PROTEIN COMPOSITION OF THE BLOOD SERUM IN EXPERIMENTAL HYPERTENSION INDUCED BY A PARTIAL CONSTRICTION OF THE LUMEN OF V. PORTA AND ISCHEMIZATION OF THE LIVER

F. A. Morokhov

Department of Pathophysiology (Head, Prof. L. R. Perel'man)
of the Leningrad Sanitary-Hygienic Medical Institute (Scientific
Director, Corresponding Member of the AMN SSSR Prof. P. D. Gorizontov)
(Presented by Active Member AMN SSSR I. R Petrov)

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In recent years, through clinical observations by many authors [2,3,9], the development of hypertension has been established in patients suffering from thrombosis and embolism of the vessels of the abdominal cavity, as well as upon the impairment of local circulation in the liver and other pathological processes in the organs of the abdominal cavity.

We established in previous experiments on dogs [6,7] that in acute and partial constriction of the lumen of the portal vein and ischemization of the liver caused by the application of constricting ligatures a prolonged and marked hypertension develops.

The present work is devoted to the study of changes of the protein fractions of the blood serum in dogs which had been subjected to the above-stated intervention.

METHOD

Studies were carried out on seven dogs in chronic experiments which lasted from 2 to 17 months. We performed a total of 48 refractometric and electrophoretic determinations of the composition of blood serum proteins; of these 15 were controls and 33 were carried out during the process of development of hypertension induced by the above-stated intervention. As controls, we used the indexes of the initial determinations performed twice on each dog prior to the development of hypertension, and in one dog prior to and following the operation of a laparotomy, but without constricting the portal vein and ischemization of the liver.

Blood specimens were obtained from the femoral vein. Directly after obtaining the specimen we prepared the serum in which we determined the protein content by means of a Pulfrich refractometer and electrophoresis on paper. The electrophoresis lasted 18 hours in a veronal buffer at pH 8.6, voltage 5 v/cm, and current strength of 0.3 ma on 1 cm of the cross section. The electrophoregrams were stained with bromophenol blue in an acid bichloride of mercury solution and washed off with a 1% solution of acetic acid. The quantitative evaluation of the electrophoregram was made by means of a densitometer. The densitograms were additionally checked with electrophoregrams and cut into separate pieces, each corresponding to a definite protein fraction. The pieces of paper were weighed on analytical scales, following which the percentage ratio was calculated and, taking into account the refractometric data, the content of each protein fraction was calculated in gram-percent.

RESULTS

It can be seen in the composite table of changes in the indices of protein fractions that the total protein quantity in the blood serum of normal dogs constituted 6.8% on the average (fluctuation range 6-7%); of this, 3 gm% is albumins (fluctuation range 2.4-3.3%) and 3.8 gm% is globulins (fluctuation range 3.3 to 4.2 gm%). The albumin-globulin coefficient for normal serum is 0.8.

The α_1-globulin content equals 0.7 gm% (fluctuation range 0.4 to 1.0 gm%), α_2-globulins - 0.9 gm% (fluctuation range 0.5 to 1.4 gm%), β-globulins - 1.1 gm% (fluctuation range 0.5 to 2.0 gm%), γ-globulins - 1 gm% (fluctuation range 0.4 to 1.4 gm%). The data obtained in our experiments for normal serum coincide with the data in the literature [4,5].

It is seen in Table 1 that the changes in protein content are characterized by an increase of the total quantity of proteins of the blood serum by 0.2 gm% on the average. The most marked increase was noted in globulins

TABLE 1. Changes in the Quantity of Serum Proteins, Arterial Pressure, and Pulse in Norm and in Hypertension in Dogs

