Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Sonographic Correlation Between Placental Thickness And Umbilical Cord Morphological Parameters During Third Trimester: Comparison Between Diabetic And Non-Diabetic Pregnancies

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Keywords Maternal Diabetes, Placental Thickness, Umbilical Cord, Coiling Index, Ultrasound, Fetoplacental Circulation

Received on 02 Apr 2026

Accepted on 03 May 2026

Published on 10 May 2026

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Abstract

Abstract

Background: The development of the placenta is altered due to maternal diabetes. The placenta has blood flowing between it and the fetus. This exposes them to more risks at birth of the baby. When we compare diabetic pregnancies with non-diabetic pregnancies we do not know much about the influence of maternal diabetes on the thickness of the placenta and the shape of the umbilical cord.

Objective: To compare the placental thickness and umbilical cord morphological parameters between diabetic and non-diabetic pregnancies in the third trimester and to determine their relationship.

Subjects and Methods: A case control study was designed where 140 women were used 71 of them had maternal diabetes and 69 of them did not have maternal diabetes. These women were 28-40 weeks pregnant. We measured the placental thickness of the placenta and the cord diameter and the arteries and veins in the cord using ultrasound. We also checked the body mass index of the mothers and HbA1c. We employed tests to determine whether there were any differences between the two groups of women.

Results: The placenta was thicker in the women with diabetes. The umbilical cord was also bigger and the arteries and veins in the cord were bigger too. The cord was not twisted as much in the women with maternal diabetes. We found that the thickness of the placenta was related to the size of the blood vessels. The twisting of the cord was not related in the same way. The umbilical cord was more likely to be attached in a way in the women with maternal diabetes.

Conclusion: Maternal diabetes changes the way the placenta and the umbilical cord develop. Looking at these things with a machine can help us find problems early and take care of them. This is a way to check on the health of the baby and the mother without hurting them. Maternal diabetes is a condition that can affect the placenta and the umbilical cord. We need to keep studying diabetes to learn more, about it.

INTRODUCTION

Placenta is a highly evolved temporary organ which constitutes the most important physiological interface between the mother and fetus, through which nutrients are transported, gases exchanged, wastes removed, endocrine, and immune functions controlled during pregnancy[1]. The placenta during the third trimester is characterized by dramatic structural and functional remodelling in terms of villous maturation, vascular enlargement and proliferation of trophoblasts to accommodate the rising metabolic needs of the fetus [2]. Placental thickness sonography has become a non-invasive and easy measure of placental functioning. [3].

Increased and decreased placental thickness have been linked to poor pregnancy outcomes, such as fetal growth retardation, preeclampsia, pre-term birth, and intra-uterine fetal death. The umbilical cord is the vital pathway between fetus and placenta, made of two arteries and one vein that are embedded in Wharton jelly, which cushions against vascular compression and provides uninterrupted fetoplacental circulation [4]. The fetal circulation conditions are reflected in the Umbilical cord morphological parameters, such as its diameter, coiling index, vessel calibre and volume of Wharton jelly. Hyper coiling and hypo coiling are abnormal coiling patterns that have been linked to fetal distress, growth retardation, and perinatal morbidity[5]. Maternal hyperglycaemia triggers severe placental alterations, such as placental weight gain, villus immaturity, capillary expansion, glycogen and vascular congestion, which are initially adaptive, but subsequently hypoxic and maladaptive to fetal growth and development 6. Other structural changes that can be seen in diabetic pregnancies are changes in the size of the vessel in the umbilical cord, abnormal coil configurations and alteration in the Wharton jelly composition, which is the adaptation of the fetus to the metabolic stress [7].

Ultrasound imaging is the preferred choice of fetoplacenta imaging because it is safe, accessible, and real-time with no ionizing radiation 8. It makes it possible to measure the placental thickness in a standardized way and observe the morphology of the umbilical cord in detail with the help of grayscale and Doppler, which makes it possible to identify the abnormalities early and correlate them with the well-being of the fetus [9]. Although literature has been available, there are few studies that systematically tested the relationship between the placental thickness and umbilical cord morphological parameters in diabetic and non-diabetic pregnancies, especially in the third trimester [10]. In Pakistan, researches have been conducted on placental thickness and the impact of diabetes on placenta, however, the umbilical cord is not well studied. The comparison between diabetic pregnancies and non-diabetic ones is also lacking, especially in later stages of pregnancy, which point to a requirement of more detailed ultrasound studies.

