THE VISCOSITY OF THE BLOOD OF THE DOG AFTER OBSTRUCTION OF THE UPPER GASTRO-INTESTINAL TRACT.

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(Received for publication, May 27, 1926.)

Viscosity is a definite property of blood dependent upon the force with which the molecular constituents adhere to one another. Normally the viscosity of blood remains quite constant though influenced by a number of factors. The amount and type of protein in the plasma is a very important factor. Globulin is much more viscous than albumen. Knowing the viscosity of a given plasma it is possible to estimate its protein content. Viscosity of blood likewise varies with the corpuscle volume.

Estimations of viscosity of the blood have been little used in clinical medicine. Austrian (1) found no characteristic alterations in any disease. He concluded that the viscosity depends on the number of red corpuscles, the hemoglobin content, the gaseous richness, and to a lesser degree on the protein, fat, and salt content, but did not vary in direct proportion with any one factor. Bircher (2) has emphasized especially the predominant influence of the dissolved protein on viscosity.

As a part of a study of the physicochemical changes in the blood after experimental obstruction of the upper gastrointestinal tract we have made successive determinations of the viscosity of the plasma and of the whole blood.

Method.

Dogs were used for all experiments. All operations were done under ether anesthesia with aseptic technique. The obstruction of the cardiac end of the stomach and of the pylorus was made with a tape ligation. The jejunum was obstructed by severing the gut and inverting the cut ends.

The Hess viscosimeter was employed for the viscosity determinations. With this instrument the results are expressed in units of distilled water. The non-protein nitrogen was determined by the Folin and Wu method (3), and the chloride on the tungstic acid filtrate in the manner suggested by Gettler (4). Blood for the

TABLE I.

Viscosity of the Whole Blood and Plasma of the Normal Dog.

	Whole blood.	Plasma.
	units	*units*
Average (30 dogs)..........................	6.65	1.77
Highest..................................	10.40	2.00
Lowest..................................	4.50	1.50

TABLE II.

Obstruction of the Cardiac End of the Stomach.

Dog No.	Day after operation.	Blood (mg. per. 100 cc.).		Viscosity.		Hematocrit reading.
		Non-protein nitrogen.	Chlorides (as NaCl).	Whole blood (oxalated).	Plasma.	
		mg.	*mg.*	*units*	*units*	*per cent*
1	0	30	450	1.7	7.3	56
	1	43	440	2.1	11.0	55
	2	131	410	2.2	14.0	58
2	0	32	440	1.9	5.2	50
	1	115	360	2.3	10.0	53
3	0	26	450	1.7	9.6	—
	1	46	420	1.6	—	77
	2	48	390	1.9	9.6	64
	3	162	370	1.8	14.0	71
	4	238	360	2.1	21.0	64
4	0	31	480	1.5	6.0	55
	1	44	460	2.2	9.3	—
	2	121	450	2.6	10.8	43
5	0	32	460	1.7	7.4	54
	1	59	470	1.8	10.4	56
	2	145	410	2.0	14.4	68

determination was withdrawn from the jugular vein before operation and at 24 hour intervals thereafter until the end of the experiment. One small drop of a saturated solution of potassium oxalate was added for each 5 cc. of blood.

TABLE III.

Obstruction of the Pylorus.

Dog No.	Day after operation.	Blood (mg. per 100 cc.). Non-protein nitrogen.	Blood (mg. per 100 cc.). Chlorides (as NaCl).	Viscosity. Whole blood (oxalated).	Viscosity. Plasma.	Hematocrit reading.	Remarks.
		mg.	*mg.*	*units*	*units*	*per cent*	
6	0	28	420	1.7	5.8	57	
	1	102	320	1.9	11.0	63	Died.
7	0	27	460	1.7	7.0	49	
	2	59	360	2.1	15.0	—	
	3	141	360	1.5	14.0	69	"
8	0	35	430	1.6	5.7	50	
	2	32	330	1.8	14.0	—	
	3	30	330	1.7	9.2	72	
	4	33	310	2.2	10.2	63	
	5	38	290	2.0	10.8	56	
	6	42	320	2.3	7.7	62	
	7	60	360	2.1	9.0	—	
	9	79	320	2.0	7.6	50	10 gm. NaCl by mouth.
	10	68	350	2.1	11.0	45	10 " " " "
	11	39	470	1.8	4.8	42	10 " " " "
	12	23	500	1.7	4.8	40	Recovered.
9	0	22	460	2.0	5.8	42	
	1	27	400	2.2	6.5	45	Obstruction released.
	2	45	380	2.5	6.9	53	
	3	88	370	2.1	6.0	42	Died.
10	0	25	450	1.9	6.0	50	
	1	28	400	1.9	8.4	55	
	2	89	330	2.3	9.0	57	
	3	72	320	2.0	6.2	43	
	4	35	380	2.0	6.0	40	
	6	40	420	1.9	4.3	35	
	7	38	400	1.7	4.0	31	
	8	35	420	2.0	5.7	35	
	9	30	440	1.8	3.7	32	Recovered.

