The validity of this hypothesis was confirmed by an analysis of the dynamics of Kernohan's index, which is the ratio of the thickness of the vessel wall to the width of its lumen (internal diameter). A decrease in Kernohan's index is evidence of a relative increase in the lumen of the vessel, i.e., its dilatation.

Analysis of the data in Table 2 shows that after a fall of BP and throughout the period of observation the lumen of the vessels with an external diameter of under 15 μ showed little change (disregarding a temporary increase in this parameter on the 7th day of the experiment, when considerable dilatation of vessels of all calibers was observed). For example, the increase in the lumen of vessels with a diameter of 15-25 μ was particularly considerable, it appeared soonest of all, and persisted throughout the period of observation.

The results described above show that a fall of BP causes adjustments to the microcirculatory bed in the region of hypotension, the most characteristic feature of which is dilatation of the resistive vessels, leading to a decrease in their hydrauliic resistance, and thus contributing to the maintenance of the normal blood supply and metabolism of the tissues, despite a considerable fall of perfusion pressure.

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EFFECT OF PRELIMINARY ADAPTATION TO SHORT-TERM STRESS ON RESISTANCE OF MYOCARDIAL CONTRACTILITY TO HYDROGEN PEROXIDE

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Adaptation of animals to short-term stress has no significant effect on myocardial contractility but, at the same time, it prevents any marked disturbance of contractility such as usually arises under the influence of long-term stress [6, 7]. When the mechanism of this prophylactic effect is studied it must be recalled that during long-term stress in animals [5] and man [8] lipid peroxidation (LPO) is activated, and this activation is particularly marked in the heart muscle. Activation of LPO plays a key role in injury to cardiomyocyte membranes and the development of stress-induced disturbances of cardiac function [2]; such disturbances are therefore prevented by administration of antioxidants [3, 4]. This suggested that the heart muscle of animals adapted to short-term stress ought to have increased resistance to factors inducing LPO. One such factor is hydrogen peroxide (H_2O_2), which induces LPO in the isolated working heart and disturbs its contractility [9, 10].

The aim of this investigation was to study the effect of preliminary adaptation to short-term stress on resistance of contractility of the isolated right atrium (IRA) of animals to H_2O_2.

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TABLE 1. Effect of Preliminary Adaptation to Short-Term Stress on Resistance of Spontaneously Contracting IRA to H_2O_2

Time after addition of H_2O_2, min	Number of rhythmically contracting atria		Number of arrested atria	
	Control (18)	Adaptation (18)	Control (18)	Adaptation (18)
0	18	18	—	—
1	18	18	—	—
2	8	14	—	—
4	8	10	2	—
6	4	8	6	2
8	2	6	8	4
10	4	8	6	4
12	4	10	6	2
14	4	10	12	2
15	6	10	10	2

Legend. Significance of results was determined by the Z (sign test) and T (Wilcoxon's test) nonparametric statistical tests [1] for tied pairs of observations: $P_Z < 0.1$ and $P_T < 0.01$ for both parameters. Number of IRA shown in parentheses.

TABLE 2. Effect of Preliminary Adaptation to Short-Term Stress on Resistance of Contractility of IRA to H_2O_2

Time after addition of H_2O_2, min	F, min^{-1}		T_d, mg		IFS, mg/min	
	Control	Adaptation	Control	Adaptation	Control	Adaptation
0	231,1	209,2	417,8	440,0	96,6	91,9
1	242,2	224,4	705,6	673,0	170,8	151,0
2	157,6	199,1*	602,2	534,0	94,9	106,3
4	132,3	151,3	450,6	389,0*	59,5	58,9
6	86,9	106,1	283,3	519,0*	24,7	55,1
8	88,1	108,2*	267,8	362,0	23,6	39,1*
10	69,8	111,2*	301,1	366,0	21,0	40,7*
12	61,3	99,7*	128,7	435,0*	8,9	43,8*
14	51,1	105,4*	189,4	489,0*	10,0	51,5*
15	55,0	109,0*	230,0	411,0*	12,6	44,8*

Legend. Asterisk indicates significance, determined for each pair of parameters at each successive minute of the experiment, by Z and T tests for ties pairs of observations: $P_{Z,T} < 0.01$ for all parameters.

EXPERIMENTAL METHOD

Experiments were carried out on male Wistar rats weighing 200-280 g. The control group consisted of 18 rats. The remaining 18 rats were adapted to short-term stress by immobilizing them in the supine position (all the limbs and the head were fixed); the rats were immobilized for 15 min on the first day, for 30 min on the 2nd day, for 45 min on the 3rd day, and for 1 h on each of the following 10 days. To assess the resistance of the atrial myocardium to H_2O_2, contractility of the IRA was studied. The atrium was placed in a constant-temperature bath with oxygenated Krebs–Henseleit solution (95% O_2, 5% CO_2, pH 7.4, 34°C) in such a way that the base of the atrium was fixed rigidly and the apex of the auricle was attached to the F-50 myograph of the DMP-4B physiograph (from Narco-Biosystems, USA). The IRA contracted spontaneously for 40-50 min. after which it was gradually stretched to a length at which it developed maximal tension under isometric conditions of contraction, i.e., it flattened out on the plateau of the Starling curve. The spontaneous contraction frequency (F), the developed tension (T_d), the resting tension (T_θ), and the intensity of functioning of structures (IFS), an integral parameter of contractility, equal to the product of contraction frequency and developed tension (IFS = $F \times T_d/1000$) were determined for the atria of the control and adapted animals.

