ORIGINAL ARTICLE

The Morphological Changes in Umbilical Cord in Pregnancy Induced Hypertension (PIH) with respect to severity of the Disease

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ABSTRACT

Aim: To evaluate the morphological changes in umbilical cord in pregnancy induced hypertension and its relationship with severity of the disease.

Methods: A study was conducted on the fresh specimens of placentae with umbilical cords which were collected within 2 hours of delivery from emergency labour rooms of Lady Aitcheion Hospital and Lady Walingdon Hospital Lahore. The Umbilical Cords were removed from the babies by cutting along the clamp about 4-5 cm from fetal ends. The samples were divided into four groups comprising of 10 umbilical cords in group "B, C and D", while 20 in group "A" (control group).

Results: The morphological changes in umbilical cord in pregnancy induced hypertension were significantly associated with the severity of the disease. In this study, the color of the UC were significantly affected from the experimental group (p=0.002). The diameter of UC were significantly also significantly affected in the experimental groups (p=0.05). The histological changes produced by PIH were more pronounced in the umbilical veins compared to umbilical arteries, the caliber of these veins were significantly reduced (p=0.0002). The disruption of endothelium and basement membrane was observed in experimental groups and was directly related to the level of hypertension (p=0.02). Hypertrophy, fibrinoid necrosis and thrombosis of tunica media was observed in experimental groups as compared to control. The Wharton"s Jelly, cellularity was also decreased in experimental groups as compared to control group.

Keywords: Pregnancy induced hypertension. Endothelium, Basement membrane, Wharton's jelly

INTRODUCTION

Histological examination of the placenta provided a good audit for prenatal changes related to the health of the baby and the mother. Pregnancy induced hypertension including gestational hypertension, pre-eclampsia or eclampsia, complicates a significant proportion of all pregnancies and contributes significantly to increased maternal and perinatal morbidity and mortality. Blood pressure that goes up during pregnancy is a sign of pregnancy- induced hypertension. Pregnancy-induced hypertension may lead to pre eclampsia or toxemia. This usually occurs after the 20th week of pregnancy[1,2,3].

It has been observed and seen that in pre-eclampsia the maternal utero-placental blood flow is reduced due to maternal vasospasm. Reduced maternal utero-placental blood flow leading indirectly to constriction of foetal stem arteries has been associated with the changes seen in the placentae of pre-eclamptic women[4].

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Pre-eclampsia is a syndrome that is usually defined as the onset of hypertension and proteinuria after 20 weeks of gestation in previously normotensive non-proteinuria pregnant woman[5]. There are variable pathological changes observed in pregnancy induced hypertension like infarcts, minimal hypoxic changes, chronic villitis, intervillous thrombosis, sub-choral thrombosis, immaturity of the villi, and placental insufficiency[3,4,7].

The present study has been undertaken to evaluate the morphological changes in umbilical cord in pregnancy induced hypertension and its relationship with severity of the disease. The findings were compared with the placental findings in women with normotensive pregnancies.

MATERIALS AND METHODS

A minimum of 50 cases with pregnancy induced hypertension and 20 cases of normotensive pregnancies will be selected for the study. History of any past illness and investigated values of blood sugar, urea, creatinine, hemoglobin levels, blood group & type and presence of albumin and pus cells in the urine shall be recorded.Immediately after

delivery, the cord shall be clamped and the placenta shall be cut and placed in 10% neutral-buffered formal saline and allowed to fix for 2 weeks. The samples were collected from Lady Wallingdon Hospital (LWH) and Lady Aitchison Hospital Lahore (LAH). The thirty samples from PIH groups were classified into three subgroups based on the type of the pregnancy-induced hypertension, namely hypertension alone, pre-eclampsia and eclampsia.

Pregnant women with blood pressure levels of 140/90 mms of Hg or greater after 28 weeks of gestation were included in this study. Control group of pregnant women with normal blood pressure level (110/70 mm HG). Women suffering with other diseases like, Essential hypertension, Diabetes mellitus, Cardiac disease, Renal disorders, Rhesus incompatibility and cases of albuminuria due to local causes in the urinary tract. Experimental plan is given in table 1.

