# REGIONAL VASCULAR REACTIONS OF THE INTERNAL ORGANS IN RESPONSE TO INTEROCEPTIVE STIMULI IN NORMAL CONDITIONS AND IN EXPERIMENTAL HYPERTENSION

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Investigations of the regional circulation have been directed, on the one hand, towards the further study of the special features of the circulation in the various organs and determination of the degree to which the reactions of the vessels of a particular organ participate in the general reactions of the cardiovascular system, and on the other hand, to the elucidation of the relationships of the regional vascular reactions of the various organs to each other [1-4, 7-10, 12-16, 19, 20].

We have made a simultaneous comparative investigation of the reactions of the vessels of the kidneys, liver, small intestine, and spleen. The object was to compare the course of the pressor reflexes from the reflexogenic zones of the cardiovascular system (the carotid sinuses) and the receptor zones of organs (stomach, small intestine), and to study the special features of the course of the depressor reaction elicited by inflation of the lungs.

These features of the regional vascular reactions in normal animals were compared with the character of their course in experimental hypertension, the development of which has been investigated by N. N. Gorev, M. I. Gurevich, M. A. Kondratovich, and L. P. Cherkasskii [4-6, 11].

## EXPERIMENTAL METHOD

The regional vascular reactions were studied by tracing the changes in the blood flow in the test organs by a thermoelectric method, using various modifications enabling the inflow of blood and its outflow from an organ to be controlled and the blood flow within the organ itself to be measured directly. The tissue circulation was investigated by means of thermocouples, inserted into the tissues, one junction of which was warmed; the thermocouples were prepared as described in the literature [17, 18]. The blood flow in the major vessels was investigated by means of Rein's electrodes or, in most cases, by means of thermocouples introduced into their lumen. Intravenous nembutal anesthesia was used (30-35 mg/kg body weight ) [3].

The experiments were conducted on 95 animals, 65 normal (50 rabbits and 15 dogs) and 30 with experimental hypertension (12 rabbits and 8 dogs with renal, and 10 rabbits with reflexogenic hypertension). The animals with experimental hypertension were investigated mainly in the early periods of development of hypertension (1st-3rd months after the operation).

## EXPERIMENTAL RESULTS

Stimulation of the mechanicoreceptors of the proximal portion of the small intestine by inflation of an isolated segment of the organ (up to 40-60-80 mm Hg) was accompanied by a marked increase in the blood supply to the segment of small intestine situated distally to the part stimulated, and by a moderate increase in the blood flow in the liver. In the kidneys and spleen the blood flow was usually unchanged or increased. During stimulation of the mechanicoreceptors of the stomach the increase in arterial pressure was accompanied by a marked increase in the


Fig. 1. Regional vascular reactions of the internal organs of the abdominal cavity to interoceptive stimuli from the mechanicoreceptors of the stomach. a) Experiment on a dog (inflation of balloon with 400 ml of air); b) experiment on a rabbit (inflation of balloon by 100 ml of air). The thick vertical lines denote the beginning and end of stimulation. In cut a: the first thick vertical line denotes the beginning of insertion of the tube, 2nd line) beginning of inflation of the balloon in the stomach, 3rd line) end of stimulation. In cut b only the beginning of insertion of the tube and the end of stimulation are marked.

blood supply to the wall of the proximal portion of the small intestine and to the liver tissue (sometimes the blood flow in the liver was very slightly reduced at first). In the spleen a fall in blood flow was often found, presumably on account of its function as a blood depot. The blood flow in the kidneys was substantially unchanged, but sometimes it was very slighly increased (Fig. 1).

The blood flow was also investigated in large vessels such as the superior mesenteric artery, the portal vein, the hepatic artery and vein, and also in various parts of the wall of the small and large intestine. During application of stimuli to the mechanicoreceptors of the stomach, the blood flow was increased only in the proximal portion of the small intestine. In the distal portion of the small intestine and in the large, the blood flow was reduced. The vascular reactions taking place in different directions in the different parts of the intestine evidently compensate one another to a considerable degree.

It is clear from Fig. 1 that the increase in the blood supply to the liver was brought about mainly as a result of an increased blood flow along the hepatic artery. The blood flow along the portal vein was reduced or unchanged. In the heptaic vein a reduction in the blood flow was often found, from which it may be concluded that the vessels in the liver were dilated.

