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Physiological parameters of erythrocytes against the background of regular exercise in the model conditions.

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ABSTRACT

The lack of the ability to follow the earliest stages of the emergence of microrheological disorders of erythrocytes on a human in view of the dropping out of the field of vision of clinicians of persons with the first signs of arterial hypertension dictates the need for carrying out experimental studies on laboratory animals with modeling of their arterial hypertension. In conditions of arterial hypertension, a relatively high efficiency of regular muscle loads in relation to, lowering blood pressure, and weakening platelet and vascular dysfunctions was previously shown. At the same time, the question of the effect of regular physical training on the rheological properties of erythrocytes in the very debut of the development of arterial hypertension remains unclear. Purpose: to assess the possibility of regular physical exertion in inhibition of pathological manifestations in erythrocytes under conditions of experimental formation of arterial hypertension. The study included 87 male rats of the Wistar line aged 2.5-3 months. Of these, 29 animals made up the control group of healthy. 58 rats after the formation of arterial hypertension were randomly divided into an experimental (31 rats) group and a control group of patients (27 rats). The rats of the experimental group underwent daily physical exertion on a horizontal treadmill for 60 days. Biochemical, hematological and statistical methods of investigation have been applied. In the formation of arterial hypertension in rats, a significant decrease in the number of erythrocytes-discocytes and the number of reversible and irreversible changes in their forms, which return to the level of regular control of healthy physical activity during 60 days, was revealed. With the development of arterial hypertension in rats, an increase in plasma lipid peroxidation and an increase in erythrocyte aggregation returned to the control values of healthy animals by the end of 60 days of physical exertion. The lack of regular physical exertion in rats with arterial hypertension was accompanied by the preservation of all violations of the recorded parameters with a consistently high level of blood pressure.

Keywords: model of arterial hypertension, rats, physical loads, erythrocytes, rheological properties.

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INTRODUCTION

Researchers still pay great attention to the study of the early stages of development of various pathologies and the initial mechanisms for its implementation [1,2]. A great interest is shown by researchers to the rheological features of various blood elements [3] and especially to their most numerous population - erythrocytes in cardiovascular disease [4,5]. Among them, in the whole civilized world, one of the leading positions is arterial hypertension (AH), which in its pathogenesis has genetic [6] and environmental companion [7]. It leads to wide disability of the population and makes a significant contribution to the mortality figures of people of working age [8]. It was noted that in the unfolded clinical picture of hypertension, especially aggravated by metabolic disturbances, micro-rheological properties of erythrocytes [9] and vascular control over them were noted [10], which significantly reduces the efficiency of microcirculation and the intensity of metabolism in all tissues [11,12]. At the same time, the state of microrheological characteristics of erythrocytes in the early stages of AH development remains very poorly studied.

The lack of the ability to trace the earliest stages of the emergence of microrheological disturbances of red blood cells on a person in view of the dropping out of the field of vision of clinicians of persons with the first signs of hypertension dictates the need for carrying out experimental studies on laboratory animals with the modeling of their AH. In AH conditions, a relatively high efficacy of regular muscle loads in relation to, lowering blood pressure and weakening platelet [2] and vascular dysfunctions was previously shown [5]. At the same time, the question of the effect of regular physical training on the rheological properties of erythrocytes in the very debut of AH development remains unclear. In this regard, the goal is to assess the possibility of regular physical exertion in inhibiting pathological manifestations in erythrocytes in conditions of experimental formation of arterial hypertension.

MATERIALS AND METHODS

The research was conducted in strict accordance with ethical principles established by the European Convent on protection of the vertebrate used for experimental and other scientific purposes (adopted in Strasbourg in March, 18th, 1986, and confirmed in Strasbourg in June, 15th, 2006) and approved by the local Ethics Committee of Russian State Social University (Record №16, dated December, 7th, 2015).