The umbilical arteries and veins were cannulated and flushed with normal saline followed by 10% formal saline. Then the labeled specimens were preserved and fixed in a labeled jar containing 10% formal saline for at least 24 hours. One cm thick sections were taken from each umbilical cord for processing in an automatic processor. 5 μm thick sections were cut and stained with haematoxylin, eosin and PAS (Periodic Acid Schiff) stains. The stained slides were studied under light microscope and following observation were made regarding

RESULTS

Morphological study for umbilical vessels (UV) and Wharton's jelly (WJ) was performed on 50 umbilical cords, 20 of which were of normal pregnancies while 30 specimens were of pregnancy induced hypertension (PIH). These 30 experimental samples from PIH groups were classified into three subgroups based on the type of pathogenesis i.e., the pregnancy-induced hypertension, namely hypertension alone, pre-eclampsia and eclampsia.

In group "A" out of 20 UCs, 16/20 (80%) were attached centrally, (0, 8±0.42), 2/20(10%) was battledore (0.1±0.31) and 2/20(10%) was villamentous (0.1±0.31). The colors of all UCs were pink and the mean weight of UC was 42.8±1.13 grams. Each of the UC has one vein and two arteries. The mean length of UC was 57.4±1.17 cm while the mean diameters of Proximal end, central and distal end of UC were 2.7±0.2, 2. 4±0.2 and 2.08±0.22 cm respectively. There was a significant difference in the UC Diameter of different groups with comparison to Control at Proximal and Distal level (P=0.05), (Table 2). Endothelium, basement membrane, tunica media of all (20/20; 100%) Umbilical vessels (UV) were intact while there was no abnormality detected in the wall of any vessel nor any thrombosis or necrosis seen. (Table 3-4). The maximum wall thickness of Umbilical vein (Uv) was 0.28 mm while minimum wall thickness was 0.24 mm (mean thickness of was 0.261±0.012 mm). The maximum luminal diameter of UV was 2.9 mm while minimum diameter was 2.5 mm and the mean diameter was 2.6±0.133 mm. (Table 9).Endothelium, basement membrane, tunica media of all (20/20; 100%) Umbilical Artery A (UA-A) were intact while there was no abnormality detected in the wall of any vessel nor any thrombosis or necrosis seen. (Table 7-9). The maximum wall thickness of UA-A was 0.60 mm while minimum wall thickness was 0.50 mm and the mean thickness of was 0.54±0.036 mm).The maximum luminal diameter of UA-A was 1.05 mm while minimum diameter was 0.85 mm and the mean diameter was 0.93±0.071 mm. (Table 9).Endothelium, basement membrane, tunica media of all (20/20; 100%) Umbilical Artery B (UA-B) was intact while there was no abnormality detected in the wall of any vessel nor any thrombosis or necrosis seen. (Table 7-8). The maximum wall thickness of UA-B was 0.63 mm while minimum wall thickness was 0.58 mm and the mean thickness of was 0.60±0.014 mm).The maximum luminal diameter of UA-B was 1 mm while minimum diameter was 0.75 mm and the mean diameter was 0.92±0.085 mm. (Table 9)

In group "B" out of 10 UCs, 8 (80%) were attached centrally (0.8±0.42), 1/10(10%) was battledore (0.1±0.31) and 1/10(10%) was villamentous (0.1±0.31). The colors of 8/10 (80%) UCs were pink while 2/10 (20%) were blue. The mean weight of UCs of PIH group was 40.8±1.68 grams. Each of the UC of this group has one vein (10/10; 100%), while one UC had single UA and the other 9 UCs were containing two arteries in each (mean 1.9±0.33). The mean length of UC was 52.9±1.44 cm while the mean diameters of Proximal end, central and distal end of UC were 2.15±0.25, 1.7±0.25 and 1.5±0.18 cm respectively. (Table 2). Eight out of ten (80%) Uvs showed intact endothelium while 2/10 (20%) showed disruption. Eighty percent (8/10) Uv exhibited normal basement membrane while 2/10 (20%) showed disruption. The tunica media of all (10/10; 100%) Uvs were intact. The wall thickness of all (10/10; 100%) was increased due to hypertrophy, there was no any thrombosis seen. Two of the Uvs (2/10; 20%) were showing partial fibrinoid necrosis in their walls (Table 3-4).Significant number of vessels showed hypertrophy in TM (Group B, C, D) and necrosis (C compared to A) (*P=0.0001, 0, 04*). (Table 5-6)