Subjects And Methods

The case control study is a 4-month study at Kishwar Sultana Hospital, Lahore, inclusion criteria include 140 participants (70 diabetic and 70 non-diabetic) in their third trimester (28-40 weeks) with singleton pregnancies. Convenience sampling was used to select the participants and those with multiple gestations, hypertension, systemic diseases, fetal anomalies or placental problems were excluded.

Obstetric ultrasound scans were conducted on participants in the 3.5-5 MHz convex transducer, placental thickness at cord insertion, cord diameter, vessel diameters, coiling index and Wharton jelly thickness. All scans were done by an experienced sonographer, who saved demographic information and diabetic status, and participants were in supine or left lateral position, which provided consistency and accuracy.

Statistical Software of Social Sciences (SPSS version 24) and Microsoft Excel 2016 were used to evaluate and analyse the data. The distribution of data was assessed using descriptive analysis. Quantitative variables were reported in terms of mean and standard deviation and categorical variables were calculated in terms of frequency and percentage. Histograms and bar charts were created. The t-test was used with the p-value of less than 0.05 being taken to be statistically significant.

The research complied with the ethics in Superior University, which included informed consent, confidentiality, and anonymity. The participants were aware of their ability to leave anytime without any penalty and the risk involved in the safe ultrasound was minimal. It was a voluntary participation with a focus on privacy and the intention to enhance the knowledge concerning placental and umbilical cord health.

Results

The sample used in this study was 140 pregnant women (70 diabetic, 70 non-diabetic) with a mean gestational age of 34.4 weeks and mean maternal age of 28.97 years. The umbilical cord diameter (0.99 cm vs 0.75 cm), umbilical artery diameter (2.95 mm vs 2.37 mm), placental thickness (35.06 mm vs 30.16 mm), umbilical vein diameter (5.16 mm vs 3.98 mm) were significantly higher in diabetic participants and a lower coiling index (The diabetic group also had higher BMI (28.27 kg/m²) and HbA1c (5.90%). Feto-placental parameters were significantly correlated with each other with an inverse relationship between coiling index and cord dimensions. The type of cord insertion (p=0.006) was found to be associated with diabetic status, but not with placental location.

Discussion

Mother diabetes has the ability to influence the placenta, umbilical cord, which influences blood flow to the fetus. Investigations in 140 pregnant women revealed that diabetes pregnant women possessed bigger umbilical cords and blood vessels, thicker placentas, and less coiling of umbilical cord. Such alterations can endanger fetal wellbeing, which is why special attention should be paid to diabetes management in pregnancy [11]. The enlargement of the placenta is believed to be a compensatory mechanism to ensure that the fetus receives oxygen in maternal hyperglycaemia. This is confirmed by our results, in which there is an augmented placental thickness and vessel diameters in diabetic pregnancies. On the same note, Raio et al. also found a lower umbilical coiling index in diabetic pregnancies, which are signs of an abnormal cord development and high likelihood of poor outcomes [12].

This is in line with our findings where the index of coiling is much lower in the diabetic group (0.13 vs 0.17 coils/cm). Shorter coiling can result in less flexibility of the cord and more prone to compression, this could lead to reduced fetal circulation. We also find that there is an inverse strong correlation between coiling index and

vascular diameters. In the same way, Sepulveda et al. found that diabetic pregnancies had greater umbilical vein and artery diameters as a result of chronic fetal hyperglycaemia and hyperinsulinemia which caused vascular remodelling and high blood flow requirements [13].

This concurs with our results, both umbilical artery and umbilical vein mean had high values of both umbilical artery and umbilical vein which had a very high statistical significance ($p = 0.001$) which supports the relationship between diabetes and vascular changes. The correlation analysis revealed that coiling index and umbilical cord diameter, vessel diameters, and placental thickness exhibited a strong negative relationship with each other, which was attributed to the fact that the high placental and vascular growth is linked with low coiling. Predanic et al. argue these findings by claiming that abnormal coiling patterns are correlated with differences in cord thickness and vascular dimensions, as part of an overall developmental process of the umbilical cord [14]. Our research builds on the literature by measuring these relationships and establishing their statistical significance. There was also a substantial correlation between diabetic status and the type of umbilical cord insertion with velamentous insertion being more prevalent in diabetic pregnancies (16.9% vs 1.4) and central insertion being less common. This has clinical significance because abnormal cord insertion has been associated with fetal complications like growth retardation and preterm birth. On the same note, Ebbing et al. reported more prevalence of abnormal cord insertion in pregnancies with maternal metabolic disorders, that means there is a relationship between placental development and maternal health [15].