The study included 87 male Wistar rats aged 2.5-3 months, obtained from healthy females with the first-second litter. Of these, 29 animals were not affected and formed a control group of healthy individuals. They were examined two times: in the end and at the age of 5-5.5 months, that is, simultaneously with the end of the observation of the experimental rats. In the absence of statistically significant differences between the results of both surveys, the data obtained are represented by a single digit - their average arithmetic. 58 arterial hypertension was formed in 58 rats by prescribing a cardiovazonepho pathogenic semi synthetic diet for 2 weeks enriched with cholesterol loaded with salts of disubstituted sodium phosphate and potassium and magnesium deficient against the background of daily intramuscular injection of a 1.5 mg hydrocortisone acetate suspension per 100 g of body weight of the animal upon substitution water for drinking on a 1% solution of common salt and cold exposure to animals at the end of this 2-week exposure - 4°C for 4 hours. Subsequently, these rats were randomly divided into an experimental (31 rats) group and a control group of patients (27 rats). The rats of the experimental group experienced daily physical loads on the horizontal TORNEO treadmill of KETLER company, moving at a speed of 5 m / min for 60 consecutive days. The animals were placed in one of the sections of a wooden frame of a rectangular shape mounted on a treadmill, divided by wooden partitions into 3 parts for the individual placement of the animal. On the first day, the duration of the load was 1 minutes, followed by its lengthening by 1 minutes per day, bringing it up to 25 minutes per day and the subsequent unchanged duration for the day before the end of the observation. Patient control group was examined twice - at the time of formation of their pathology and at the age of 5-5.5 months, that is, at the same time when the observation of rats with AH subjected to physical exertion was completed. Due to the absence of static differences between the results of the first and second studies, the results are represented by a single digit - the average of the arithmetic mean between them.

Measurements of blood pressure (BP) in animals were performed non-invasively on the MLU / 4c501 instrument by applying the tail cuff (MedLab, China). The level of lipid peroxidation (LPO) in the plasma of animals was detected by the amount of thiobarbituric acid (TBA) -active products contained in it in the Agat-Med kit and in the content of acyl hydroperoxides (AHP), taking into account the level of antioxidant activity

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(AOA) of the liquid part of the blood [13]. In the red blood cells, concentrations of malonicdialdehyde (MDA) and AHP, as well as the activity of catalase and superoxide dismutase (SOD) were determined [13]. In them, the level of cholesterol was assessed enzymatically by a set of Vitaldiagnostikum (Russia) and the concentration of total phospholipids was determined by the content of phosphorus with the calculation of the ratio of cholesterol/total phospholipids. Cytoarchitectonics of erythrocytes was determined by phase contrast microscopy with their subdivision into discocytes, reversibly deformed and irreversibly altered forms. Aggregation activity of erythrocytes was determined with the help of a light microscope in the Goriaev chamber in terms of the number of aggregates, the number of aggregated red blood cells not aggregated and suspended in the suspension of washed red blood cells. The results are processed by Student's (t) test.

RESULTS AND DISCUSSION

The experimental rats showed a stable increase in systolic and diastolic blood pressure. With regular loads on the treadmill, a gradual decrease in the systolic and diastolic blood pressure values was observed in this group of rats and after 60 days. Observations of blood pressure were statistically significantly different from those in the group of healthy control animals (Table).

Table: Dynamics of arterial pressure, biochemical and hematological parameters in experimental rats

Indicators	Experimental formation of pathology, M±m		Use of meldoniumin rats with formed pathology, M±m, n=31				Control, M±m	
	initialstate, n=58	end of pathology modeling, n=58	initialstate	20 days	40 days	60 days	sick, n=27	healthy,n=29
systolic blood pressure, mm Hg.	110.1±0.29	155.3±0.46 p<0.01	110.6±0.43 p<0.01	142.7±0.40 p<0.01	122.1±0.33 p<0.05	112.6±0.27	113.6±0.54 p<0.01	110.3±0.36
diastolic blood pressure, mm Hg.	74.6±0.24	95.1±0.39 p<0.01	94.9±0.42 p<0.01	88.2±0.36 p<0.01	81.3±0.32 p<0.01	76.2±0.25	95.5±0.47 p<0.01	74.2±0.30
Acylhydroperoxides of plasma, D_{233}/l ml	1.62±0.017	1.91±0.034 p<0.01	1.92±0.032 p<0.01	1.85±0.028 p<0.01	1.75±0.024 p<0.05	1.64±0.029	1.95±0.039 p<0.01	1.63±0.019
Thiobarbituric acid-products of plasma, umol/l	3.71±0.036	4.22±0.047 p<0.01	4.24±0.044 p<0.01	4.10±0.037 p<0.01	3.96±0.035 p<0.01	3.72±0.029	4.25±0.045 p<0.01	3.69±0.32
Antioxidant activity ofplasma, %	28.7±0.31	24.3±0.49 p<0.01	24.5±0.52 p<0.01	25.7±0.43 p<0.01	26.9±0.45 p<0.01	28.2±0.36	24.1±0.51 p<0.01	28.8±0.29
cholesterol of erythrocytes, umol/10^{12} erythrocytes	0.92±0.022	1.00±0.031 p<0.05	1.01±0.034 p<0.05	0.98±0.030 p<0.05	0.95±0.026	0.93±0.028	1.01±0.038 p<0.05	0.92±0.023
total phospholipids of erythrocytes, umol/10^{12} erythrocytes	0.67±0.024	0.65±0.036	0.65±0.032	0.65±0.035	0.66±0.028	0.67±0.025	0.65±0.036	0.68±0.022
cholesterol/totalphospholipids of erythrocytes	1.37±0.020	1.56±0.029 p<0.01	1.55±0.019 p<0.01	1.51±0.023 p<0.01	1.43±0.020 p<0.05	1.39±0.025	1.55±0.032 p<0.01	1.35±0.019
acylhydroperoxides of erythrocytes,	2.76±0.019	3.36±0.024 p<0.01	3.39±0.033 p<0.01	3.28±0.029 p<0.01	3.04±0.027 p<0.05	2.77±0.030	3.41±0.032 p<0.01	2.74±0.017

