Original Article

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Umbilical Cord Changes in Anemia, Gestational Diabetes and Pregnancy Induced Hypertension

Mithil Potuganti[1], **B. R. Zambare**[2]

[1]Assistant Professor, Department of Anatomy, DVVPF's Medical College, Ahmednagar, Maharashtra, India, [2]Professor, Department of Anatomy, Shivaji College of Physiotherapy, Shivaji Nagar, Pune, India.

Abstract

Background: The Umbilical cord (UC) structure is designed in such a way that it provides uninterrupted blood flow to the developing fetus even though it is influenced by uterine conditions and external forces throughout the pregnancy period. UC and placenta are the only structures, which nourish the fetus until term. **Subjects and Methods:** This cross-sectional study was carried out in the department of Obstetrics and Gynaecology, DVVPF'S Medical college and hospital. **Results:** In the GDM group without treatment, eccentric insertion is seen in 249 placentae and central insertion in 76 placentae. In the GDM group with treatment, central insertion is seen in 236 placentae and eccentric is seen in 89 patients. In the PIH group, without treatment, 22 central insertions and 68 eccentric insertions were observed. With treatment, PIH patients central insertions are seen in 76 and eccentric in 14. In the anemia group without treatment, 24 central insertions and 76 eccentric insertions are observed. **Conclusion:** On a concluding note, we observed in our study that, the pathological features observed in anemia, pregnancy induced hypertension and gestational diabetes mellitus are on a minimal note in treated patients after their onset, than in untreated patients. Various awareness programs constitutionalized by Governments and various NGO's are bringing upon a desired change, but at the same time, intensity and frequency are to be increased.

Keywords: Umbilical Cord, Placenta, Anemia, Pregnancy-Induced Hypertension, Gestational Diabetes Mellitus.

Corresponding Author: Mithil Potuganti, Assistant Professor, Department of Anatomy, DVVPF's Medical College, Ahmednagar, Maharashtra, India.
E-mail: pmithil@gmail.com

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Introduction

The Umbilical cord (UC) structure is designed in such a way that it provides uninterrupted blood flow to the developing fetus even though it is influenced by uterine conditions and external forces throughout the pregnancy period. UC and placenta are the only structures, which nourish the fetus until term. An infant's life begins by sacrificing the life of UC and placenta. UC is a long, tortuous and flexible funicle connecting the fetus with the mother through the placenta that transports nourishment to the fetus and removes its waste products. In Latin, umbilicus means navel, middle or center.

Umbilical vessels are well protected by mucoid tissue Wharton's jelly (WJ). The two umbilical arteries wrap around the vein in a helical pattern. WJ is a porous fluid-filled connective tissue rich in hyaluronic acid, which protects the blood vessels from compression and acts like an adventitial layer. WJ contains myofibroblasts derived from mesenchymal cells and have both smooth muscle cell (SMC) and fibroblast characteristics. [1,2]

WJ is important for maintaining the structural and functional properties of the cord. The normal structure and functioning of UC are very much essential for the well-being of the fetus. The UC plays an important role in maintaining and regulating fetoplacental circulation. [2]

Hence, cord morphology helps to understand the fetomaternal functional relationship and pathological conditions related to feto-placental circulation. Any obstruction in the blood flow through the umbilical vessels can result in severe and sometimes fatal consequences in fetal health.

Anemia in pregnancy is well recognized and more frequently observed in developing countries. The global prevalence of anemia in pregnancy is 55.9% and in India, the incidence has been noted as high as 40-80%. [3]

Hypertension affects7-10% of pregnancies throughout the world. Hypertension in pregnancy is found to be associated with variable histomorphological changes in the placenta,

which shows a clear reflection of poor foetal outcomes. [4]

Gestational diabetes mellitus (GDM) is described as glucose intolerance of varying severity with the onset or first recognition during pregnancy and disappears with delivery. [5–7] In India the prevalence of GDM is 4-11.6% and varies according to geographical areas and diagnostic methods employed. [8,9]

Diabetes mellitus (DM) in pregnancy is associated with a variety of placental abnormalities. The extent of these changes depends on a number of factors, particularly the quality of glycemic control achieved during the critical periods in placental development. [7,8] Examination of the placenta immediately after delivery provides much insight into the prenatal health of the baby and the mother. [9]

Considering the outcomes of these diseases on the umbilical cord, we decided to study this topic using different staining methods. Going through the literature, we observed earlier researchers had done the morphological and histological studies of placenta only. In our study, we aim to study the umbilical cord's morphology and histological parameters.

Subjects and Methods

After getting Institutional Ethics Committee clearance, this cross-sectional study was carried out in the department of Obstetrics and Gynaecology, DVVPF'S Medical college and hospital.

The study participants were divided into seven groups as follows.