The maximum wall thickness of Umbilical vein (Uv) was 0.40 mm while minimum wall thickness was 0.34

mm (mean thickness of was 0.37±0.02 mm). The maximum luminal diameter of Uv was 2.5 mm while minimum diameter was 1.9 mm and the mean diameter was 2.14±0.16 mm. (Table 9). Eighty percent (8/10) UA-A showed intact endothelium while 2/10 (20%) depicted the disruption. Eight (8/10) UA-As displayed intact basement membrane while 2/10 (20%) showed disruption. The tunica media of all (10/10; 100%) UA-As showed hypertrophy. All of the vessels showed increase in the wall thickness of UA-As but no thrombosis seen. Two of the UA-As (2/10; 20%) were showing partial fibrinoid necrosis in their walls (Table 6). Significant numbers of UA-A showed hypertrophy in TM, vessel walls (Group B, C, D) as compared to A (P=0.0001, 0001 respectively). (Table 5-6). The maximum wall thickness of UA-A was 0.63 mm while minimum wall thickness was 0.55 mm and the mean thickness of was 0.58±0.027 mm). The maximum luminal diameter of UA-A was 0.96 mm while minimum diameter was 0.80 mm and the mean diameter was 0.85±0.60 mm (Table 9)

Eighty nine percent (8/9; 89%) UA-B showed intact endothelium while 1/9 (11%) depicted disruption. Eighty nine (8/9; 89%) UA-Bs displayed intact basement membrane while 1/9 (11%) showed disruption. The tunica media of all (9/9; 100%) UA-Bs showed hypertrophy. There was 100% (9/9) abnormality detected in the wall thickness due to hypertrophy of UA-Bs but no thrombosis was seen anywhere. One of the UA-B (1/9; 11%) was showing partial fibrinoid necrosis in its wall (Table 6). A significant number of UAs-B showing changes in endothelium, basement membrane, hypertrophy of wall and tunica media, however no significant changes were seen in thrombosis and Fibrinoid necrosis (*P=0.05,0.05,0.0002,0.0002 respectively*) (Table 7-8). The maximum wall thickness of UA-B was 0.64 mm while minimum wall thickness was 0.59 mm and the mean thickness of was 0.61±0.02 mm. The maximum luminal diameter of UA-B was 0.9 mm while minimum diameter was 0.58 mm and the mean diameter was 0.66±0.01 mm (Table 9).

The maximum cellularity of WJ was 45 cells/ High Power Field (HPF) and minimum cellularity was 32 cells/HPF while the mean cellularity of WJ was 38±4.5 cells/HPF (Table 9).