In contrast to the pressor reactions from the visceral receptor zones, the pressor reflex to compression of both carotid arteries was not accompanied by any appreciable changes in the blood flow in the internal organs tested. Nevertheless, in a series of experiments the blood flow in the main vascular trunks and in the organs was increased, presumably on account of the increased arterial pressure usually observed in these circumstances (Fig. 2, a).

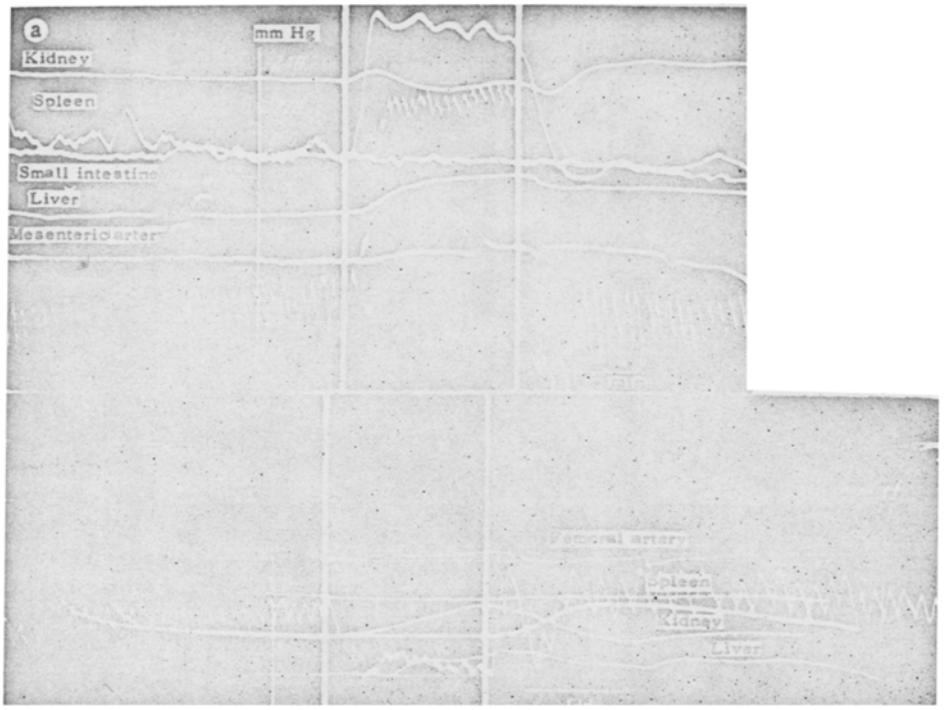


Fig. 2. Regional vascular reactions of the internal organs of the abdominal cavity in a dog during compression of both common carotid arteries (a) and during inflation of the respiratory passages of the lungs to 200 ml water for 30 sec (b). The thick vertical lines mark the beginning and end of stimulation.

During the depressor reaction from the lungs an increase in the blood flow in the internal organs was observed, indicating dilatation of their vessels. This was observed most frequently in the small intestine and spleen (Fig. 2). The regional vascular changes described above differed in degree from one experiment to another, although their trend was the same in most normal animals (in 45 or 50 rabbits and 15 dogs).

In the animals with experimental hypertension the course of the regional vascular reactions differed in character from that in the normal animals. Firstly, attention was directed to the tendency of the renal vessels, observed in our previous investigations, to respond by spasm to pressor stimuli regardless of which interoceptive zone – the carotid sinus or the visceral zones – was stimulated. When the renal vessels were constricted, the regional vascular reactions to reflex stimulation of the stomach and small intestine were sometimes close to normal. When, however, no spasm of the renal vessels appeared, the blood flow in the liver tissue fell in response to stimulation. The blood flow in the hepatic artery fell; an increased outflow along the hepatic vein was frequently observed. The blood flow in the wall of the intestine remained almost normal for a long time, but in some experiments it was observed to be lowered instead of raised. The results of an investigation of animals with experimental renal hypertension are shown in Fig. 3. When the blood flow in the cortex of the kidney was reduced during stimulation of the mechanicoreceptors of the stomach, the reaction in the small intestine and liver was close to normal (see Fig. 3, a), whereas in the absence of a decrease in the hepatic blood flow a decrease was observed in the blood flow in both the liver tissue and the small intestine in response to the same stimulation (Fig. 3, b).

