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Histoclinical analysis of blood-placental barrier in pregnant women with hypertension

Histokliniczna ocena bariery krwio-łożyskowej u ciężarnych z nadciśnieniem tętniczym krwi

In a pregnancy complicated by hypertension, blood flow analysis in the artery allows us to foresee a threat to the fetus. Abnormal blood flow in the umbilical artery makes it possible to discover vascular changes in placenta which can endanger the life of the fetus [7].

In the sheep pattern, Morrow et al. indicated that progressive embolization of the blood-placental vessels was connected with the gradual reduction in a part of the late-diastolic Doppler wave [10]. The results of the clinical and experimental observations show that abnormal shape of foetal umbilical artery suits increased vascular blood-placental resistance. Some fetuses with abnormal flow velocity waveforms demonstrate hypoxia and signs of acidosis. According to Morrow et al. hypoxia and acidosis of a fetus are not responsible for abnormality of the wave´s form [9]. A suggested mechanism of increased vascular blood-placental resistance formation is the closing of term villi arteriolas or their hypoplasia [2,6].

MATERIALS AND METHODS

Fifty three pregnancies complicated by hypertension were taken into evaluation. Hypertension was recognized when the pressure taken twice in within six hours was higher than 140/90 mm Hg. After all deliveries, placenta underwent morphologic examination in the Department of Pathomorphology. The number of epithelial plate and the number of vessels of terminal villi were counted in 1 mm^2 of placenta. The following were estimated: the surface, the perimeter and the diameter of villi and the length, the thickness and the surface of thin epithelial plate as well as the surface of vessels in villi. Quotient of the number of epithelial plates in 1 mm^2 to an average plate´s thicknesswas taken as an index of placental transport efficiency. The analysis utilized the method for counting the surface of metabolic exchange done by plate in placenta according to the formula (placental SMEP- surface of exchange of plates in the measured specimen, specimen´s V - specimen´s volume connected with the thickness of histological specimen suits 5 μm.)

According to the analysis of the umbilical artery flow velocity waveforms were defined qualitative indexes- systolic-diastolic index -A/B; resistance index -RI; pulsation index -PI. Values of fetal umbilical artery PI in normal pregnancies were used as references - PI≤ mean + 2SD was considered to be normal whereas > mean +2SD were defined as abnormal. The gravidas with hypertension were divided into 2 groups according to the result of blood flow in the umbilical artery: the first group- 35 patients with normal feto-placental flow, the second group – 18 patients with abnormal feto-placental flow; in 2 cases we observed the absence of end-diastolic flow of umbilical artery Doppler.According to the accepted criteria, those values were considered correct which were in the following range: average value plus twice the value of the standard deviation in the control group. The bordering value of the resistance index was 0,67. The T- Student test was used for statistical analysis of the results. Preg-

nancy week when measurements of blood flow were done was 37,4±2 week of gestation in a group with normal blood flow and 37±2 in patients with abnormal blood flow.

RESULTS

The average plate′s thickness in the group with abnormal feto-placental flow was 1,98 ±0,31µm, and it was significantly higher than in patients with hypertension and with normal Doppler examination-1,76 ± 0,17 µm (table 1). Results show that Doppler derived vascular patterns correlate well with normal and adverse perinatal outcome. In the group of gravidas with hypertension and abnormal fetoplacentel blood flow twice more often a cesarean section was made because of fetal emergency symptoms. The state of a newborn in patients with high hypertension and abnormal fetoplacetal flow was worse than in pregnant women with normal fetoplacental flow (table 2).

The results of our study indicate that the quality of feto-placental flow in pregnant women with hypertension results in parameters of filtration area in terminal villi. In the cases of complicated fetoplacental blood flow a thicker blood-placental barrier i.e. epithelial plate was found. An abnormal umbilical artery flow to be a predictor of IUGR and fetal distress in pregnancy complicated by hypertension. The analysis results of fetoplacental blood flow are one of the most important prognostic factors in pregnancies complicated by hypertension.

