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A Gross and Histomorphological Study of the Umbilical Cord in Gestational Diabetes Mellitus

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Abstract

Objective: *Clinically the adverse effects of the diabetes on the out come of pregnancy are well established. The present study was designed to look for the impacts of gestational diabetes on the gross and histomorphological features of the umbilical cord.*

Type of study: *A descriptive study having analytical components.*

Place and period of study: *Department of Anatomy, Chittagong Medical College, Chittagong, from May 2006 to April 2007.*

Materials: *Total fifty (50) umbilical cords with the placenta were collected within 36th to 40th weeks of gestation from Chittagong Medical College hospital and Memon maternity hospital of Chittagong City Corporation. Out of them 25 cords were from non diabetic pregnant mother (Control group) and 25 cords from mothers with gestational diabetes mellitus (GDM group).*

Method: *After proper fixation with 10% formalin the diameter of the umbilical cord were measured with a vernier calipers in millimeters. Circumference, Cross-Sectional Area (CSA) of the umbilical cord and CSA of the Wharton's jelly were measured by computerized micrometric method in millimeters and sq. millimeters respectively. Number of the umbilical vessels were examined and counted on the cut surface of the umbilical cord, later confirmed by histological examination. Presence or absence of the true knots were noted.*

Result: *Among the gross morphological variables of the umbilical cord, the mean diameter was significantly larger in the GDM group than in the Control group ($P< 0.05$). Though the mean circumference, mean CSA of the umbilical cord and mean CSA of the Wharton's jelly were found to be higher in the GDM group than in the Control group, but the difference did not reach to the significant level. All the cords of the GDM group, the umbilical cord contained two arteries and one vein, whereas, two cords of the Control group, the umbilical cord had three arteries and one vein and one cord contain four arteries and one vein. No true knots were found in any groups. Pearson's correlation test revealed significant positive correlation in both GDM and Control groups between mean diameter and circumference of the umbilical cord ($r = 0.881$, $P = 0.000$ & $r = 0.689$, $P = 0.000$) and between CSA of the umbilical cord and Wharton's jelly ($r = 0.988$, $P = 0.000$ & $r = 0.990$, $P = 0.000$).*

Key words: *Umbilical cord, Gross and Histomorphology, GDM.*

Introduction:

The umbilical cord is an important organ of the fetus. It is two centimeters in diameter, fifty to sixty centimeters in length and tortuous in appearance [1]. It has an organ-like property. Fetal well-being depends much on normal function and structure of the umbilical cord. Therefore, the macroscopic and microscopic morphology of the umbilical cord should be important aspects to be considered in understanding feto-maternal functional relationship and related clinical conditions.

As the umbilical cord is the gateway to the fetus from the mother, its gross dimensions are very likely to be important in how it serves as an efficient gateway. Thus, the cord diameter, circumference and cross-sectional area (CSA) are important measurements from research perspective. The umbilical cord was found to be significantly larger

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in diameter in the fetuses of mothers with gestational diabetes than in the normal population and the increase in the width was attributed to an increase in its Wharton jelly content [2]. Researcher also found that, there were gross alterations of connective tissue component of the Wharton's jelly with appearance of large empty spaces within them [3]. Thus, CSA of the Wharton's jelly is also important parameter to be studied in the GDM mother.

The main components of the umbilical cord are blood vessels embedded in an embryonic connective tissue: the Wharton's jelly. Although the cord begins with two arteries and two veins, it ends up normally having only one vein and two arteries. These blood vessels act as communicating channels between the placental and fetal circulations. It is a possibility that, conditions that bring about any changes in the placental vascular tree will have effect on the umbilical blood vessels and this in turn might have effects on the well-being of the fetus. Thus, the number of vessels present in the umbilical cord has been a subject of interest to the researchers. Variations in the number and type of vessels may also be associated with gestational diabetes causing congenital anomalies, intrauterine growth retardation, prematurity and perinatal morbidity [4,5]. Gestational diabetes has been found to be significantly correlated with true knots of umbilical cord. The incidence of fetal distress and meconium stained amniotic fluid was significantly higher among patients with true knots of cord [6].

As the umbilical cord is the communicating channel between the fetus and the placenta, any pathological changes in the umbilical cord may have the potential to cause harm to the fetus. Therefore, a gross and histomorphological study of the umbilical cord in GDM may provide us with valuable informations about the possible hidden clue to fetal & maternal complications.

