

MEDICAL SCIENCES

THE RHEOLOGICAL PROPERTIES OF BLOOD IN HEMORRHAGIC VASCULITIS IN DIFFERENT ECOLOGICAL REGIONS

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ABSTRACT

The aim of the work: to assess the physicochemical adsorption and rheological properties of the blood serum of patients with hemorrhagic vasculitis (HV) according to the hygienic condition of the air, water and soil in regions of patients residence. **Materials and methods.** The study involved 106 patients with HV (56% of men and 44% women with the average age 26 years). Indicators of surface viscosity (SV), bulk viscosity (BV), surface elasticity (SE), module of viscoelasticity (MV), relaxation time (RT), the surface tension at $t=0,01$ s (ST1), $t=1$ s (ST2), $t=100$ s (ST3), and the equilibrium (static) surface tension at $t \rightarrow \infty$ (ST4), the angle of inclination (AI) and phasic angle (PA) of tensiograms were studied using computer tensiometry of serum, surfactant criterion of interfacial activity (SCIA) were calculated. The results were compared with environmental pollution by xenobiotics and microelements of air, water and soil of zones of patients residence. **Results and discussion.** Adsorption-rheological properties of serum of patients with HV depend on the integrated degree of pollution by xenobiotics of air and drinking water (but not of soil by chemical elements), the degree of emissions and accumulation of industrial waste in it, the nature of the impact of modernization of agriculture, metallurgical, chemical and engineering industries in the regions, levels of 3,4-benzpyrene (ST2, PA), phenol (BV, PA), ammonia (SCIA), nitrogen dioxide (ST1, ST2, ST3), carbon dioxide (SE, RT, ST1, ST2, ST4) in the breathing air, the degree of mineralization and hardness of drinking water (MV), the parameters of toxic microelements and essential zinc (ST3) in the soil. **Conclusions.** Breach of the adsorption-rheological properties of blood serum in HV depend on hygienic condition of air, water and soil in regions of patients residence, the environmental burden on the atmosphere by the different branches of industry and agriculture.

Keywords: hemorrhagic vasculitis, blood, serum, rheology, ecology, air, water, soil.

Introduction. As is known, the most common variant of systemic vasculitis is immune complex hemorrhagic vasculitis [2, 8], the prevalence of which depends on the ecological components of the region of residence of patients [12, 13]. Now clearly established the adverse vascular effects of environment pollution due to energy development [11] and production of construction materials [10], power steel [1, 4], chemical [3] and other industries [9].

Exogenous xenobiotics contribute to the formation of endothelial dysfunction of blood vessels (ED), followed severe disturbances of blood rheological properties [15]. HV pathogenesis is unclear, but a specific value is given the ED, which in these patients is accompanied by changes of blood rheology [14] with high plasma viscosity [5, 6]. It should be noted that the severity of changes in physico-chemical prop-

erties of blood in systemic vasculitis determines the negative effect on the endothelial cells of the vascular wall [7]. The impact of environmental constituents on the state of the adsorption-rheological properties of blood serum in patients with HV not been studied.

The aim of the study was to assess the physicochemical adsorption-rheological properties of blood serum in patients with HV depending on hygienic condition of the air, drinking water and soil of the region of residence of patients.

Material and methods. The study included 106 patients 106 patients with HV aged from 15 to 53 years (average $26 \pm 1,1$ years). Among these patients there were 56% men and 44% women. Disease duration was $9 \pm 0,5$ years. The age of onset of the pathological process ranged from 8 to 39 years (mean $18 \pm 0,8$ years). The acute course of the disease oc-

curred in 19% of cases, 1th degree of activity of pathological process – 15% 2nd-38%, 3rd – 47%.

