THE REACTIVITY OF THE CARDIOVASCULAR SYSTEM IN EXPERIMENTAL NONINFECTIOUS PERITONITIS

COMMUNICATION I. REACTION TO THE INTRAVENOUS INJECTION OF ADRENALIN AND CAFFEINE

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(Received December 10, 1958. Presented by Active Member AMN SSSR V. V. Parin)

The study of the changes in the general reactivity of the body during the development of a pathological process is of great theoretical and practical importance.

The presence of a pathological process leads to a functional change in the reflex apparatus, which may react differently, under these circumstances, to the action of stimuli. In such cases it may be possible to observe, for example, a change in the response to the intravascular injection of various drugs [7]. Changes in the reactions of the vessels to administration of drugs have also been observed in inflammation [21], in septic febrile diseases [8], in poisoning by enzyme poisons [13], in atherosclerosis [11, 12], in persons resuscitated after clinical death [6], in increased intraperitoneal pressure [9], in different forms of shock [2] and in experimental typhoid fever [4].

Several authors [2, 4, 15-18] account for the changes in the response reaction of the cardiovascular system in the presence of a pathological process in the body by changes in the reactivity of the central nervous system.

In the present research, our aim was to investigate the reactivity of the cardiovascular system to adrenalin and caffeine in experimental noninfectious peritonitis.

EXPERIMENTAL METHOD

Experiments were carried out on rabbits in 4 series (with 5 animals in each). In the first series we studied the character of the reaction of the cardiovascular system of healthy rabbits to the intravenous injection of adrenalin (0.01% solution, 0.2 ml/kg body weight) and in the second series the reaction to injection of caffeine (10% solution, 0.4 ml/kg body weight).

In the third and fourth series of rabbits, 20 hours before injection of the same drugs, peritonitis was induced by injection of 10 ml of a 10% solution of peptone into the peritoneal cavity. The presence of peritonitis was established by an increase of the body temperature, a rise in the leucocyte count and a shift to the left in the leucocyte formula.

During the acute phase of the experiment kymographic tracings were made of the arterial pressure in the common carotid artery. The test substances were injected at the same rate into the femoral vein.

EXPERIMENTAL RESULTS

Analysis of the arterial pressure curves took into consideration the time from the start of injection of the drug until the change in the arterial pressure, the duration of the phase of rise and fall of its maximum and minimum level (Table 1).

TABLE 1

Figures Showing the Trend of the Changes in Arterial Pressure in Response to Injection of Adrenalin (in mm Hg, time in seconds)

	Initial level	Time of beginning of rise	Time of reaching maximum	Maximum level	Duration of phase of falling	Minimum level	Magnitude of rise	Magnitude of fall
In control animals								
Limits of variation	88—130	3—8	5—18	140—170	43—102	50—100	40—60	60—110
Mean value	105	5	10	155	60	74	50	81
In experimental animals (with peritonitis)								
Limits of variation	70—95	3—4	4—10	120—160	114—145	20—55	50—70	95—130
Mean value	88	4	7	148	133	37	60	111

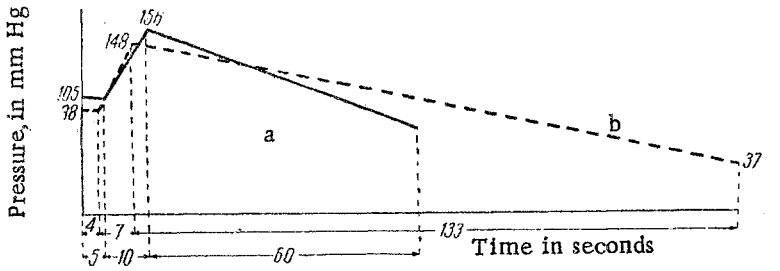

Fig. 1. Trend of the changes in arterial pressure in rabbits after the intravenous injection of adrenalin. a) In healthy animals; b) in those with peritonitis.

