CHARACTERISTICS OF THE HYDREMIC PHASE OF COMPENSATION OF ACUTE BLOOD LOSS IN ANIMALS WITH EXPERIMENTAL DIABETES

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Experiments on rabbits showed that the development of alloxan diabetes is accompanied by an increase in the plasma volume and by some decrease in the mass of erythrocytes, so that the circulating blood volume is increased but the number of erythrocytes and the content of hemoglobin per unit volume of blood and the hematocrit index are reduced. In the posthemorrhagic period in diabetes the hydremic phase of compensation is disturbed; the decrease in plasma volume actually produces temporary hypovolemia with relative polycythemia, as shown by restoration of these erythrocyte indices to their initial values.

In acute posthemorrhagic oligemia the hydremic phase of compensation is expressed as the rapid entry of tissue fluid into the blood, leading to restoration of the circulating blood mass through an increase in the plasma volume [2, 4, 8].

Diabetes mellitus is often accompanied by processes requiring surgical treatment associated with blood loss. Blood loss may also arise in diabetics as the result of injury and during childbirth.

Since insulin plays an important role in the compensatory reactions of the body it is logical to suppose that changes in the process of compensation for acute blood loss may arise in insulin deficiency. The investigation described below was carried out to study this problem.

EXPERIMENTAL METHOD

Experiments were carried out on 93 rabbits, 30 of which were controls (series I) while the rest received an intravenous injection of 5% alloxan solution in a dose of 150-160 mg/kg to produce diabetes. Stable diabetes developed in 30 animals (48%; series II), as shown by the hyperglycemia (250 mg% or more), polydipsia, polyphagia, polyuria, and loss of weight.

Bleeding took place from the common carotid artery to the extent of 10% of the circulating blood mass, determined colorimetrically [1]. The bleeding was carried out on the 14th day after injection of alloxan, when the side effects of the drug have cleared up and the diabetes has assumed a pure form [5].

The hemoglobin concentration was determined by the FÉK-M photoelectric colorimeter [3]. The remaining indices were investigated by the usual methods. They were studied before, 3 h, and 1 and 6 days after blood loss, while the erythrocyte count and hemoglobin concentration also were determined 4 days after blood loss. The numerical results were subjected to statistical analysis by the method of direct differences [6, 7].

EXPERIMENTAL RESULTS

As Table 1 shows, the plasma volume is increased in diabetes, in agreement with data in the literature [9, 10]; the mass of erythrocytes was reduced to a lesser degree. As a result of this the circulating blood mass was increased and all the erythrocyte indices were reduced.

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TABLE 1. Changes in Plasma Volume (PV), Circulating Blood Mass (CBM), Mass of Erythrocytes (ME), and Hematocrit Index (HI) In Rabbits of Series I and II

Index	Series I				Series II				
	initial data	time after blood loss			initial data	in diabetes	time after blood loss		
		3 h	1 day	6 days			3 h	1 day	6 days
PV (in ml)	125	138	141	138	120	140	137	137	129
$M \pm m$		+13±2,0	+16±2,2	+13±2,4		+20±3,4	−3±2,4	−9±2,7	−11±2,9
P		<0,001	<0,001	<0,001		<0,001	>0,2	<0,01	<0,001
P_1					194	208	<0,001	<0,001	<0,001
CBM (in ml)	195	194	194	196		+14±3,9	199	191	192
$M \pm m$		−1±2,2	−1±2,5	+1±3,2		<0,001	−9±3,0	−17±3,0	−16±3,1
P		>0,5	>0,5	>0,5			<0,01	<0,001	<0,001
P_1					39	33	<0,05	<0,001	<0,001
HI	36	29	29	30		−6±1,0	31	32	34
$M \pm m$		−7±0,6	−7±0,7	−6±0,6		<0,001	−2±0,7	−1±0,7	+1±1,2
P		<0,001	<0,001	<0,001			<0,01	>0,1	>0,2
P_1					74	68	<0,001	<0,001	<0,001
ME (in ml)	70	56	53	58		−6±1,8	62	60	63
$M \pm m$		−14±1,0	−17±1,5	−12±2,2		<0,01	−6±1,6	−8±1,8	−5±2,6
P		<0,001	<0,001	<0,001			<0,001	<0,001	>0,05
P_1							<0,001	<0,001	<0,05

Note. Here and in Table 2: M) mean difference; m) mean error of mean difference; P) significance of differences within series; P_1) significance of differences between series.

TABLE 2. Change in Erythrocyte Count and Hemoglobin Content After Blood Loss in Rabbits of Series I and II.

Series of exp.	Index	Initial data	In diabetes	Time after blood loss		
				3 h	1 day	6 days
I	Erythrocyte (in millions/mm^3)	4,75		3,95	3,85	4,06
	$M \pm m$			−0,80±0,08	−0,90±0,09	−0,69±0,09
	P			<0,001	<0,001	<0,001
	Hemoglobin (in g%)	11,3		9,7	9,5	9,5
	$M \pm m$			−1,6±0,07	−1,8±0,2	−1,8±0,3
	P			<0,001	<0,001	<0,001
II	Erythrocyte (in millions/mm^3)	5,06	4,18	4,04	3,98	4,02
	$M \pm m$		−0,88±0,13	−0,14±0,07	−0,20±0,09	−0,16±0,14
	P		<0,001	>0,05	<0,05	0,1
	P_1			<0,001	<0,001	<0,01
	Hemoglobin (in g%)	11,7	9,9	9,3	9,0	9,3
	$M \pm m$		−1,8±0,2	−0,6±0,1	−0,9±0,2	−0,6±0,3
	P		<0,001	<0,001	<0,001	>0,05
	P_1			<0,001	<0,001	<0,01

After blood loss the plasma volume of the rabbits of series I was increased but the mass of erythrocytes was reduced; the circulating blood mass remained unchanged at all times of the investigation. The increase in plasma volume led to a decrease in the hematocrit index, the erythrocyte count, and the hemoglobin content per unit volume of blood (Table 2). The approximately equal decrease in these indices reflects the normochromic character of the resulting anemia with an unchanged mean erythrocyte volume.

In the rabbits of series II the plasma volume decreased after blood loss, causing a progressive decrease in the circulating blood volume. The mass of erythrocytes, which was reduced in the early period after blood loss, regained its original level by the 6th day. The more marked decrease in the erythrocyte count than in the hemoglobin concentration (Table 2) indicated the development of hypochromia. The absence of a parallel in the dynamics of the changes in the hematocrit index and the erythrocyte count was reflected by the change in the mean erythrocyte volume in the posthemorrhagic period.

The control animals thus developed a hydremic reaction after blood loss: the increase in the plasma volume restored the circulating blood mass to its initial level after 3 h.

Blood loss in rabbits with diabetes, on the other hand, led to a decrease in the plasma volume, which caused the development of hypovolemia, which changed from oligocythemic (in the earlier periods) into relatively polycythemic (compared with the control series). Consequently, in rabbits with diabetes the hydremic phase of the posthemorrhagic reaction is disturbed.

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