At previous stages the skin lesions in the form of a hemorrhagic palpable purpura was present in all patients, without exception. At the time of examination of skin pathology diagnosed in 77% of cases, renal in 70%, heart – 53%, joint – 47%, liver – 25%, digestive tract – 15% of skeletal muscles in 9%. Antibodies to proteinase-3 in serum was detected in 4% of patients, myeloperoxidase – 68%, hyperimmunoglobulin-A-emia (>M+SD indicators healthy) – 89%. The level of immunoglobulin (Ig) A in the blood amounted to 2.7 ± 0.15 mmol/l, $IgA/\Sigma Ig = 12,3 \pm 0,77\%$, rheumatoid factor and $6.1 \pm 0,54$ mE/ml. Arterial hypertension installed in 36% of cases. Parameters mean arterial pressure in the examined patients was 106 ± 2.3 mm Hg, total peripheral vascular resistance – $2546 \pm 109,1$ dyn \times s \times cm $^{-5}$, the glomerular filtration rate is 114 ± 3.2 ml/min (according to the formula of Cockcroft-Gault). 23% patients of the total number and 32% of patients with established glomerulonephritis renal failure (chronic kidney disease stage I). Violations of excitability of the myocardium found in 17% of cases, the electrical conductivity of the heart in 30%, change the valves and chambers of the heart respectively in 40% and 25%, diastolic dysfunction of the left ventricle is 4%.

To assess the adsorption-rheological properties of blood serum conducted dynamic interphase tensiometry using computer devices "MPT2-Lauda" (Germany), "ADSA-Toronto" (Germany-Canada) and "PAT2-Sinterface" (Germany). Studied surface viscosity (SV), surface elasticity (SE), the modulus of viscoelasticity (VE), relaxation time (RT) and the dynamic surface tension (ST) at the "life times" of the surface, equal to 0.01 s (ST1), 1 (ST2), 100 (ST3), and the equilibrium or static (ST4) at $t \rightarrow \infty$ calculated the ratio ST4/ST1, the angle of inclination (AI) and phase angle (PA) tensioners determined criterion surfactant interfacial activity (SCIA). By using a rotational viscometer "Low-Shear-30" (Switzerland) investigated the bulk viscosity (BV) serum. As a control, there were 52 healthy volunteers (25 men and 27 women aged 17 to 56 years).

Hygienic assessment of anthropogenic pollution of the environment was conducted based on the determination of xenobiotics in air, soil and drinking water. Data were obtained in laboratory studies of the regional offices of the State committees for Hydrometeorology, environmental control and environmental safety. In soil 34 regions of Donetsk region investigated the levels of trace microelements (DOE) – Ba, Be, Bi, Co, Cr, Cu, Hg, Li, Mn, Mo, Ni, Pb, Sn, Ti, V and Zn.

Statistical processing of the results of research conducted by computer variation, nonparametric, correlation, single- (ANOVA) and multivariate (ANOVA/MANOVA) analysis of variance (program "Microsoft Excel" and "Statistica-Stat Soft", USA). Estimated mean values (M), their standard errors (m), standard deviations (SD), Pearson correlation coefficient (r), the criteria of dispersion of the Brown-Forsythe (D) analysis Wilcoxon-Rao (WR), student (t)

and the reliability of statistical indicators (r). The critical level of significance when testing statistical hypotheses in this study took over one that was equal to 0.05.

Results and their discussion. Patients with HV in comparison with healthy people of the control group there is a significant increase in BV blood by 23%, ST2 by 2% ST3 by 5%, ST4 by 8%, increased ST4/ST1 by 10% PA by 38% reduction in the SV of 21%, MV - 20%, ST1 - 2% SCIA and of 21%, respectively, stated (more or less $M \pm SD$ healthy) in 42%, 47%, 43%, 55%, 53%, 55%, 47%, 19%, 34% and 85% of patients.

As shown by multivariate analysis analysis Wilcoxon-Rao, integrated state adsorption-rheological properties of blood serum in patients with HV is affected by the degree of disease activity (WR=5,17, $p=0.011$) and severity (WR=of 6.80, $p<0.001$). Performed ANOVA/MANOVA indicates a significant impact on the physicochemical properties of the blood serum of pancreatic lesions, nervous system and heart. According to the analysis of the brown-Forsythe AI centigram closely associated with the severity of changes in the nervous system and valve apparatus of the heart. The BV parameters have a significant impact activity HV, pathology of the kidney and nervous system, SE – changes in the gastrointestinal tract, RT is the pancreas and liver, SCIA – pancreas and nervous system. In addition, RT depends on the availability of patients with arterial hypertension and PA centigram from kidney failure.