Table 1 shows that in response to injection of adrenalin the arterial pressure of both control and experimental rabbits underwent a biphasic change: immediately after injection an increase was observed, and was followed by a fall below the initial level. The same biphasic reaction in response to the injection of adrenalin has been observed by many workers [5, 10, 13, 22]. According to Litwin's [22] findings, the phase of lowering of the arterial pressure is associated with the centrifugal fibers of the vagus nerve, since it almost completely disappears after bilateral vagotomy.

The course of the changes in arterial pressure had its special features in each of our groups of experimental animals (Fig. 1). In the first place the rabbits with peritonitis showed slightly lower initial values. The increase of pressure after injection of adrenalin developed slightly sooner and quicker than in the controls. The maximum level was also slightly lower, although the difference from the initial level was greater in these animals than in the controls.

The time for the pressure to fall from the maximum to the minimum levels in the animals with peritonitis

TABLE 2

Values Showing the Trend of the Changes in Arterial Pressure in Response to Injection of Caffeine (in mm Hg; time in seconds)

	Initial level	Time to reach maximum	Minimum level	Duration of phase of increase	Maximum level	Magnitude of fall	Magnitude of rise
In control animals							
Limits of variation	70—105	2—4	63—96	21—27	81—117	7—13	17—22
Mean value . . .	90	3	80	24	100	10	20
In experimental animals (with peritonitis)							
Limits of variation. . . .	67—100	4—13	40—80	24—24	70—115	20—50	24—60
Mean value . . .	87	8	55	38	97	32	42

was twice as long as in the controls. The pressure in these animals fell more considerably, so that the difference between the maximum and minimum levels was also significantly greater than in the controls.

Hence the cardiovascular system of the rabbits with peritonitis responded more rapidly and intensively to the injection of adrenalin in the first phase (increase of pressure) and more slowly but just as intensively in the second phase (fall of pressure).

When analyzing the changes in the arterial pressure after injection of caffeine, we took into consideration the duration of the phase of fall of pressure to its minimum level, its value and the duration of the phase of rise of pressure and its maximum level (Table 2).

Analysis of these findings showed that the intravenous injection of caffeine was also accompanied by a biphasic reaction of the arterial pressure: at first a fall was observed and then its level rose.

The considerable difference in the trends of the changes in arterial pressure of the control and experimental animals must also be mentioned (Fig. 2). In the latter the phase of fall of pressure was almost three times greater than in the controls. The minimum level of the pressure in these animals was much lower, and the degree of fall three times greater than in the controls. In the rabbits with peritonitis the phase of rise of pressure was more prolonged, but the value of the maximum level was almost the same in the two groups of animals.

The cardiovascular system of the rabbits with peritonitis thus responded more slowly but intensively to injection of caffeine by a fall in pressure in the first phase and responded just as slowly by an increase in pressure in the second phase.

From an analysis of the intensity of the response reaction of the cardiovascular system (Fig. 3), it may be seen that, by comparison with the controls, the arterial pressure in the experimental rabbits with peritonitis was raised either to the same degree after injection of caffeine, or rather more, on the average by 20%, after injection of adrenalin. The fall in pressure, however, was much more sharply expressed in these animals. For instance, after injection of adrenalin the pressure was lowered by 64%, and after injection of caffeine by 220% more than in the controls.

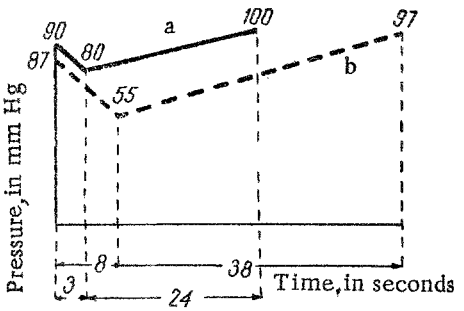

Fig. 2. Trend of the changes in the arterial pressure in rabbits after intravenous injection of caffeine. Legend as in Fig. 1.

