EFW. So, the results support the proposal that placental thickness can be fairly used as an accurate indicator of normal fetal weight, but because of wide variations in placental thickness corresponding to particular fetal weights, a more thorough search should be undertaken when a fetus is considered to be at risk.

That was in agreement with what was found by Noor *et al.* (2018), who conducted a study of 152 pregnant women aged 20 to 35 years and determined the association between ultrasound measures of placental thickness and EFW by undergoing ultrasound examination of placental thickness at GA 18 to 40 weeks [2]. According to their findings, the average placental thickness was 31.634.79 mm, and the average fetal birth weight they estimated was 2145.86121.24 g. They were related by a Pearson's correlation coefficient of 0.982. That confirmed the correlation between placental thickness and EFW. In their study, they observed that EFW was a very significant component of ANC, and ultrasonography plays a key role in it. Due to its linear connection, measuring the thickness of the placenta at the location of the inserting cord can be used as a trustworthy sonographic indicator for estimating fetal weight [2].

Also, Ashmawy *et al.* (2020) found that the association between placental thickness, EFW, and GA in late pregnancy was positive. Their Iranian cross-sectional study involved 214 pregnant women aged 15–45. In their statistical study, it was determined that the r-value was 0.53 ($P < 0.05$) [12]. According to their findings, the placental thickness rose by 1 millimeter in the middle trimester of pregnancy and by 0.4 mm in the late trimester per 100 g of fetal weight gain. According to the study's results, there was no discernible connection between the thickness of the placenta and the gender of the fetus [12].

Afrakhteh *et al.* (2013) also looked at the relationship between the thickness of the placenta and fetal birth weight in 250 pregnant women in the second and third trimesters. Pregnant women's average age was 26.4±5.1 years, the average fetal birth weight was 3051.5±657.0 g, and the average placental weight was 551.7±104.8 g. The mid-to-late pregnancy changes in placental thickness measured by ultrasonography were 21.68±4.52, 36.26±6.46, and 14.67±5.67 mm, respectively. They discovered a strong positive relationship between fetal birth weight and placental thickness in mid-to-late pregnancy (r = 0.15, $P = 0.03$; r = 0.14, $P = 0.04$, correspondingly) [13]. In this study, there were no cases of notched uterine artery Doppler or low diastolic flow.

Changes in uterine artery PI and EFW were recorded in 50 cases. The mean value of PI was 0.92 (0.42–1.76), the mean gestational age was 31 (13 to 40) weeks, and the mean EFW was 1992.2 (83–3797) g.

We found that there was no significant correlation between EFW and uterine artery PI. Therefore, the findings of this study refute the idea that in low-risk pregnancies there is a connection between the uterine artery PI and EFW. So, it was not necessary to correlate uterine artery Doppler indices with fetal size.

In this study, there were no instances of end-diastolic flow that was missing or reversed. A change in PI and EFW was recorded in 50 cases. The mean value of PI was 0.95 (0.33–1.66), the mean gestational age at measurements was 31 (13–40) weeks, and the mean EFW was 1992.2 (83–3797) g.

By applying Spearman's correlation test, there was a statistically significant weak negative correlation between the PI of UA and the EFW. Therefore, the findings of this study provide credence to the idea that in low-risk pregnancies, the PI of the UA and EFW are correlated. This is in agreement with a study conducted by Sirico *et al.* (2019) that analyzed 14554 pregnancies from 2004 to 2015 in Hamburg, Germany, to investigate the correlation between umbilical artery PI and EFW. They conducted the study on low-risk pregnant women after 28 weeks of gestation. They conclude that the higher the EFW, the lower the PI of UA. There was a linear decrease in PI values of UA with high EFW [14].

Contrary to the study conducted by Owen *et al.* (2003), which aimed to investigate the relationship between EFW and UA Doppler indices in 274 low-risk pregnant women from 30 weeks of gestation until delivery, they found that the UA Doppler indices and EFW are not related [15].

The study's drawbacks included the fact that ultrasound measurements are operator-dependent, so the high percentage of error in the estimation of the fetal weight and placental thickness may stem from the operator dependence of the procedure. Also, more information and data would be available with a larger sample size, particularly when addressing the connection.

Conclusion

In the current study, a positive correlation was found between EFW and placental thickness, so the findings back up the theory that in low-risk pregnancies, placental thickness and EFW are correlated. This implies that placental thickness can be used as a fairly accurate indicator of normal fetal weight. Also, no significant correlation was found between EFW and uterine artery PI. So, it is not necessary to correlate uterine artery Doppler indices with fetal size. But there was a week-long negative correlation between EFW and umbilical artery PI.

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Ethics approval and consent to participate

This study was approved by the Research Ethics Committee M 442 No. 65 Date 13/10/2019, Faculty of Medicine, Fayoum University. Contents of consent were clarified and written and completed by all participants.

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