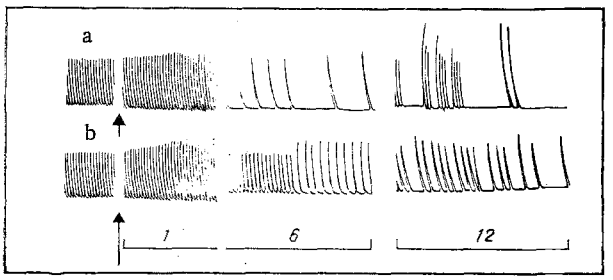

Fig. 1. Mechanograms of contraction of IRA of control (A) rats and rats adapted to short-term stress (B) before and after addition of H_2O_2 to incubation medium. Abscissa, time after additon H_2O_2 (in min); ordinate, developed tension (in mg). Arrows indicate time of addition of H_2O_2.

H_2O_2 was added to the working chamber containing the contracting myocardium up to a final concentration of 0.1 nM, after which the number of atria contracting rhythmically, the number contracting with arrhythmia, and the number which ceased contracting were counted each minute.

EXPERIMENTAL RESULTS

Mechanograms of functioning of the IRA of the control and adapted rats are shown in Fig. 1. In the control the response of the atrium to H_2O_2 had three phases (Fig. 1). In the first phase a marked positive chronotropic and inotropic effect was observed, together with a relaxing effect, namely reduction of the resting tension. Marked bradycardia developed in the second phase. Finally, the third phase was characterized by bradyarrhythmia and cardiac arrest. The response of the IRA of the adapted rats consisted of the same three phases, but the bradycardia and bradyarrhythmia in the second and third phases were less pronounced and cardiac arrest did not arise (Fig. 1). The study of the resistance of the atria of the adapted rats to H_2O_2 showed that 14 of the 18 atria of the adapted animals but fewer than half of the atria of the control rats were contracting rhythmically 2 min after addition of H_2O_2. The rest exhibited a varied degree of bradyarrhythmia (Table 1). As exposure to H_2O_2 continued of rhythmically contracting atria of the adapted animals rose to 1.5-2.5 times more than in the control. After exposure to H_2O_2 for 15 min, when some atria had resumed rhythmic contraction, this ratio was still preserved (Table 1).

It was also found that two atria of the control group ceased to function 4 min after addition of H_2O_2, and that 12 and 10 atria ceased to contract after 14 and 15 min respectively. None of the atria of the adapted animals had stopped contracting after exposure to H_2O_2 for 4 min, and only two of the 18 atria had stopped after 14-15 min, i.e., 5-6 times fewer than in the control.

Thus adaptation to short-term stress considerably increased the resistance of the atrial myocardium to the LPO induced hydrogen peroxide.

This state of affairs corresponded to experimental data showing depression of the contraction frequency, developed tension, and IFS of the heart muscle of the control and adapted animals after addition of H_2O_2 (Table 2). However, the degree of this depression of the atria was much less for animals adapted to short-term stress than for the control. As a result, the contraction frequency and developed tension after 14-15 min were about twice as high after adaptation, and IFS was about four to five times as high as in the control (Table 2).

On the whole the experimental results provide unambiguous evidence that adaptation to repeated short-term stress significantly increases the resistance of the heart muscle to the LPO inducer. Consequently, the protective effect of adaptation to short-term stress against long-term stress cannot be reduced simply to adaptive changes developing at the level of central regulatory mechanisms alone. It is also determined by adaptive changes arising in effector organs, for example, in the heart.

When this fact is assessed it must be recalled that during each exposure to stress the excess of catecholamines leads to activation of LPO, which modifies to some degree or injures the lipid bilayer of the cardiomyocyte mebranes [11]. The possibility cannot be ruled out that frequent repetition of this situation ultimately leads to the gradual development of certain adjustments which limit LPO activation, i.e., which increase tissue resistance to the LPO inducer. There are at present two likely possibilites. First, activation of LPO and phospholipases, arising periodically under the influence of an excess of catecholamines during short-term exposure to stress may gradually lead to changes in the phospholipid and fatty-acid composition of the lipid bilayer of the mebranes — for example, to a reduction in

their content of unsaturated fatty acids, which are a substrate of LPO, and hence to restriction of LPO activation. Second, periodic repeated activation of LPO may induce synthesis of antioxidant enzymes (superoxide dismutase, glutathione peroxidase, catalase) and may thereby increase tissue resistance to the LPO inducer.

Considering the important role of increased resistance of the body to complex and essentially stress-inducing situations as a factor in the organism's successful adaptation to the external environment, these and other possible mechanisms of such adaptation, in the writers' view, deserve experimental study.

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HYPOTENSIVE ACTIVITY OF PLASMA PROTEINS DURING NORMOVOLEMIC EXCHANGE TRANSFUSION

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An important role in the mechanism of action of blood transfusion and, in particular, of massive blood transfusions, is ascribed to incompatibility between plasma proteins of donor and recipient [3]. After transfusion of allogenic blood an increase in the content of high-molecular-weight protein fractions is observed in animals' blood plasma, whereas after transfusion of autologous blood no such changes were found [5]. This reorganization of the protein system of the recipient's blood is accompanied by the appearance of abnormal fractions (protein complexes), which have unusual physicochemical properties and biological activity. This leads to a change in the absolute and relative levels of physiologically active substances, resulting in modified reactivity of the microvascular wall and the development of circulatory disturbances in the microvascular bed [2]. However, no data have been obtained on the role of regulator proteins in the genesis of these phenomena.

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