It is established that the integral degree of air pollution (Q) has a significant effect on the parameters SE, RT, ST1, ST2, ST3, ST4, ST4/ST1 and PA, the nature of drinking water (R) – only on the level of interfacial activity in the field of long time of existence of the surface, and the content of ME in the soil (S) at adsorption-rheological properties of blood serum patients no effect. Parameters ST4 and ST4/ST1 directly correlate with the index Q, and AI and PA. ST4 and ST4/ST1 have positive relationship with R, which, moreover, negatively correlated with PA centigram. Given the one-way ANOVA made the following conclusion: poor environmental state of the atmosphere in areas of residence of patients with hemorrhagic vasculitis causes an increase in equilibrium interfacial activity of blood serum that must be considered when analyzing the performance of the adsorption-rheological properties of blood serum.

As shown by multivariate analysis analysis Wilcoxon-Rao, integrated state adsorption-rheological properties of blood serum in patients with HV influence emission levels in the atmosphere (WR=4,74, $p=0,022$) and the accumulation of industrial waste (WR=7,06, $p<0.001$). According to the results of the performed ANOVA, the level of emissions of industrial waste to the territory for the year depend on the indicators RT, ST1, ST2, ST3, ST4, ST4/ST1 and PA per person – ST1, ST2, ST3, ST4/ST1 and PA, and the level of accumulation in the atmosphere of industrial waste effect on the parameters SE, ST1, ST2, ST3, ST4/ST1 and PA. Correlation analysis indicates a direct relationship between the equilibrium interfacial

activity and decreased ST4/ST1 with the degree of atmospheric pollution of industrial enterprises.

Only the strong development in the region coal mining industry and energy do not have a dispersive effect on selected indicators of adsorption-rheological properties of blood serum in patients with HV. In turn no dependence on atmospheric pollution by industries of the parameters BV, ST3, ST4, AI and SCIA. However, highly developed metallurgical industry affects the values of SE, RT, ST1, ST2, ST4/ST1 and PA, chemical – RT, ST1, ST2, and PA, engineering – SE and ST4/ST1, strong development of rail and road transport – SV, agriculture – MV, RT, and PA.

A high degree of development in the region's steel industry increases, the equilibrium surface activity, as evidenced by direct correlation with ST4 and ST4/ST1, possibly due to the reduction in patients blood macromolecular surfactants. In addition, there are direct correlations S with the development of production of construction materials, and SCIA with the level of agro-industrial complex.

The individual components of the composition of the inhaled air when VSG are independent indicators of SV, MV and AI, there is no effect of sulphur dioxide on the parameters of the adsorption-rheological properties of blood serum. The concentration of 3,4-benzpyrene independent values, ST4/ST1 and PA, phenol – BV and PA, from ammonia – SCIA, nitrogen dioxide – ST1, ST2 and ST3, from carbon dioxide – SE, RT, ST1, ST2, ST4 and ST4/ST1, from hydrogen sulfide – SE, RT, ST2, ST4/ST1 and PA.

According to the performed ANOVA, the nature of the constituents of drinking-water has no effect on the performance of the adsorption-rheological properties of blood serum in patients with hemorrhagic vasculitis. In turn the MV back depend on the degree of mineralization and water hardness, which demonstrates a correlation analysis.

A challenge for further research became based on the adsorption-rheological properties of blood serum in patients with hemorrhagic vasculitis of the level of micronutrients in the soil. Were selected those indicators that had both a reliable dispersion and correlation. This was only one influence on the ST3 content in soil Zn ($D=4,27$, $p=0,030$) and the correlation between these parameters ($r=0,616$, $p<0,001$).

Conclusions.

1. Changes in adsorption-rheological properties of blood serum in patients with HV depend on the integral of the degree of pollution by xenobiotics accumulation in it of waste mainly metallurgical industry, levels in the air of carbon dioxide, which primarily concerns the equilibrium interfacial activity of serum and mineralized drinking water in relation to the viscoelastic properties of blood.

2. Adsorption-rheological properties of blood serum in patients with HV related to the nature of the microelement composition of soil, what is the main importance is given to Zn and indicator ПН3.

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