Materials and Method:

A study having both descriptive and analytical components was carried out to explore the gross and histomorphological features of the umbilical cord in the gestational diabetic mothers of our population and to find out the correlation of the variables of the umbilical cord within themselves in the study group. The study was done in the Department of Anatomy, Chittagong Medical College, Bangladesh from May'2006 to April'2007. The total number of subjects was fifty, out of which, 25 were non-diabetic pregnant mothers (Control group) and 25 were mothers with gestational diabetes mellitus (GDM group). The umbilical cord with the placenta was collected within 36 to 40th weeks of gestation from selected hospitals. Mothers with Rh-negative blood group, VDRL positive, HBsAg positive, hypertension, pre-eclampsia, eclampsia, as well as mothers delivering still born or congenitally malformed babies were excluded from the study.

The mean diameter of the umbilical cords was measured by vernier calipers [(Maximum diameter + Minimum diameter)/2] in millimeters. Circumference and CSA of the umbilical cord were measured in millimeters and sq. millimeters respectively using AutoCAD computer program after taking dye imprint of the cut section of the umbilical cord on 80 grams white paper [7]. CSA of the umbilical vessels were also measured in sq. millimeter in the same way using AutoCAD computer program after taking tracing of out line of umbilical vessels on a tracing paper from prepared histological slides with the help of an Olympus Binocular microscope equipped with a drawing tube (Periscope). Then the AutoCAD values were converted into the real values by dividing with an appropriate magnification factor. Finally the CSA of the Wharton's jelly was calculated in sq. millimeters by subtracting the measured total CSA of umbilical vessels from the measured CSA of the umbilical cord [8]. Number of arteries and vein were examined and counted on the cut surface of the umbilical cord, later confirmed by histological examination. Presence or absence of true knots were noted. Student **t-**test and Pearson's correlation test as applicable were used for analyzing the result.

Results:

Results of the present study are shown in Table I, II, III and Fig. 1, 2, 3, 4.

Table-I

Morphological variables of the umbilical cord in the two groups

Variable	Control n = 25	GDM n = 25	Significance of difference
Diameter of the umbilical cord (mm)			
Range	8.00 – 13.35	9.05 – 16.75	
Mean ± SD	11.02 ± 1.37	12.68 ± 2.50	S (P = 0.008)
Circumference of the umbilical cord (mm)			
Range	24.53 – 57.82	27.30 – 52.40	NS (P = 0.194)
Mean ± SD	36.57 ± 6.26	39.19 ± 7.72	
CSA of the umbilical cord (sq. mm)			
Range	43.63 – 140.63	53.00 – 175.00	NS (P = 0.071)
Mean ± SD	81.66 ± 24.77	97.97 ± 36.62	
CSA of the Wharton's jelly(sq. mm)			
Range	37.00 – 129.70	41.57 – 162.81	NS (P = 0.093)
Mean ± SD	70.96 ± 24.27	86.60 ± 36.78	

CSA: Cross-sectional area. ND: Not done. **S: Significant.** Student's **t** test was done to find out the differences in the variables between the two groups. ***P* ≤ 0.05** was considered as the level of significance. NS: Not significant.

Table-II

Status of correlation between the mean diameter and circumference of the umbilical cord in the study groups

Correlation variables	Group	Correlation coefficient (r)	Significance of difference
The mean diameter and	0.689	S (P = 0.000)	
circumference of the umbilical cord	GDM Control	0.881	S (P = 0.000)

Pearson's correlation test was done to see the relationship between above two variables in the GDM and Control group.***P* ≤ 0.05** was considered as the level of significance. **S: Significant**.

Table-III

Status of correlation between the cross-sectional area of the umbilical cord and the Wharton's jelly in the study groups

Correlation variables	Group	Correlation coefficient (r)	Significance of difference
The cross-sectional area of the	Control	0.990	S (P = 0.000)
umbilical cord and the Wharton's	GDM	0.988	S (P = 0.000)
jelly			

Pearson's correlation test was done to see the relationship between above two variables in the GDM and **Control group.*P ≤ 0.05 was considered as the level of significance. S: Significant.**

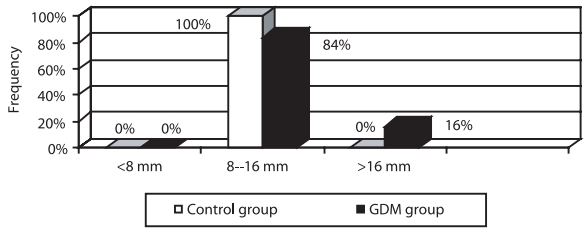

Fig. -1: *Multiple bar diagram showing the percentage frequencies of various categories of mean diameter of the umbilical cord in the two groups.*

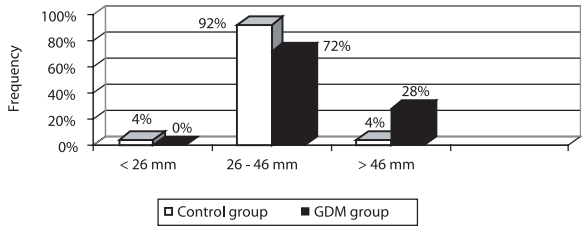

Fig. 2: *Multiple bar diagram showing the percentage frequencies of various categories of mean circumference of the umbilical cord in the two groups.*