Dog's name	Type of operation	Examination date	Arterial pressure, mm Hg	Pulse rate per min	Amt. serum protein found (gm %)	Serum protein fraction content, gm %					
						albumins	globulins				
							total	α_1	α_2	β	γ
Norka		30/V 1957	135	93	7,0	2,8	4,2	1,0	1,4	0,9	0,9
		19/VI 1957	138	98	7,0	3,1	3,9	0,6	1,0	1,1	1,2
	Control laparotomy	1/XI 1957	130	94							
		11/XI 1957	134	91	6,8	2,6	4,0	0,5	1,0	1,5	1,0
Taiga		30/V 1957	118	70	6,8	3,3	3,5	0,5	1,2	0,5	1,3
	Constriction of portal vein lumen	5/VI 1957	126	74	6,9	3,2	3,7	0,6	1,0	0,7	1,4
		19/VI 1957	158	92	7,7	2,7	5,0	0,4	2,3	2,3	
		29/VI 1957	181	90	7,5	3,0	4,5	0,6	1,6	0,8	1,5
Dzhuba		30/V 1957	141	102	7,1	3,4	3,7	1,0	1,0	0,8	0,9
	Constriction of portal vein lumen	5/VI 1957	146	110	7,0	3,0	4,0	0,7	1,0	1,3	1,0
		19/VI 1957	185	120	7,8	3,7	4,2	0,4	1,1	0,9	1,8
		29/VI 1957	193	122	7,5	3,1	4,4	0,5	0,8	1,7	1,4
		11/XI 1957	236	136	7,7	3,0	4,0	0,5	1,5	1,4	0,6
		26/III 1958	170	108	7,6	2,7	4,9	0,7	1,1	1,9	1,2
		14/V 1958	160	92	6,8	2,8	4,0	0,6	0,8	1,5	1,1
		26/V 1958	177	102	7,0	2,6	4,4	0,7	1,2	1,6	0,9
		5/VI 1958	170	104	7,2	2,7	4,5	0,6	1,3	1,3	1,3
	Ischemization of the liver	17/VI 1958	161	92	7,0	2,6	4,4	0,9	0,9	1,3	1,3
		29/VI 1958	213	118	6,8	2,5	4,3	0,6	1,2	2,5	
Sharik		30/V 1957	120	88	7,0	3,0	4,0	0,5	0,5	2,0	1,0
	Ischemization of the liver	5/VI 1957	126	82	7,0	3,0	4,0	0,9	0,7	1,3	1,1
		13/VI 1957									
		19/VI 1957	171	108	7,4	2,9	4,5	6,6	1,1	1,7	1,1
		29/VI 1957	175	108	7,4	2,9	4,5	0,5	1,1	1,7	1,12
		11/XI 1957	142	98	7,4	2,6	4,82	0,6	1,0	3,22	
	Ischemization of the liver	28/XI 1957									
		26/III 1958	141	102	6,7	2,6	4,16	0,5	1,1	1,4	1,16
		14/V 1958	138	86	6,5	2,4	4,14	0,6	1,0	1,5	1,04
	Constriction of portal vein lumen	19/V 1958	130	92	6,4	2,3	4,1	0,6	1,0	0,8	1,7
		22/V 1958	170	112	7,2	2,3	4,9	0,6	1,4	1,6	1,3
		26/V 1958	183	120	6,75	2,1	4,65	0,6	1,2	1,7	1,15
		30/V 1958	164	120	7,5	2,6	4,9	0,5	1,3	2,1	1,0
		2/VI 1958	178	120	7,1	2,2	4,9	0,7	2,3	1,9	
Barsik		24/V 1957	129	80	6,7	3,4	3,4	0,7	1,3	1,0	0,4
		30/V 1957	128	62	6,6	3,3	3,3	0,6	0,9	1,1	0,7
	Constriction of portal vein lumen	1/VI 1957									
		5/VI 1957	188	100	7,0	2,4	4,6	0,4	1,3	1,7	1,2
		19/VI 1957	197	102	7,1	2.4	4,7	1,3	1,3	0,9	1,2
		29/VI 1957	199	108	7,0	2,4	4,6	0.45	1,25	2,0	0,9
Kazbek		5/IV 1958	122		6,8	2,8	4,0	0,4	1,0	1,6	1,0
	Constriction of portal vein lumen	14/V 1958	113	80	6,4	2,8	3,6	0,7	0,8	1,3	0,8
		19/V 1958	188	102	7,0	2,3	4,7	0,8	0,9	1,9	1,1
		26/V 1958	194	100	7,2	2,5	4,7	0,5	1,1	1,5	1,5
		30/V 1958	204	104	7,3	2,5	4,8	1,5	1,8	1,0	0,5
Buyan		14/V 1958	121	80	6,9	2,3	4.15	0,5	0,9	1,6	1,25
	Constriction of portal vein lumen	19/V 1958	121	86	6,9	2,8	4.15	0,94	0,7	1.45	0,86
		22/V 1958	176	102	6,6	2,5	4,1	0,6	0,9	1.7	0,9
		26/V 1958	178	104	6,3	2,4	3,9	0,6	1,0	1.6	0,7
		30/V 1958	184	106	5,9	2,1	3,8	0,7	0,8	1,4	0,9
		2/VI 1958	165	114	6,0	2,2	4,76	0,6	1,2	1,3	1,66
	Ischemization of the liver	17/VI 1958	133	80	6,6	2,4	4,2	1,3	0,9	0,8	1,2
		29/VI 1958	156	82	6,6	3,0	3,6	0,7	1,3	1,6	