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$D_{233}/10^{12}$ erythrocytes								
malonicdialdehyde of erythrocytes, nmol/10^{12} erythrocytes	0.90±0.016	1.12±0.029 p<0.01	1.14±0.031 p<0.01	1.07±0.028 p<0.05	1.00±0.024	0.92±0.020	1.15±0.034 p<0.01	0.91±0.018
catalase of erythrocytes, ME/10^{12} erythrocytes	9870.0±12.6	8802.0±14.7 p<0.01	8810.0±16.3 p<0.01	9100.0±13.8 p<0.05	9510.0±10.1 p<0.05	9875.0±14.3	8809.0±16.2 p<0.01	9880.0±11.9
superoxidismutase of erythrocytes, ME/10^{12} erythrocytes	1820.0±3.74	1640.0±4.28 p<0.05	1610.0±6.31 p<0.05	1720.0±6.86 p<0.05	1776.0±6.86	1807.0±5.92	1695.0±8.42 p<0.05	1830.0±4.05
erythrocytes-discocytes,%	83.8±0.39	72.7±0.48 p<0.01	71.9±0.52 p<0.01	74.6±0.47 p<0.01	78.7±0.39 p<0.05	82.5±0.41	71.4±0.55 p<0.01	84.0±0.34
reversibly modified erythrocytes,%	9.7±0.32	16.8±0.41 p<0.01	17.4±0.37 p<0.01	15.0±0.33 p<0.01	12.4±0.30 p<0.01	10.6±0.36	17.2±0.46 p<0.01	9.5±0.29
irreversibly modified erythrocytes,%	6.5±0.28	10.5±0.32 p<0.01	10.7±0.34 p<0.01	10.4±0.31 p<0.01	8.9±0.27 p<0.01	6.9±0.25	11.4±0.35 p<0.01	6.5±0.25
sum of all the erythrocytes in an aggregate	37.5±0.09	46.8±0.12 p<0.01	47.0±0.08 p<0.015	45.0±0.05 p<0.01	42.1±0.08 p<0.05	38.5±0.09	46.6±0.13 p<0.01	37.3±0.07
quantity of aggregates	8.7±0.10	11.8±0.09 p<0.01	11.9±0.07 p<0.01	10.2±0.08 p<0.01	9.6±0.08 p<0.05	8.9±0.06	11.7±0.11 p<0.01	8.8±0.04
quantity of free erythrocytes	248.1±0.56	229.0±0.67 p<0.01	228.3±0.64 p<0.01	235.7±0.53 p<0.05	243.1±0.56	247.1±0.44	229.2±0.71 p<0.01	249.2±0.52

Conventional signs: p - found reliability of indices' differences with control group of healthy animals.

In rats with hypertension, there was an increase in the amount of AHP and TBA-active products in the plasma. With the maintenance of regular loads in these rats, the concentrations of AHP and TBA products in plasma gradually decreased to a level close to that of healthy ones. The revealed enhancement of LPO in modeling in AH rats was possible due to a decrease in plasma AOA by 18.1%. Regular muscular loadings were accompanied by an increase in the level of this indicator from 24.5 ± 0.52% at the beginning to 28.2 ± 0.36% by 60 days observations (Table).