DISCUSSION

Kreczy et al. show the correlation between the quality index of feto-placental flow and the number of vessels in terminal villi of placenta [5]. They suggested that the decrease of the number of vessels could be caused by delayed angiogenesis. Studies by Mitra′s et al., which estimate feto-blood flow and carry out a morphometric estimation of placental vessels, indicate a correlation between RI and thickness of placental vessels [8].

Giles et al. noticed a statistically lower number of vessels in terminal villi in the group of 35 pregnancies with higher systolic-diastolic index [2]. According to the authors prenatal Doppler estimation identifies specific microvascular damages in placenta which are characterized by the vessels' obliteration in terminal villi. According to McCowan et al. there is a negative correlation between PI and the number of vessels in one terminal villi [6]. The only possible explanation for the PI decrease is, according to the authors, obliteration of small placental vessels.

In contradistinction to the mentioned authors, in the analysed group there were not statistical differences in the number of vessels in villi measured according to Doppler examination in the placentas of gravidas with hypertension (table 1). In both groups the average number of vessels in villi was 2,94 ± 0,4. Bracero et al. published similar results after analysing groups of patients in which gravidas with hypertension were in majority [1]. They did not notice a statistical difference in the number of vessels in villi in the group with increased A/B in the umbilical artery. According to Hitschold et al. the number of vessels in placental villi in the group of gravidas with hypertension is not statistically different from the group with an abnormal feto-placental flow from the group with a normal flow [3]. The same author in another article on fetuses with low birth weight did not notice any difference in the number of vessles in the group with normal feto-placental flow and in the group with abnormal feto-placental flow. However, he proves, as does the present study, the existence of a wider blood-blood barrier, i.e. a thicker plate in fetuses' placenta with a pathologic flow.

Likewise, scientists from Toronto observed thicker plates, without indicating differences in the number of vessels in placental villi in the pregnancies in which fetuses had a low birth weight [4]. According to the authors it is a result of vessels development disorder characterized by delayed maturation blood-blood barrier. All this causes not only increased feto-placental flow resistance (noticed in an earlier stage of pregnancy) but also a considerable restriction in exchange surface through which maternal-fetal exchange takes place. It causes a decrease in placental oxygen transport and, as a result, leads to fetuses' hypoxia and its development and growth disorder [4].

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ABSTRACT

Objectives: Correlations between quality indices of the blood flow in the fetal umbilical artery in pregnancies complicated by hypertension and parameters of low molecular exchange on the level of placental barrier was evaluated. Study design: Based on the result of umbilical artery flow, 53 pregnancies complicated by hypertension were divided into two groups: the first group of 35 patients with normal values of foeto-placental flow, the second - 18 patients with abnormal results of foeto-placental flow. The number of epithelial plates, the number of epithelial plates in 1 mm^2 of placental villous tissues and number of vessels in terminal villi were counted. The area, perimeter and diameters of terminal villi, length, thickness and area of thin epithelial plate, area of the blood vessel were estimated. Results: The morphometric analysis indicates that the quality of the feto-placental blood flow in pregnant women with hypertension results in parameters of filtration area in terminal villi. In cases of complicated foeto-placental blood flow, thicker blood-placental barrier i.e. epithelial plate was found. Conclusions:. In the cases of complicated feto-placental blood flow a thicker blood-placental barrier i.e. epithelial plate was found.

