DYNAMICS OF CHANGES IN SOME INDICES OF THE CIRCULATION AFTER ACUTE BLOOD LOSS

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The effect of acute blood loss (30-40 ml/kg body weight during 5 min) on the arterial pressure, electrical activity of the brain, muscles, and heart, and of the diameter of the blood vessels of the optic fundus and pia mater was investigated in experiments on 10 rabbits and 10 dogs. Acute blood loss causes phasic changes in the state of the circulatory system and marked disturbances of electrical activity of the brain, heart, and muscles.

Rational treatment of the sequelae of acute blood loss is impossible without a study of all aspects of the pathogenesis of this state [1-4].

This paper describes a study of the changes in some indices of the circulation during the period of the posthemorrhagic reaction.

EXPERIMENTAL METHOD

Experiments were carried out on 10 chinchilla rabbits weighing from 1.8 to 3.2 kg and 10 adult dogs weighing from 6 to 18 kg. Blood was taken from the femoral artery of the dogs and the carotid artery of the rabbits (30-40 ml/kg) over a period of 3-5 min. Before blood loss and at various stages of the posthemorrhagic reaction until death of the animal the following parameters were recorded: in rabbits, the pressure in the common carotid artery, pulse rate, electrical activity of the brain, heart, and muscles (using the 4 EEG-1 electroencephalograph); ophthalmoscopy was performed and the vessels of the optic fundus photographed (BO-2 ophthalmoscope, Zenit camera); in dogs, in addition, the pressure in the femoral artery and at the mouth of the inferior vena cava, potentials in the region of the thalamus (electrodes inserted by Kogan's method [5]) and the state of the blood vessels of the pia mater (photographed with the MBS-2 microscope and Kristall camera) also were recorded.

EXPERIMENTAL RESULTS

The experiments showed that responses of the animals to acute blood loss were definitely phasic in character (Tables 1 and 2). During the first 3-5 min after blood loss the arterial pressure fell sharply and the heart rate rose (in the dogs). Next followed the early period of the posthemorrhagic reaction, characterized by a gradual rise of arterial pressure and pulse rate and by sharp constriction of the blood vessels of the retina and brain surface. For the next 30-40 min the arterial pressure and pulse rate showed a marked degree of stabilization. During this period of stabilization the vessels of the pia mater and retina dilated and almost regained their initial diameter. In the next, later period there was a steady fall of arterial pressure and pulse rate, a terminal state developed, and all the animals died.

The ECG after blood loss showed a decrease in amplitude of the R waves, shortening of the T-P intervals, and displacement of the S-T segment relative to the isoelectric line (Fig. 1). Slow, high-amplitude waves appeared on the EEG of the cortex immediately after blood loss, with a marked decrease in the

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TABLE 1. Effect of Acute Blood Loss on Some Indices of the Circulation in Rabbits (M ± m)

Period of reaction	Arterial pressure (in mm Hg)	P	P_1	Pulse rate (beats/min)	P	P_1	Diameter of retinal arteries (in conventional units)	P	P_1	Diameter of retinal veins (in conventional units)	P	P_1
Initial	108,4±4,5			229,7±5,9			2,24±0,11			3,79±0,16		
Inhibition	41,5±3,4	0,001	0,001	172,0±14,3	0,005	0,005	2,20±0,15	0,85	0,85	3,50±0,21	0,3	0,3
Early	55,2±3,4	0,001	0,02	182,0±11,6	0,006	0,63	1,35±0,16	0,002	0,005	2,54±0,17	0,001	0,008
Stabilization	70,1±4,3	0,001	0,03	172,8±11,7	0,002	0,63	1,89±0,12	0,08	0,05	3,24±0,15	0,05	0,015
Late	29,6±1,2	0,001	0,001	115,6±13,5	0,001	0,13	1,10±0,06	0,001	0,001	1,79±0,17	0,001	0,001

Note: Here and in Table 2: P) significance of difference compared with initial period, P_1) significance of difference compared with previous period.

TABLE 2. Effect of Acute Blood Loss on Some Indices of the Circulation in Dogs (M ± m)

Period of reaction	Arterial pressure (in femoral artery (in mm Hg)	P	P_1	Central venous pressure (in mm water)	P	P_1	Pulse rate (beats/min)	P	P_1	Diameter of pial vessels (in mm)	P	P_1
Initial	125,6±5,7			7,6±0,7			79,3±8,3			0,23±0,02		
Inhibition	35,0±4,1	0,001	0,001	10,6±0,6	0,009	0,009	177,6±8,0	0,001	0,001	0,20±0,02	0,40	0,40
Early	53,6±4,9	0,001	0,05	9,5±0,6	0,09	0,33	190,8±9,5	0,001	0,34	0,11±0,01	0,001	0,003
Stabilization	69,2±6,6	0,001	0,05	10,8±0,9	0,02	0,36	204,6±8,4	0,001	0,34	0,21±0,02	0,50	0,004
Late	32,0±3,3	0,001	0,001	11,7±0,6	0,002	0,45	141,2±12,7	0,003	0,003	0,11±0,02	0,003	0,008

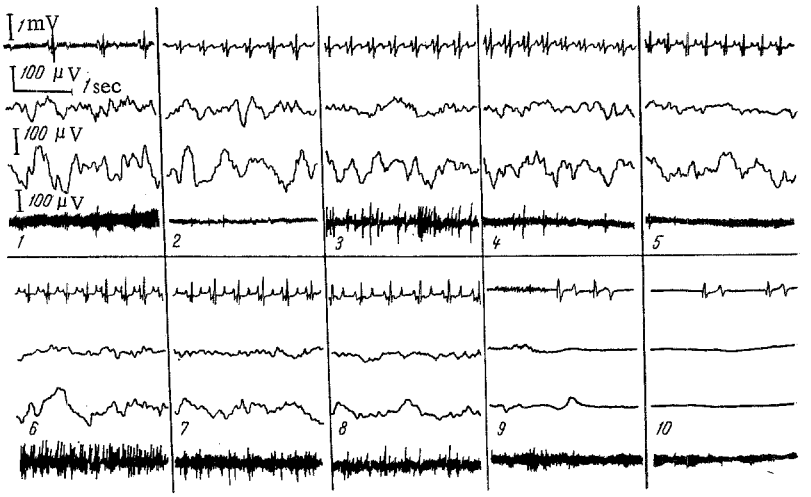

Fig. 1. Fragments of records of experiment No. 12 on March 21, 1970 on a dog weighing 6 kg; blood loss 210 ml. From top to bottom: ECG, EEG of cortex, EEG of thalamus, EMG. 1) Original records; 2) 5 min after blood loss; 3, 4) 15 and 30 min after blood loss – early period of posthemorrhagic reaction; 5) 1 h after blood loss – period of stabilization; 6, 7, 8) 1.5 and 3.5 h after blood loss – late period; 9) 4 h after blood loss – terminal phase; 10) 4 h 14 min after blood loss – clinical death.

amplitude and number of fast waves (12-18 waves/sec). On the EEG of the thalamus the amplitude of the slow waves was increased and superposed waves appeared. The electrical activity of the muscles was sharply reduced. In the early period and in the period of stabilization of the hemodynamic parameters, the electromyographic indices improved somewhat.

In the late period gradual deformation of the cardiac complex was observed on the ECG. Bursts of groups of high-voltage potentials appeared initially on the EMG and then merged, reflecting the increased electrical activity of the muscles.

It can be concluded from these observations that acute massive blood loss induces a phasic reaction of the circulatory system and marked changes in the electrical activity of the cerebral cortex and thalamus.

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