When AH was formed in rat erythrocytes, the amount of cholesterol was slightly increased, while the content of their membranes in the total phospholipids tended to decrease, which led to a significant increase in the gradient of cholesterol/total phospholipids. Against the background of regular muscular loadings in erythrocytes, a gradual decrease in cholesterol and an increase in the total phospholipids was revealed, which ensured the optimization of the ratio of cholesterol/total phospholipids and the improvement of their functions [14,15].

During the formation of hypertension in erythrocytes in rats, lipid peroxidation was activated by weakening the activity of their antioxidant protection. Against the background of physical loads on the treadmill in rats with AH, the content of AHP and MDA in erythrocytes progressively decreased and by 60 days. The experiment achieved a level of control of healthy, apparently, due to increased metabolism [16,17]. The revealed changes in LPO activity in erythrocytes in the observed animals during the formation of hypertension and against subsequent physical exertion were possible as a result of depression, followed by the activation of catalase and superoxide dismutase by 10.8% and 10.9%, respectively (Table). This is due to the increased synthesis of these molecules [18, 19].

With the formation of AH in the blood in rats, the number of erythrocytes-discocytes decreased and the amounts of reversed and irreversible erythrocytes changed, returning to the control level of healthy for 60 days as a result of regular muscle loads [20,21]. With the development of AH rats, an increase in the amount of red blood cells in the aggregate and in the number of these aggregates was found while reducing the number of free red blood cells returning to control values by the end of 60 days of physical activity, optimizing metabolism [22,23]. The lack of regular physical activity in the rats of the patient control group was accompanied by the preservation of all disorders of biochemical and hematological characteristics with a consistently high level of blood pressure. Apparently, low physical activity leads to a deterioration in hematological parameters [24-29].

CONCLUSION

Regular physical exertion with developing hypertension enhances the antioxidant defense of blood plasma and red blood cells, weakening LPO in them. Physical loads in rats with AH normalize cytoarchitectonics of erythrocytes and their aggregation capacity for 60 days.

REFERENCES

[1] Kotseva K, Wood D, De Backer G. (2009) Euroaspre Study Group. Cardiovascular prevention quidelines in daily practice: a comparison of Euroaspre I, II, and III surveys in eiqht European countries. Lancet.373 : 929-940.

[2] Kotova OV, ZavalishinaSYu, Makurina ON, KipermanYaV, Savchenko AP, Skoblikova TV, Skripleva EV, Zacepin VI, Skriplev AV, AndreevaVYu. (2017) Impact estimation of long regular exercise on hemostasis and blood rheological features of patients with incipient hypertension.Bali Medical Journal. 6(3): 514-520. doi:10.15562/bmj.v6i3.552

[3] Zamorano J, Edwards J.(2011) Combining antihypertensive and antihyperlipidemic agents - optimizing cardiovascular risk factor management. Integr.Blood Press Control.4 : 55-71.

[4] VatnikovYuA, ZavalishinaSYu, Pliushchikov VG, Kuznetsov VI, Seleznev SB, Kubatbekov TS, Rystsova EO, Parshina VI. (2017) Early-changes diagnostics of erythrocytes microrheological features in the model of dyslipidemia development in rats at the late stages of ontogenesis. Bali Medical Journal. 6(1) : 216-222.doi: 10.15562/bmj.v6i1.483

[5] Skoryatina IA, ZavalishinaSYu. (2017) Ability to aggregation of basic regular blood elements of patients with hypertension anddyslipidemia receiving non-medication andsimvastatin.Bali Medical Journal. 6(3): 514-520.doi:10.15562/bmj.v6i3.553

[6] Gurevich VS. (2013) Correction of dyslipidemia with concomitant arterial hypertension from the perspective of an updated paradigm of cardiovascular risk.Systemic hypertension.3 : 54-59.

[7] ZavalishinaSYu, VatnikovYuA, Kulikov EV, Yagnikov SA, Karamyan AS, Sturov NV, Byakhova VM, Kochneva MV, Petryaeva AV. (2017) Diagnostics of erythrocytes' microrheological features and early abnormalities of rats in the model of experimental hypertension development. Bali Medical Journal. 6(3): 470-475. doi:10.15562/bmj.v6i3.589

[8] Bikbulatova AA, Karplyuk AA, Tarasenko OV. (2017) Model of Activities of the Resource Training Center of the Russian State Social University in Terms of Professional Orientation and Employment of Persons with Disabilities.Psikhologicheskayanaukaiobrazovanie. 22(1): 26-33.