STRESZCZENIE

Poszukiwano korelacji pomiędzy współczynnikami jakościowymi przepływu krwi w tętnicy pępowinowej u chorych w ciąży powikłanej przez nadciśnienie, a parametrami niskocząsteczkowej wymiany krew-krew w łożysku. W oparciu o wynik przepływu krwi w tętnicy pępowinowej podzielono 53 ciężarne z nadciśnieniem na 2 grupy: - 35 ciężarnych z prawidłowymi wartościami przepływu płodowo-łożyskowego i 18 ciężarnych z patologicznymi wartościami przepływu. W kosmkach terminalnych obu analizowanych grup obliczano liczbę płytek nabłonkowych, ich liczbę w 1 mm^2, liczbę naczyń w kosmkach oraz powierzchnię, obwód, średnicę kosmka, jego długość, grubość, powierzchnię cienkiej płytki nabłonkowej i powierzchnię naczynia w kosmku. Przeprowadzona analiza morfometryczna wskazuje, że u ciężarnych z nadciśnieniem jakość przepływu płodowo-łożyskowego znajduje swoje odniesienie w parametrach strefy filtracyjnej kosmków III-rzędowych. W przypadkach zaburzonego przepływu płodowo-łożyskowego bariera krwio-łożyskową była istotnie szersza a płytka nabłonkową grubsza.

Table1. The results of morphometric placental examination in the group of gravidas with hypertension with reference to the results of umbilical flow

	Feto-placental-blood velocimetry	
	Normal n=35	Abnormal n=18
Thickness of thin epithelial plate (µm)	1,76 ±0,17	1,98 ±0,31*
Number of villis in 1 mm^2	145,8 ± 10,0	141,2 ±14,3
Number of terminal villis in 1 mm^2	67,7 ± 8,0	64,4 ± 8,0
Villi´s surface (μm^2)	1646,0±150,1	1698,1 ± 207,1
Villi´s circumference(µm)	148,1 ± 6,0	149,1 ± 7,0
Villi´s diameter(µm)	49,0 ± 2,6	49,8 ±1,3
Number of plates in mm^2	124,2 ± 26,4	116,2 ± 40,5
Lenght of plate (µm)	10,3 ± 1,5	9,9 ± 1,9
Plate´s surface (μm^2)	20,4 ± 3,9	22,3 ± 4,7
Number of plates in villi	1,83 ± 0.31	1,79 ± 0,49
Length of plates in villi (µm)	18,9 ± 4,6	18,3 ± 7,9
Plates' length to circumference ratio (%)	12,8 ± 3,0	12,2 ± 5,0
Number of vessels in villi	2,94 ± 0,4	2,94 ± 0,4
Vessels´surface in villi (μm^2)	160,0 ± 56,1	162,4 ± 73,6
Number of plates to number of vessels ratio (%)	62,6 ± 10,2	60,5 ± 14,7
Vessels' surface to villi´s surface ratio (%)	28,4 ± 8,7	28,0 ± 10,8
Placental index = fetal/placental weight	5,85 ± 1,5	5,27 ± 1,5
Placental transport index/exponent	71,8 ± 18,1	61,6 ± 28,5
Surface of exchange through plate in placenta (m^2)	1,37 ± 0,72	1,07 ± 0,86

*significance level p<0,05.

Table 2. Analysis of course of pregnancy and state of a newborn after delivery in correlation with feto-placental flow in women with hypertension

parametr	Feto-placental-blood flow				p
	Normal		abnormal		
	n=35	% 66	n=18	% 34	
Operative delivery for fetal distress	9	26	10	56	< 0.001
Apgar score ≤ 7 pkt. in 1 min.	9	26	11	61	< 0.001
Apgar score ≤ 7 pkt. w 5 min.	8	23	10	56	< 0.001
Maximum value of systolic > 180 mm Hg and	4	11	4	22	< 0.001
diastolic> 110 mm Hg blood pressure	6	17	8	44	< 0.001
proteinuria (≥ 300 mg/24 h)	10	29	9	50	< 0.001
Birthweight < 10 percentyl	7	20	11	61	< 0.001
Birthweight (g)	3170±644		1879±792		< 0.001
Gestational age at delivery (days)	264±14		261±14		NS
Apgar score in 1 min.	6,7±1,4		4,9±2,8		< 0.001
Apgar score in 5 min.	8,2±0,9		7,2±3,6		< 0.001
Mean arterial pressure	95±13		105±21		< 0.05