EXPERIMENTAL OBSERVATIONS.

In Table I are summarized the viscosity determinations on thirty normal dogs. The average for the whole blood is 6.65 units and for the plasma 1.77 units. Quite wide variations were encountered.

TABLE IV.

Obstruction of the Jejunum.

Dog No.	Day after operation.	Blood (mg. per 100 cc.).		Viscosity.		Remarks.
		Non-protein nitrogen.	Chlorides (as NaCl).	Whole blood (oxalated).	Plasma.	
		mg.	*mg.*	*units*	*units*	
11	0	29	400	1.9	8.2	
	1	44	320	2.2	8.5	
	3	88	280	1.7	8.0	
	4	53	280	1.8	6.2	
	7	75	230	1.7	6.3	
	8	78	200	1.7	5.2	
	10	102	190	1.7	4.2	Died.
12	0	24	440	1.7	6.0	
	1	33	360	1.9	7.0	
	3	35	370	1.8	7.0	
	4	—	340	1.8	9.0	
	7	37	300	1.8	6.6	
	8	44	270	1.8	7.0	
	10	60	270	1.8	5.7	
	13	53	230	1.8	4.9	Killed.
13	0	27	470	1.7	4.8	720 cc. 1% NaCl.
	1	35	420	1.6	9.4	720 " 1" "
	3	31	410	1.8	5.4	720 " 2" "
	5	33	360	1.9	7.2	576 " 5" "
	7	40	360	1.7	6.2	Killed.
14	0	27	470	1.7	6.0	Given NaCl daily.
	1	35	430	1.7	8.0	
	2	—	350	1.7	8.0	
	5	65	350	1.7	6.3	
15	0	27	450	1.7	6.8	Given NaCl solution daily.
	1	37	430	1.7	7.5	
	2	—	460	1.7	7.5	
	5	27	440	1.7	8.0	

The determinations on five dogs with obstruction of the cardiac end of the stomach are shown in Table II. All animals showed a steady rise in viscosity which began before the rise in non-protein nitrogen was apparent. The increase was much more marked in whole blood than in plasma.

After obstruction of the pylorus (Table III) there is likewise a rapid and marked increase in viscosity of both whole blood and plasma. The increase parallels the event of the toxemia. One animal was treated with dry sodium chloride by mouth after the obstruction was released. The viscosity fell to a low point and the animal recovered.

After obstruction of the jejunum the results are variable (Table IV). There was usually little rise in viscosity. The change here did not run parallel with the rise in non-protein nitrogen or fall in chlorides.

DISCUSSION.

The marked change in viscosity of the blood after obstruction of the pylorus and cardiac end of the stomach is evidence of a physico-chemical change occurring in such conditions. The change in viscosity parallels quite closely the degree of toxemia. The toxemia after obstruction of the cardiac end of the stomach is more severe than with an obstruction at a lower level. Likewise the increase in viscosity is most marked here.

The explanation for the change is not definitely apparent. In cardiac obstruction there is a marked increase in fibrinogen which constitutes the major part of the globulin fraction of the plasma protein (5). Likewise there is a marked increase in the sedimentation rate of the erythrocytes which is dependent on agglutination of the cells. These two factors probably largely account for the changes observed.

Hematocrit readings were made daily on several animals with both pyloric and cardiac obstruction (Tables II and III). These show that there is no marked concentration of the blood, hence an increase in red cells cannot account for the change in viscosity.

SUMMARY AND CONCLUSIONS.

Estimations of the viscosity of the whole blood and plasma of the dog after experimental upper gastrointestinal tract obstruction are reported.

With cardiac obstruction there is a rapid and marked rise in the viscosity of the whole blood and some increase in the viscosity of the plasma.

The changes after pyloric obstruction are similar to those observed after cardiac obstruction.

After obstruction of the upper jejunum only slight changes are observed.

The increase in viscosity parallels quite closely the degree of the toxemia. It is unaccompanied by any marked concentration of the blood.

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