Our results are consistent with the prior studies that indicate that there is no significant correlation between diabetic status and placental location. The locations of placental implantation were also the same in both groups, which means that maternal diabetes is not a factor that affects placental location. This is in line with Jauniaux et al., who indicated that the site of the placenta is predominantly driven by the implantation dynamics and not the maternal metabolic factors [16]. Women with diabetes during pregnancy have worse placental and fetal vascular health. One study found that they were found to weigh more in terms of BMI and HbA1c which was associated with thicker placental, larger blood vessels, less coiling of the umbilical cord and abnormal cord insertion. These alterations are probably because of the effects of high blood sugar to blood vessels and placenta, and thus detailed ultrasound monitoring is essential in monitoring fetal health.

Acknowledgments:

The authors wish to acknowledge the cooperation and the assistance of the staff of Kishwar Sultana Hospital, Lahore, in data collection and imaging processes. We also recognize all the participants who have agreed to participate in this research. This research did not receive any external funding or financial support. The authors state that no other people were involved in the work in such a way that the requirements of authorship set forth by the International Committee of Medical Journal Editors (ICMJE) guidelines would be satisfied.

Supporting Agency:

This study did not get any financial aid. No financial aid of the public, private, or non-profit funding agencies was given to conduct the study. The authors and the institution the research was conducted in handled all the costs of the research work, such as data collection, imaging procedures, and analysis as regular clinical and academic work. No third party or financial institution was involved in funding this study. Moreover, none of the funding agencies were involved in the study design, methodology development, data collection, statistical analysis, result interpretation, manuscript preparation, or the choice of publishing the article. The researchers were able to carry

out the study on their own to promote transparency, objectivity and scientific integrity in the study.

Conclusion

Maternal diabetes changes the feto-placental parameters such as the umbilical cord/vessel diameter, the placenta thickness and the index of coiling, with a greater occurrence of velamentous cord insertion. There is no effect on placental location and increased maternal BMI and HbA1c are typical, which indicates why special care must be employed to monitor a diabetic pregnancy with ultrasound.

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Table: Independent Samples t-Test Comparing Feto-Placental Parameters Between Diabetic and Non-Diabetic Groups

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of th Difference	
									Lower	Upper
Umbilical Cord Diameter (cm):	Equal variances assumed	.917	.340	-13.584	138	.000	-.23556	.01734	-.26985	-.20127
	Equal variances not assumed			-13.620	134.653	.000	-.23556	.01730	-.26977	-.20136
Umbilical Artery Diameter (mm):	Equal variances assumed	7.657	.006	-15.196	138	.000	-.58971	.03881	-.66644	-.51298
	Equal variances not assumed			-15.304	113.544	.000	-.58971	.03853	-.66605	-.51337
Placental Thickness (mm)	Equal variances assumed	11.071	.001	-7.964	138	.000	-4.90122	.61542	-6.11809	-3.68436
	Equal variances not assumed			-8.033	104.038	.000	-4.90122	.61017	-6.11121	-3.69124
Umbilical Vein Diameter (mm):	Equal variances assumed	13.126	.000	-12.507	138	.000	-1.18379	.09465	-1.37094	-.99664
	Equal variances not assumed			-12.617	103.054	.000	-1.18379	.09383	-1.36987	-.99771
Coiling Index (coils/cm):	Equal variances assumed	3.059	.082	8.183	138	.000	.04176	.00510	.03167	.05185
	Equal variances not assumed			8.242	113.077	.000	.04176	.00507	.03172	.05180

Table: The findings of the independent t-tests of feto-placental ultrasound parameters in diabetic and non-diabetic participants are presented in this table. All parameters ($p < 0.001$) showed significant differences. Diabetic were found to be higher in umbilical cord diameter, umbilical artery diameter, placental thickness, and umbilical vein diameter, and coiling index was lower than that of non-diabetic participants. The test of Levene revealed non-equal variances of some variables, although the significance was the same.