In group “C” Out of 10 UCs, 7 (70%) were attached centrally (0.7±0.48), 2/10(20%) were battledore (0.2±0.42) and 1/10(10%) was villamentous (0.1±0.31). The colors of 7/10 (70%) UCs were pink (0.7±0.48) while 3/10 (30%) were blue (0.3± 0.48). The mean weight of UCs of this group was 38.9±0.87 grams. Each of the UC of this group has one vein (10/10; 100%), while 2 UCs had single UA and the other 8 UCs were containing two arteries in each (mean 1.8±0.42). The mean length of UC was 51.6±2.01 cm while the mean diameters of Proximal end, central and distal end of UC were 2±0.23, 1.5 and 1.3±0.25 cm respectively. (Table 2).Seven out of ten (70%) Uvs showed intact endothelium 0.7±0.48 while 3/10 (30%) showed disruption 0.3±0.48. seventy percent (7/10) UV exhibited normal basement membrane 0.7±0.48 while 3/10 (30%) showed disruption 0.3±0.48. The tunica media of 7 (70%) Umbilical vessels (UV) were intact 0.7±0.48 while 3/10 (30%) showed hypertrophy 0.3±0.48. There were three (30%) Uvs, which showed necrosis 0.3±0.48 in their walls, while only 3 vessels wall (30%) showed mild thrombosis 0.3±0.48. Regarding necrosis, 2/10 (20%) of the Uvs wall displayed partial 0.2±0.42, while 1/10 (10%) depicted complete 0.1±0.31 fibrinoid necrosis in their walls (Table 3-4).There was a significant difference in disruption of basement membrane of different experimental group C and D as compared to control group A (*P= 0.02 and P=0.05* respectively) (Table 3). The maximum wall thickness of Umbilical vein (Uv) was 0.41 mm while minimum wall thickness was 0.33 mm (mean thickness of was 0.38±0.027 mm). The maximum luminal diameter of Uv was 2.2 mm while minimum diameter was 1.7 mm and the mean diameter was 2±0.17 mm. (Table 9). Seventy percent (7/10) UA-A showed intact endothelium while 3/10 (30%) depicted disruption0.7±0.48. Seventy (7/10) UA-As displayed intact basement membrane while 3/10 (30%) showed disruption 0.3±0.48. 7/10(70%) UAs-A. No tunica media (TM) was normal in UA-As, but showed hypertrophy in all (10/10,100%). The mild thrombosis was noted in 3/10 (30%) with mean 0.3±0.48 in UA-As lumen and partial fibrinoid necrosis was seen in the walls of 3/10 (30%) with mean 0.3±0.48 in UA-As, while complete necrosis was seen in one artery 0.1±0.31. (Table 5-6). A significant numbers of UAs-A showed fibrinoid necrosis of Group C as compared to Control group A (Table 5-6). The maximum wall thickness of UA-A was 0.66 mm while minimum wall thickness was 0.57 mm and the mean thickness of was 0.61±0.031 mm). The maximum luminal diameter of UA-A was 0.83 mm while minimum diameter was 0.78 mm and the mean diameter was 0.8±0.017 mm (Table 9). Five of the eight (62.5%) UA-B showed intact endothelium and intact BM while 3/8 (37.5 %%) depicted disruption and necrosis. The entire TM and vessels wall, of UA-Bs, of this group showed hypertrophy. There was mild thrombosis noted in 3/8 (37.5%) UA-B lumen and partial fibrinoid necrosis was seen in the walls of 3/8 (37.5%) UA-Bs, while complete necrosis was seen in one artery (1/8: 12.5%). (Table 7-8). The maximum wall thickness of UA-B was 0.64 mm while minimum wall thickness was 0.59 mm and the mean thickness of was 0.62±0.016 mm. The maximum

luminal diameter of UA-B was 0.67 mm while minimum diameter was 0.58 mm and the mean diameter was 0.62±0.028 mm (Table 9). The maximum cellularity of WJ was 31 cells/ High Power Field (HPF) and minimum cellularity was 29 cells/HPF while the mean cellularity of WJ was 30.2±1.03 cells/HPF (Table 9).