TABLE 2. Statistical Analysis of the Data Cited in Table 1

Index	Symbol	Serum protein content, gm%	Serum protein fraction content, gm%					
			globulins					
			glo-bulins	albu-mins	α_1	α_2	β	γ
Arithmetical mean in norm	M_1	6,8	3,0	3,8	0,7	0,9	1,1	1,0
Arithmetical mean in hypertension	M_2	7,0	2,6	4,4	0,6	1,1	1,5	1,2
Mean square deviation in norm	$\sigma_1\pm$	0,355	0,251	0,295	0,277	0,232	0,408	0,427
Mean square deviation in hypertension	$\sigma_2\pm$	0,679	0,316	0,358	0,25	0,39	0,379	0,320
Standard deviation in norm	$m_1\pm$	0,094	0,067	0,079	0,072	0,062	0,136	0,066
Standard deviation in hypertension	$m_2\pm$	0,118	0,05	0,062	0,045	0,067	0,074	0,062
Index of the difference of the data significance	T—	1,3	4,7	6,0	2,5	2,2	2,7	2,2
Difference probability	P—	0,2	0,01	0,001	0,05	0,05	0,05	0,05

(by 0.6 gm% on the average, fluctuation range 3.6-5.0 gm%), whereas the quantity of albumins showed a regular decrease (by 0.4 gm% on the average, fluctuation range 3.1-2.1 gm%).

Changes in separate globulin fractions were not uniform in their magnitude. For instance, the content of α_1-globulins changed least of all, whether in the direction of an increase or decrease, and in one dog no changes were observed. The content of all other globulin fractions in all dogs showed a regular increase: α_2-globulins by 0.2 gm% on the average (fluctuation range 0.8-2.5 gm%), β-globulins by 0.4 gm% (fluctuation range 0.8-2.1 gm%) and γ-globulins by 0.2 gm% (fluctuation range 0.5-1.8 gm%). Statistical analysis of the data obtained demonstrated their reliability (Table 2).

The data in the literature and the results of our experiments prove convincingly that the change in α_2-globulin content takes place in various deseases and various influences which are accompanied by the "stress" state according to Selye. On this basis we may assume that the changes in the α_2-globulin content cannot be placed in strict dependence on the development of hypertension only. In the process of development of the hypertension model in our experiments, as well as in renal-ischemic hypertension as per Page and Lewis [11] and M. Ya. Khodas [10], definite changes have been observed in the direction of an increased content of β- and γ-globulins. In addition, S. V. Belyakova [1] reports that in hypertensive patients an incease of the quantity of fibrinogen takes place.

In the literature devoted to the problem of allergy, the γ-globulin fraction of serum proteins is referred to as the material substrate of various antibodies, including autocytolysins. It is a known fact that nephrocytolysins represent the pathogenetic factor in the development of glomerulonephritis and marked hypertension. This fact has been also corroborated experimentally. The increase in the amount of γ-globulins which we have observed in all experimental dogs leads us to the assumption of their possible pathogenetic role in the development of hypertension.

SUMMARY

Protein composition of the blood serum was examined in 7 dogs prior to and after the development of hypertension caused by a partial constriction of the portial vein lumen and ischemization of the liver. A total of 48 experiments were carried out; 15 of these were control and 33 with hypertension. As established, an increase in the blood serum globulins and a reduction of albumins were seen in all the animals with hypertension. A rise of the β- and γ-globulin fractions was noted; there was also a change in the direction of increase or reduction of α_1-globulins. On the basis of literature data and personal experiments, a conclusion is drawn that the change in the serum α_2-globulin content is not specific for the hypertensive states.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