Table: Pearson Correlation Between Coiling Index, Umbilical Vessels, Cord Diameter, and Placental Thickness

Correlations						
		Coiling Index (coils/cm):	Umbilical Vein Diameter (mm):	Umbilical Artery Diameter (mm):	Umbilical Cord Diameter (cm):	Placental Thickness (mm)
Coiling Index (coils/cm):	Pearson Correlation	1	-.542**	-.644**	-.606**	-.413**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	140	140	140	140	140
Umbilical Vein Diameter	Pearson Correlation	-.542**	1	.716**	.570**	.596**

(mm):	Sig. (2-tailed)	.000		.000	.000	.000
	N	140	140	140	140	140
Umbilical Artery Diameter (mm):	Pearson Correlation	-.644**	.716**	1	.762**	.605**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	140	140	140	140	140
Umbilical Cord Diameter (cm):	Pearson Correlation	-.606**	.570**	.762**	1	.550**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	140	140	140	140	140
Placental Thickness (mm)	Pearson Correlation	-.413**	.596**	.605**	.550**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	140	140	140	140	140
**. Correlation is significant at the 0.01 level (2-tailed).						

Figure: Comparison of Placental Thickness between Diabetic and Non-Diabetic Groups

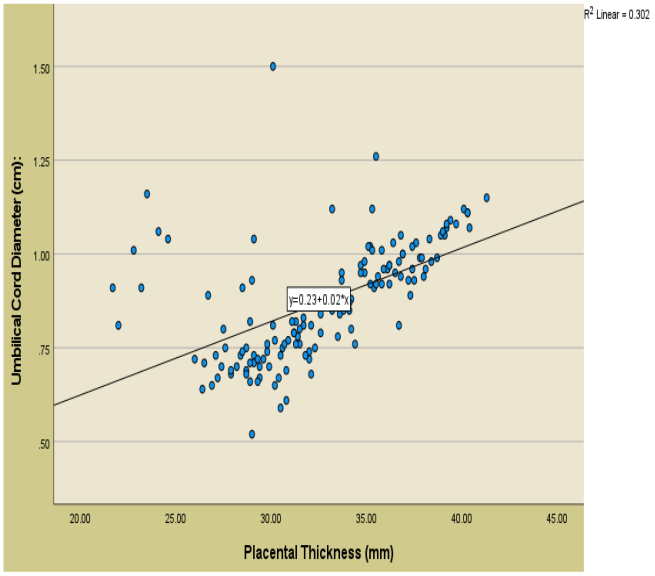

Figure: The median placental thickness in diabetic group is larger with greater variation in its values whereas non-diabetic group has smaller values with less variation.

Figure: Comparison of Umbilical cord diameter Between Diabetic and Non-Diabetic Groups

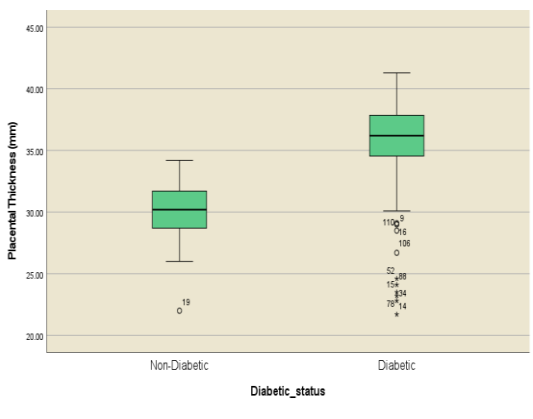

Figure: The median umbilical cord diameter of the diabetic group is larger with more variability whereas the non-diabetic group has lower and more consistent values.

Figure: Relationship Between Placental Thickness and Umbilical Cord Diameter

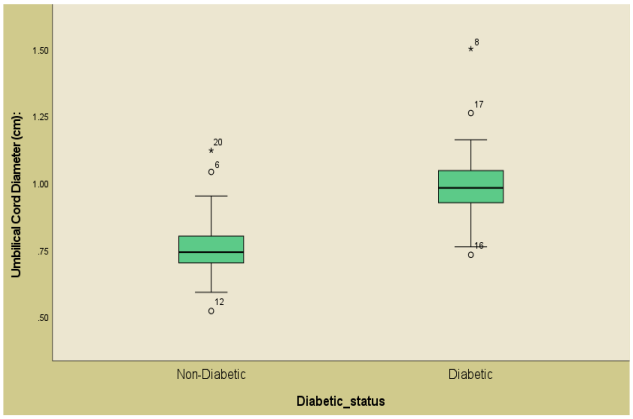

Figure: The scatter plot indicates that placental thickness is positively related to umbilical cord diameter.