In group "D" Out of 10 UCs, 7 (70%) were attached centrally 0.7±0.48, 2(20%) were battledore 0.2±0.42 and 1(10%) was villamentous 0.1±0.31. The colors of 7/10 (70%) UCs were pink 0.7±0.48 while 3/10 (30%) were blue 0.3±0.48.The mean weight of UCs of this group was 38.9±0.87 grams. Each of the UC of this group has one vein (10/10; 100%), while 2 UCs had single UA and the other 8 UCs were containing two arteries in each (mean 1.8±0.42). The mean length of UC was 48.5±2.27 cm while the mean diameters of Proximal end, central and distal end of UC were 1.9±0.1, 1.1±0.2 and 1.1±0.2 cm respectively. (Table 2). Seven out of ten (70%) Uvs showed intact endothelium 0.7±0.48while 3/10 (30%) showed disruption 0.7±0.48. Seventy percent (7/10) UV exhibited normal basement membrane0.7±0.48 while 3/10 (30%) showed disruption 0.7±0.48. The tunica media of 7(70%) Umbilical vessels (UV) were intact 0.7±0.48 while 3/10 (30%) showed hypertrophy (mean 0.3±0.48). There were three (30%) Uvs, which showed necrosis in their walls, while only 3 vessels wall (30%) showed moderate degree of thrombosis 0.7±0.48. Regarding necrosis, 3/10 (30%) of the Uvs wall displayed complete fibrinoid necrosis 0.7±0.48 in their walls (Table 3-4). The maximum wall thickness of Umbilical vein (Uv) was 0.6 mm while minimum wall thickness was 0.46 mm (mean thickness of was 0.56±0.038 mm).The maximum luminal diameter of Uv was 1.52 mm while minimum diameter was 0.8 mm and the mean diameter was 1.32±0.27 mm (Table 9). Seven out of ten (70%) UA-As showed intact endothelium 0.7±0.48 while 3/10 (30%) showed disruption0.3±0.48. Seventy percent (7/10) UA-As exhibited normal basement membrane 0.7±0.48 while 3/10 (30%) showed disruption0.3±0.48. The entire of the TM and vessels wall of UA-As showed hypertrophy. Only 3 vessels (30%) showed moderate degree of thrombosis 0.3±0.48while 3/10 (30%) of the UA-As wall displayed complete fibrinoid necrosis 0.3±0.48 in their walls (Table 5-6). The maximum wall thickness of UA-A was 0.75 mm while minimum wall thickness was 0.56 mm and the mean thickness of was 0.68±0.036 mm). The maximum luminal diameter of UA-A was 0.75 mm while minimum diameter was 0.61 mm and the mean diameter was 0.70±0.038 mm (Table 9). Five of the eight (62.5%) UA-B showed intact endothelium and BM while 3/8 (37.5%) depicted disruption and necrosis in both parameters. All of the eight, UA-B showed hypertrophy of their TM and walls. The mild thrombosis was noted in 3/8 (37.5%) UA-B lumen and partial fibrinoid necrosis was seen in the walls of 3/8 (37.5%) UA-Bs, while complete necrosis was seen in one artery1/8(12.5%). (Table 7-8). The maximum wall thickness of UA-B was 0.74 mm while minimum wall thickness was 0.58 mm and the mean thickness of was 0.68±0.052 mm. The maximum luminal diameter of UA-B was 0.59 mm while minimum diameter was 0.51 mm and the mean diameter was 0.55±0.02 mm (Table 9). The maximum cellularity of WJ was 37 cells/ High Power Field (HPF) and minimum cellularity was 21 cells/HPF while the mean cellularity of WJ was 28.2±5.07 cells/HPF (Table 9).

Table 1: Experimental Plan of study to see the morphological changes in umbilical cord in pregnancy induced hypertension with respect to severity of the disease.

Groups	Blood Pressure	n	Criteria of Patients selection
A	Normotensive	20	Normal blood pressure (60-80/100-140 mm Hg)
B	Hypertension	10	Pregnancy induced hypertension. Diastolic > 90
C	Pre eclampsia	10	Pregnancy induced hypertension with protein urea. Diastolic > 90
D	Eclampsia	10	Pregnancy induced hypertension with protein urea and grand mal seizures. Diastolic > 90

Table 2; Gross examination of the Umbilical cord of the different Experimental Groups ("B,C,D") with comparison to Control Group "A"