Controls (n=325)

GDMNT (n=325) : Gestational diabetes without treatment

GDMT (n=325) : Gestational diabetes with treatment

PIHNT (n=90) : Pregnancy-induced hypertension without treatment

PIHT (n=90) : Pregnancy-induced hypertension with treatment

ANENT (n=100) : Anemia without treatment

ANET (n=100) : Anemia with treatment

Inclusion criteria:

Only the pregnant women of 18-40 years of attending the obstetrics and gynaecology and willing to participate in the study by signing an informed consent form were included. Patients who deliver in normal and Caesarean section were included.

Exclusion criteria:

Patients who are less than 18 years and above 40, Patients with blood-borne infections like HIV, Hepatitis, Patients with drug abuse, alcohol and smoking were excluded.

Method of Collection

Specimens were collected from the obstetrics and gynecology department and stored in 10% formalin solution and then histological and morphometrical studies will be conducted on it.

In umbilical cords, the following parameters were measured:

Morphological:

Length, Diameter.

Histological:

Total cord area, Wharton's jelly area, Total vessel

Statistical analysis:

Was carried out by using SPSS14. Data expressed as mean, standard deviation and percentages as applicable. Kolmogrov smrinov test was used to assess the normality. The between-group analysis was done by using an independent t-test. The null hypothesis was rejected at 0.05.

Results

To study the role of treatment on umbilical cord changes due to anemia, gestational diabetes and pregnancy-induced hypertension, three hundred and twenty-five controls, three hundred twenty-five pregnants with gestational diabetes with treatment, without treatment, ninety pregnancy-induced hypertensives with treatment and without treatment, one hundred pregnants with gestational diabetes on treatment and without treatment were studied.

Baseline details like age, height, weight, the information about parity and type of delivery in between the groups were given in [Table 1].

[Table 2] shows the site of insertion of the umbilical cord to the placenta was depicted. The number of cotyledons of the placenta was showed in [Table 3]. The untreated pregnancy-induced hypertension group has the lowest number of cotyledons.

[Table 4] shows the umbilical cord diameter in study groups. The untreated gestational diabetes mellitus group had the lowest diameter compared to other groups. The length of the umbilical cord was depicted in [Table 5]. There was no much difference among the groups.

Total cord area between the groups as depicted in Table 6 Untreated pregnancy-induced hypertension had the lowest value in comparison to other groups. The Wharton jelly area between groups was depicted in Table 7 Untreated pregnancy-induced hypertension group had the lowest Wharton jelly area when compared to other groups. Table 8 depicts the total vessel area between the groups. The untreated anemia group had the lowest area.

Table 1: Baseline information of study participants

Sl. No	Parameter	Group						
		GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
1	Age	27.20 (3.31)	26.98 (3.30)	27.23 (3.35)	26.94 (3.11)	27.40 (3.31)	27.10 (3.28)	26.94 (3.34)
2	Height	156.59 (5.52)	156.64 (5.55)	156.70 (5.55)	156.36 (5.72)	156.54 (5.71)	155.62 (6.53)	156.36 (5.62)
3	Weight	62.53 (10.53)	64.30 (11.51)	65.67 (12.91)	66.07 (14.20)	65.89 (12.55)	66.65 (11.80)	63.75 (11.03)
4	Parity P1 P2							
		88	94	38	29	38	42	78
		237	231	52	61	62	58	247
5	Type of							
		295	273	83	78	93	89	136
		30	52	07	12	07	11	189

Vaginal

Data of age, height and weight was expressed as Mean (SD), parity and type of delivery data is the actual number.

GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 2: Site of insertion of the umbilical cord to the placenta in study participants

Site of	Group						
	GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
Centre	76	236	22	76	24	81	291
Eccentric	249	89	68	14	76	19	34

GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 3: Number of cotyledons of the placenta in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
16.30 (1.85)	22.32 (1.52)**	14.44 (1.08)	21.96 (1.84)**	15.44 (2.84)	21.00 (1.84)**	21.64 (2.02)

Data expressed as Mean (SD)

* $p < 0.001$.

GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 4: Umbilical cord diameter in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
1.38 (0.51)	2.04 (0.25)**	1.40 (0.13)	2.01 (0.17)**	1.45 (0.12)	2.02 (0.24)**	2.04 (0.25)

Data expressed as Mean (SD)

** $p < 0.001$.

GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 5: Umbilical cord length in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
53.80 (1.99)	53.98 (1.97)	53.28 (2.10)	53.60 (1.88)	53.81 (2.02)	53.95 (1.97)	53.61 (2.21)

Data expressed as Mean (SD)
GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 6: Total cord area in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
32 (1.39)	36.34 (2.18)**	25.72 (1.70)	36.38 (1.89)**	27.11 (2.69)	37.11 (2.30)**	37.03 (2.47)

Data expressed as Mean (SD)
** $p < 0.001$.
GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 7: Wharton jelly area in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
35.76 (3.36)	40.48 (5.35)**	34.88 (3.38)	41.63 (5.56)**	36.81 (2.36)	44.36 (3.25)**	44.25 (3.34)

Data expressed as Mean (SD)
** $p < 0.001$.
GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Table 8: Total vessel area in study participants

Group						
GDMNT (n=325)	GDMT (n=325)	PIHNT (n=90)	PIHT (n=90)	ANENT (n=100)	ANET (n=100)	Controls (n=325)
11.33 (1.72)	9.61 (0.97)	6.08 (0.66)	11.32 (1.71)	5.25 (0.73)	11.41 (1.73)	12.42 (1.63)

Data expressed as Mean (SD)
** $p < 0.001$.
GDMNT: Gestational diabetes without treatment; GDMT: Gestational diabetes with treatment; PIHNT: Pregnancy-induced hypertension without treatment; PIHT: Pregnancy-induced hypertension with treatment; ANENT: Anemia without treatment; ANET: Anemia with treatment.

Discussion

This study was carried out to understand the role of treatment on umbilical cord changes due to anemia, gestational diabetes and pregnancy-induced hypertension, three hundred and twenty-five controls, three hundred twenty-five pregnants with gestational diabetes with treatment, without treatment, ninety pregnancy-induced hypertensives with treatment and without treatment, one hundred pregnants with gestational diabetes on treatment and without treatment were studied.

Some remote areas of developing countries like India have still had no access to proper medical care. Hence, this study was conducted to compare the beneficial effects of medical management in maternal anemia, gestational diabetes and pregnancy-induced hypertension.

There can be several variations with cord insertion into the placenta.[10] [Table 2] shows the site of insertion of the umbilical cord to the placenta was depicted. The number of cotyledons of the placenta was showed in Table 3. The untreated pregnancy-induced hypertension group has the lowest number of cotyledons.

The normal cord contains two arteries and one vein. During the placental examination, the delivering physician should count the vessels in either the middle third of the cord or the fetal third of the cord, because the arteries are sometimes fused near the placenta and are therefore difficult to differentiate.[11]

The umbilical cord is responsible for maternal-fetal blood flow. Normally, it is composed of two arteries permeated with venous blood and a vein that transports arterial blood, cushioned by a special type of mucous connective tissue known as Wharton's jelly (WJ) and by remnants of the allantoids.[12]

Parameter	Author	Author's finding	Current study
Artery area in GDM	Sapna Amin et, al.	8.02±2.62	11.33 mm^2
Artery area in GDM	Rafah Hady Lateef	0.36±0.08 mm^2	11.33 mm^2
Diameter in GDM	Paricher Pooran sari	3.2 mm	1.38 mm

WJ consists of cells with similar characteristics to smooth muscle ones and that allows its contractile function. These cells constitute an interconnected network of collagen that form canaliculi and perivascular spaces,[13,14] permitting adequate blood flow to the fetus in cases of umbilical cord compression during pregnancy or delivery.[15]

Alterations in the area of WJ have been described in various conditions such as hypertensive disease,[16,17] tobacco smoking,[18] prematurity and fetal distress during labor.[18] The absence of WJ around vessels of the umbilical cord has been found in cases of perinatal mortality,[19] whereas the presence of a large area of WJ has been described in cases of diabetes mellitus.[20] Until recently, data on WJ abnormalities consisted of findings resulting from pathological examinations or case reports.[21] The presence of a thin cord identified during pregnancy places the fetus at risk of restricted growth and birthweight, classified as small for gestational age. This appears to be a consequence of a reduction in the area of WJ.[22]

[Table 4] shows the umbilical cord diameter in study groups. The untreated gestational diabetes mellitus group had the lowest diameter compared to other groups. The length of the umbilical cord was depicted in [Table 5]. There was no much difference among the groups. Total cord area between the groups as depicted in [Table 6] Untreated pregnancy-induced hypertension had the lowest value in comparison to other groups. The Wharton jelly area between groups was depicted in [Table 7]. The untreated pregnancy-induced hypertension group had the lowest Wharton jelly area when compared to other groups. [Table 8] depicts the total vessel area between the groups. The untreated anemia group had the lowest area.

The following table depicts the comparison between different studies and the current study.

Conclusion

On a concluding note, we observed in our study that, the pathological features observed in anemia, pregnancy induced hypertension and gestational diabetes mellitus are on a minimal note in treated patients after their onset, than in untreated patients. Various awareness programs constitutionalized by Governments and various NGO's are bringing upon a desired change, but at the same time, intensity and frequency are to be increased.

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