[9] VatnikovYuA, ZavalishinaSYu, Kulikov EV, Vilkovysky IF, Nikishov AA, Drukovsky SG, Krotova EA, Khomenets NG, Bolshakova MV.(2017) Correctional abilities of regular muscle activity in relation to erythrocytes' microrheological features of rats with experimentally developed hypertension.Bali Medical Journal. 6(3): 449-456. doi:10.15562/bmj.v6i3.586

[10] Folsom AR.(2013) Classical and novel biomarkers for cardiovascular risk prediction in the United States. J Epidemiol.2013; 23: 158-162.

[11] ZavalishinaSYu. (2012) Dynamics of hemostasis system at newborn calves with iron deficiency by use ferroglucin and glicopin. Zootekhniya.7 : 14-16.

[12] ZavalishinaSYu. (2012) Platelet activity in newborn calves with iron deficiency anemia.Veterinariya.2 : 51-52.

[13] Volchegorskiy IA, Dolgushin II, Kolesnikov OL, Tseilikman VE. (2000) Experimental modeling and laboratory evaluation of adaptive reactions of the organism.Chelyabinsk, 167.

[14] ZavalishinaSYu.(2012) Vascular hemostasis at calves in milk-and-vegetable phase of feeding. Zootekhniya.2 : 21.

[15] ZavalishinaSYu, Nagibina EV.(2012) Dynamics of microrheology characteristics of erythrocyte in children 7-8 years with scoliosis with therapeutic physical training and massage // Technologies of Living Systems. 9(4) : 29-34.
[16] Bikbulatova AA. (2018) The Impact of Daily Wearing of Medicinal-Prophylactic Clothes on The Evidence of Clinical Manifestations of Osteochondrosis Of The 2nd Degree and Platelet Activity in Persons Of The Second Mature Age. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 9(1) : 677-683.
[17] ZavalishinaSYu.(2010) Anticoagulative and fibrinolitic activity of plasma of blood at calves. Veterinariya. 11: 41-43.
[18] Bikbulatova AA, Pochinok NB. (2017) Professional Skills Competitions for People with Disabilities as a Mechanism for Career Guidance and Promotion of Employment in People with Special Needs.Psikhologicheskayanaukaiobrazovanie. 22(1) : 81-87.
[19] ZavalishinaSYu. (2011) Functional condition of system of a hemostasis at newborn calves.Veterinariya.6 : 42-45.
[20] ZavalishinaSYu.(2012) Activity of a vascular hemostasis at calfs of a dairy food. Russian Agricultural Sciences. 4 : 49-51.
[21] ZavalishinaS.Yu. (2012) Hemostatic activity of a vascular wall at newborn calfs.Russian Agricultural Sciences.1 : 37-39.
[22] ZavalishinaSYu. (2013) State of the system in neonatal calves in hemostasis with iron deficiency. Russian Agricultural Sciences. 3 : 43-46.
[23] ZavalishinaSYu. (2013) Vascular hemostasis in newborn calves with ferrum deficiency treated withferroglucin. Zootekhniya.8 : 24-26.
[24] ZavalishinaSYu.(2014) State regulation-vascular interactions in newborn piglets with iron with ferroglucin and glikopin. Russian Agricultural Sciences.1 : 57-59.
[25] ZavalishinaSYu. (2013) Hemostatic activity of thrombocytes in calves during the phase of milk feeding.Agricultural Biology.4 : 105-109.
[26] ZavalishinaSYu. (2013) Gemostatical activity of vessels piglets vegetable nutrition. Veterinariya.8 : 43-45.
[27] ZavalishinaSYu. (2010) Activity of curtailing of blood plasma in calves of a dairy feed.Veterinariya. 8 : 49-51.
[28] ZavalishinaSYu. (2010) Activity of blood coagulation system at healthy calves at phase of milk-vegetable feeding.Zootekhniya. 9 : 13-14.
[29] ZavalishinaSYu. (2011) Fibrinolysis blood activity at calves in the first year of life.Zootekhniya. 2 : 29-31.