Groups	Attachment			Color of UC		Weight	No of vessels		Length	Diameter(cm)		
	C-site	BD-site	VM-site	Pink	Blue	(Grams)	veins	arteries	Centimeter	P	C	D
Group A (Mean)	0.8	0.1	0.1	1	0	42.8	1	2	57.4	2.7	2.4	2.08
Group B (Mean)	0.8	0.1	0.1	0.8	0.2	40.8	1	1.9	52.9	2.15	1.7	1.5
Group C (Mean)	0.7	0.2	0.1	0.7	0.3	38.9	1	1.8	51.6	2.0	1.5	1.3
Group D (Mean)	0.7	0.2	0.1	0.7	0.3	38.9	1	1.8	48.5	1.9	1.1	1.1
P value	0.00	0.16	0.150	0.002	0.002	1.27	1.00	1.33	1.32	0.05	0.09	0.05

Key: UC: Umbilical Cord, C: Central, BD: Battledore, VM: Villamentous, P: Proximal, D: Distal,

Table 3. Histological changes in endothelium and Basement membrane umbilical veins of the Umbilical cord of the different experimental Groups with comparison to control group "A"

Sr. No	Endothelium		BM	
	Intact	DR	Intact	DR
	*20	0	*20	0
Group B	8	2	8	2
Group C	*7	*3	*7	*3
Group D	*7	*3	*7	*3
P value	0.02	0.050	0.02	0.050

Key words; BM: Basement membrane, DR: Disrupted

Table 4.Histological changes in endothelium and Basement membrane umbilical veins of the Umbilical cord of the different experimental Groups with comparison to control.

Sr. No	TM		Wall		Thrombosis			Fibrinoid Necrosis in wall	
	Normal	HT	Normal	HT	ML	MD	SR	Partial	Complete
	20	*0	20	0	0	0	0	*0	*0
Group B	10	0	0	10	0	0	0	2	0
Group C	7	*3	0	10	3	0	0	2	1
Group D	7	*3	0	10	0	3	0	0	3
P value	0.2	0.2		0.0001	0.2	0.2		0.2	0.2

Key words; TM: Tunica Media, HT: Hypertrophy, ML: Mild, MD: Moderate, SR: Sever;

Table 6; Histological changes in Umbilical Artery "A" of the Umbilical Cord of Different experimental Groups with comparison to the control
Key words; BM: Basement membrane, TM: Tunica Media, HT: Hypertrophy, ML: Mild, MD: Moderate, SR: Sever; DR: Disrupted.

Sr. No	Endothelium		BM	
	Intact	DR	Intact	DR
Group A (n=10)	20	0	20	0
Group B (n=10)	8	2	8	2
Group C (n=10)	7	3	7	3
Group D (n=10)	7	3	7	3
P value	0.2	0.2	0.2	0.2

Table 7; Histological changes in Tunica Media, vessel wall, thrombosis and necrosis in Umbilical Artery "A" of the Umbilical Cord of Different experimental Groups with comparison to the control group "A"

Sr. No	TM		Wall		Thrombosis			Fibrinoid Necrosis in wall	
	Normal	HT	Normal	HT	ML	MD	SR	Partial	Complete
Group A	20	0	20	0	0	0	0	0	0
Group B	0	10	8	10	0	0	0	2	0
Group C	0	10	7	10	3	0	0	3	1
Group D	0	10	7	10	0	3	0	0	3
P value		0.0001	0.2	0.0001	0.2	0.2	0	0.04	0.2

Table 8: Histological changes in umbilical Artery "B" of the Umbilical cord of the control group "A"

Sr. No	Endothelium		BM	
	Intact	DR	Intact	DR
Group A	20*	0	20	0
Group B (n=9)	8	1	8	1
Group C (n=8)	5*	3	5	3
Group D (n=8)	5*	3	5	3
P value	0.05	0.05	0.05	0.05

Key words; BM: Basement membrane, TM: Tunica Media, HT: Hypertrophy, ML: Mild, MD: Moderate, SR: Sever; DR: Disrupted

Table 9: Histological changes in umbilical Artery "B" of the Umbilical cord of the control group "A"