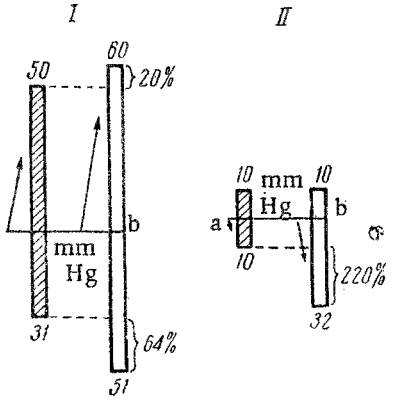

Fig. 3. Magnitude of the rise (upper column) and fall (lower column) of the arterial pressure after injection of adrenalin (I) and caffeine (II) in control (a) and experimental (b) animals.

Thus in the rabbits with peritonitis the depressor reaction was the more marked and prolonged, in response to the intravenous injection of both adrenalin and caffeine.

The reaction of the cardiovascular system in response to the intravascular injection of a chemical stimulus depends on the inclusion of the nervous reflex apparatus of the vascular tissues.

The results obtained show that in peritonitis the reaction of the cardiovascular system to the intravenous injection of these drugs is modified; the degree and duration of the fall in the level of the arterial pressure is much more sharply expressed than in the control animals.

Thus in rabbits with peritonitis, after injection of pressor drugs, the depressor component of the reaction of the cardiovascular system is predominant. At the same time the pressor component shows considerable inertia.

Our results are thus not in agreement with those of D. A. Éskin [21], who found no special features in the changes of the level of the arterial pressure in dogs with peritonitis after injection of adrenalin, nor with the results of G. A. Malov and Ts. I. Vainshtein [7], who showed that in cats with peritonitis the increase in the vascular tone after injection of adrenalin was smaller than in controls, which these authors explained by a lowering of the sensitivity of the veins to adrenalin in peritonitis.

In accounting for the results which we obtained, a whole series of important factors must be taken into consideration. As we know, stimulation of receptors may alter the functional state of the central links of the reflex apparatus and the reactivity of the vasomotor center. For instance, in acute peritonitis changes have been observed in the reactivity of the bulbar centers [19]. In addition it has been shown, morphologically, that in peritonitis a lesion of the autonomic nervous system can be demonstrated [3, 20]. The results obtained, it seems to us, can be explained as follows. The increased flow of afferent impulses in peritonitis raises the level of excitation of both divisions of the autonomic nervous system. The increased tone of the sympathetic system is revealed by a shortening of the latent period and of the time of rise of the pressure to its maximum after injection of adrenalin. The increase in the tone of the parasympathetic system is revealed by the intensive fall in the arterial pressure in the second phase after injection of adrenalin and in the first phase after injection of caffeine. A significant predominance of the depressor reaction over the pressor is observed, however, after injection of both adrenalin and caffeine.

In association with peritonitis a more marked increase in the tone of the cholinergic nerves is therefore observed. This may also be confirmed by the prolongation of the depressor reaction in rabbits with peritonitis. An increase in the sensitivity of both divisions of the autonomic nervous system in acute inflamation was also found by N. V. Puchkov [4].

The experiments of A. G. Bukhtiyarov [1], which showed that depression of the centers leads to predominance of the depressor background, and excitation of the centers to predominance of the pressor background in response to the intravenous injection of drugs, support the possibility of such a mechanism.

SUMMARY

The author studied the reactivity of the cardiovascular system of the rabbit to adrenalin and caffeine in experimental noninfectious peritonitis. On intravenous injection of these drugs against the background

of peritonitis, the cardiovascular system responded by a more intense pressor and depressor effect. The latter, however, was more pronounced, which may point to the higher tone of the cholinergic nerves in peritonitis.

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* Original Russian pagination. See C.B. Translation.