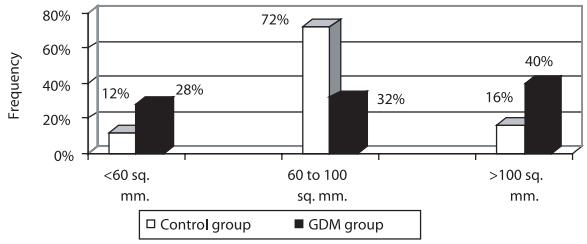

Fig. 3: *Multiple bar diagram showing the percentage frequencies of various categories of cross-sectional area of the umbilical cord in the two groups.*

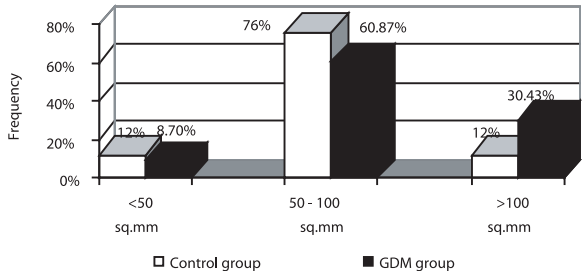

Fig. 4 *Multiple bar diagram showing the percentage frequencies of different categories of cross-sectional areas of the Wharton's Jelly in two groups.*

Discussion:

The normal diameter of the umbilical cord has been as about twenty millimeters after birth [1,9]. In the present study, the mean diameter of the umbilical cord in the GDM group was found to be significantly higher than in the Control group (P< 0.05). This result were in harmony with Weissman et al. who found that the umbilical cord was significantly larger in the fetus of mothers with gestational diabetes than in the normal population and main increase in the width was attributed to an increase in the Wharton's jelly contents [2]. However, Alam et al. in Bangladeshi cases did not find any significant difference between the Pre-GDM, GDM and Control group.

The mean circumference of the umbilical cord at the 40th weeks has been described as 36 millimeters, the range is 26 to 60 millimeters as reported by Dooley et al[10]. This value is supposed to represent the Euro-American population. In the present study the mean circumference of the umbilical cord was found to be larger in the GDM group than in the Control group. Though the result was statistically non-significant (P>0.05), but this result closely simulates the result of the study by Dooley and his associates.

In the present study, the mean CSA of the umbilical cord was larger than the Control group, but the difference was not significant. Ghezzi et al. found a strong correlation between CSA of the umbilical cord and the CSA of the Wharton's jelly (r = 0.97, P<0.001) [11]. In the present study too a significant positive correlation was found between the mean diameter and mean circumference of the umbilical cord (r = 0.881, P < 0.001 & r = 0.689, P < 0.001 respectively) and between mean CSA of the umbilical cord and Wharton's jelly within the GDM as well as in the Control group (r = 0.988, P < 0.001 & r = 0.990, P < 0.001 respectively). These results signify the results of Weissman et al. who concluded that, the umbilical cord was significantly larger in the GDM group because of the increase in the Wharton's jelly contents[2].

Present study showed that, the mean CSA of the Wharton's jelly was much greater in the GDM group than in the Control group. Though the difference did not reach a statistically significant level, but the

tendency was in conformity with the findings of weissman and his associates [2]. However, while considering this apparent similarity, it should be kept in mind that, the CSA of the Wharton's jelly was increased by appearance of numerous empty spaces within it. This might represent degeneration of mucous connective tissue, possibly reflecting the effects of GDM on the Wharton's jelly.

In our study, all the umbilical cords of the GDM group (100%) and most of the cords of the Control group (88%) had two arteries and one vein. However, in the Control group, two cords (8%) had three arteries with one vein and only one cords (4%) had four arteries with one vein and none of these cords was associated with any congenital anomalies. Presence of more than two arteries in the umbilical cord has also been reported by others [12]. A single umbilical artery (SUA) was considered as the most commonly reported umbilical cord anomaly and was found to be present in 1% of all deliveries. [5]. SUA has been found to be more common in the still born babies and has frequently associated with congenital anomalies [4]. In our study, no umbilical cord was found with SUA. Neonates with congenital anomaly and still born babies were excluded as well as lower sample size (only fifty) may also be a factor for absence of SUA in the present study.

No true knots were identified from the fifty umbilical cords in the two groups. Gestational diabetes was found to be significantly correlated with true knots of the cord as showed by Hershkovitz et al. (2001) [6]. Thus, the result of the present study does not come into agreement with the above statement. The possible correlation should therefore be revised in large samples.

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