Sr. No	TM		Wall		Thrombosis			Fibrinoid Necrosis in the wall	
	Normal	HT	Normal	HT	ML	MD	SR	Partial	Complete
	20	0	20	0	0	0	0	0	0
Group B (n=9)	0	9	0	9	0	0	0	2	0
Group C (n=8)	0	8	0	8	3	0	0	3	1
Group D (n=8)	0	8	0	8	0	3	0	0	3
P value		0.0002		0.0002	0.2	0.2		0.04	0.2

Keywords; BM: Basement membrane, TM: Tunica Media, HT: Hypertrophy, ML: Mild, MD: Moderate, SR: Sever; DR: Disrupted

DISCUSSION

In our studied the colours of the umbilical cord was significantly affected in experimental groups as compared to the control group (*P=0.002*) and indirectly it could be due to deficiency of NO as studied by Luzi et al and Harrington et al (8, 9). This hypothesis was almost similar to the findings of Zhang YN et al who claimed, hypoxia was, responsible for this changes[10]..

The gestational ages, birth weight and placental weights were significantly lower for patients with PIH as compared to controls. This is expected because of the need to for medical intervention to save the life of the unborn child and that of the mother in case of PIH. In our study the weight and length of the umbilical cord of experimental groups were affected but there was no significant difference in the mean lengths and weights of these parameter in experimental groups versus control group (*P=1.27 and 1.32 respectively*). Our findings are consistent with Koech et al who found reduction in weight and length of the UCs in patients suffering from PIH[11]. It has been suggested that the weight and length of UC may be affected by the deficiency of Ghrelin, which has potent growth hormone (GH)-releasing activity with a dose-dependent manner and experimental data suggest that that ghrelin may be an important link between nutrition and growth. Ghrelin levels have been found to be elevated in patients with anorexia nervosa compared with those in healthy controls and it is suggested that plasma ghrelin levels reflect acute and chronic energy balance in humans[12].

In this study the attachment (central, battledore and villamentous) of UCs with placenta was not significantly (P=0.00, 0.15, 0.16 respectively) affected in PIH as compared to control group “A”. Our findings are almost similar to Ashfaq et al (2005) who found that there was no difference in the attachment of UCs in hypertensive mothers[13].

The diameter of UCs of experimental patients were affected and was found that there was a significant difference found in the UC diameter of different groups with comparison to control at proximal and distal level (*P=0.05*). Our findings are consistent with Koech et al (2008) who observed that PIH was associated with structural changes in the umbilical cord elements which were more obvious in the fetal end. The observed increase in wall-luminal ratio from the placental to the fetal end suggests that the fetal end of the umbilical vein has a more refined role in the regulation of blood flow to the fetus[11].

The reduction of diameter of the umbilical cord was significant in the group with PIH, and it is realized especially due to the Wharton’s jelly. All the conditions which lead to the limitation of the uterine growth are characterized by a narrow umbilical cord and a Wharton’s jelly very much reduced, until its complete disappearance *(P=0.05*). This change was more pronounced at the distal end as compared to proximal and central area. These findings are consistent with Ilie et al (2007) (14). It is recognized the fact that the key-factor, which contributes to the growth and development of the vascular element of the umbilical cord, is the progressive growth of the blood stream .In PIH cases, a umbilical vascular disorder was initially produced, which was accompanied by the growth of the umbilical vascular resistance and the reduction of the umbilical blood stream, with a fetal hypo-perfusion.

Single umbilical artery (SUA) is a relatively rare finding. In our study the numbers of umbilical arteries were also affected with PIH patients, each of the UC of this group has one vein (10/10; 100%), while 2 UCs had single UA and the other 8 UCs were containing two arteries in each (mean 1.8±0.42), however no significant differences was observed in the number of umbilical arteries of experimental groups as compared to the normal cords. (*P=1.32*). it cannot be concluded that whether PIH is responsible for single artery or presence single artery was the pathogenesis of PIH.Different experimental data suggest that a single umbilical artery splits into 2 as the developmental stage of the embryo advances, that fused umbilical arteries represent a remnant of the embryonic phenotype, and that fused umbilical arteries are embryologically distinct from true single umbilical artery (15). It has also been claimed that Single umbilical artery is associated with fetal malformation chromosome aberration in 25–50%, with IUGR and increased perinatal mortality in normally formed infants[16-21].

In our study the morphological modifications of the umbilical cord veins was detected in pregnancy induced hypertension (PIH) versus the normotensive pregnancy. We have observed that there was significant vascular endothelium disruption and vascular caliber reduction due to hyperplastic changes in wall thickness. There was a significant difference observed in disruption of basement membrane of different experimental group C and D as compared to control group A (*P= 0.02 and P=0.05 respectively*). In our study a significant number of vessels also showed hypertrophy in TM resulting in vascular endothelium thickening and vascular caliber reduction (Group B, C, D) (C compared to A) (*P=0.0001*). Some of the vessels in group C and D showed thrombosis but this there was no significant difference from the control group A (*P=0.2*). few of the veins also showed fibrinoid necrosis in group B,C and D but these lesions were not significant as compared to control group A. (*P=0.2*). Regarding the

structural variations in umbilical veins, in our study, the morphological changes were more progressively increased from the placental end to the fetal end. The umbilical veins in PIH had a greater wall thickness and a smaller luminal area as compared to the controls. The vein's wall-luminal ratio increased from the placental to the fetal end. Umbilical arteries A and B were also affected with PIH in patients of group B, C and D as compared to control group A. PIH is associated with structural changes in the umbilical vessels. These changes are more predominant in the vein than in the artery. Endothelium of the both Umbilical arteries A and B showed similar structural changes. These morphological lesion were more sever in UA-B as compared to UA-A. (P=0.05 as compared to 0.2). These lesions were significant UA-B as compared to control group. (*P=0.05*). There were thickening of vessels wall and narrowing of lumen with thrombosis and fibrinoid necrosis. Significant numbers of UA-A showed hypertrophy in TM, vessel walls (Group B,C,D) as compared to A (*P=0.0001,0.0001* respectively) and fibrinoid necrosis of Group C as compared to Control group A.

The theories proposed for the formation of fibrinoid include precipitation and inspissation of fibrin or other blood derivatives necrosis of collagen coagulation of the ground substance or a combination of these processes. Occlusive lesions in the arterial endothelium are often caused by formation of intimal hyperplasia and fibrinoid necrosis[22]. In this study some microscopic changes were detected in the section of the umbilical Arteries A and B in PIH patients included the lumen obliteration with destruction of Tunica media, endothelium, basement membrane, thrombosis and fibrinoid necrosis. Our findings go with that found by Robertson and Dixon (1969) they descried fibrinoid necrosis of the umbilical arteries. A significant number of UAs-B showing changes in endothelium, (*P=0.05*) basement membrane (*P=0.05*), hypertrophy of wall (*P=0.0002*), tunica media (*P=0.0002*) and Fibrinoid necrosis (*P=0.04*) however no significant changes were seen in thrombosis. In this study many histological changes were detected in the section of the umbilical vessels (Vein and arteries) taken from PIH (group B, C and D) patients included the wall thickness and luminal diameter and cellularity of Wharton's jelly, all these changes are a result of placental ischemia which the basis of toxemia of pregnancy, which lead to placental infarction, retroplacental heamatoma, villous ischemia and fibrinoid necrosis with acute atherosis of the uterine and fetal vessels as described by AL-Qzazz[23]. There was highly significant difference in the mean UVs thickness (*P=0.012*), Luminal diameter (P=0.005), UAs-A vessel wall thickness (P=0.0001),luminal diameter (*P=0.001*), UAs-B vessel wall thickness (*P=0.001*), luminal diameter (*P=0.004*) and Wharton's Jelly cellularity (*P=0.001*) of all changes seen in groups B, C and D as compared to control group A.

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