In a rabbit with reflexogenic hypertension (3 weeks after the operation) and extremely high rise of arterial pressure (by 70-80 mm) was observed in response to stimulation of the mechanicoreceptors of the stomach. This was not observed in the animals with renal hypertension, in which changes usually developed gradually, and sometimes in normal animals. In this experiment the pressor reaction was combined with a marked simultaneous fall in the blood flow in the kidneys and liver, while the blood flow in the small intestine increased (see Fig. 3, c). It may be concluded from these findings that the differences in the degree of involvement of the vessels of different regions, especially the kidneys and liver, in the reaction depend on the character of the changes in the functional state of the central control of the circulation.

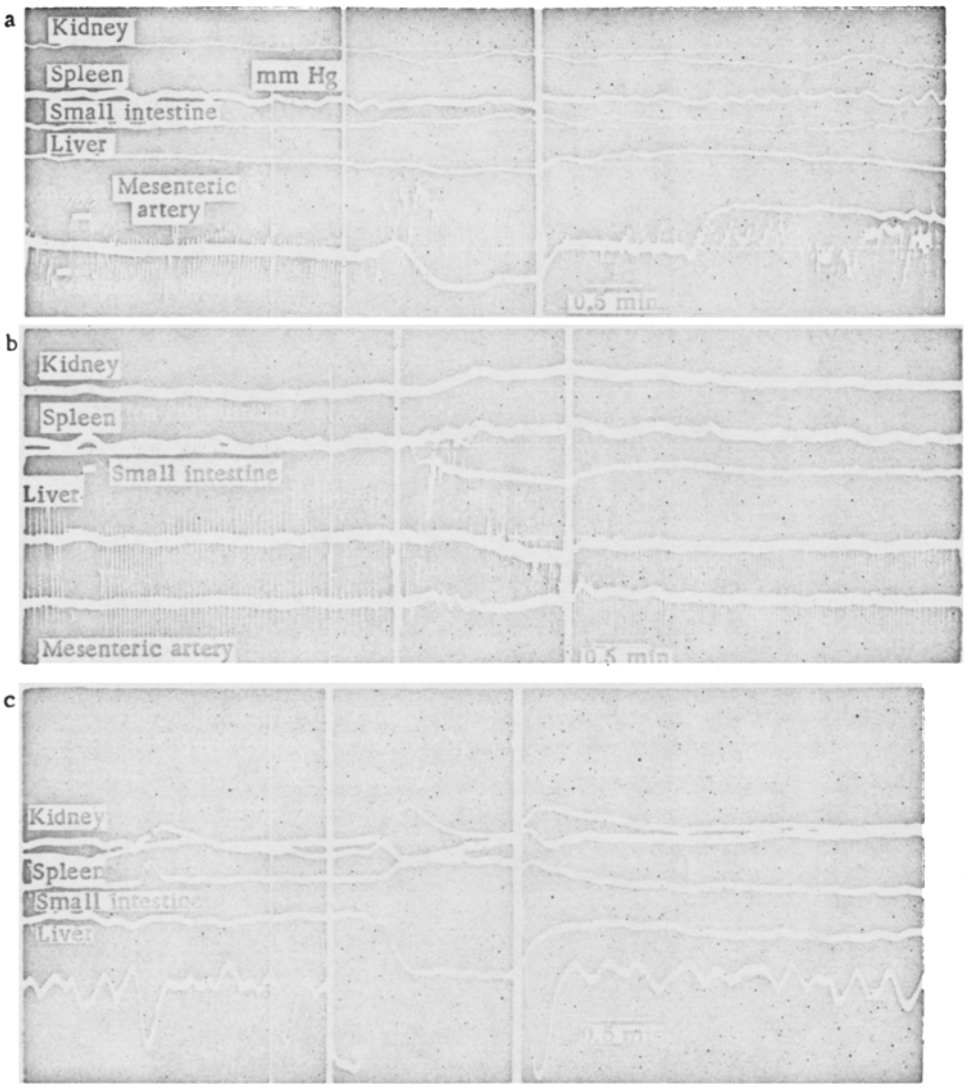


**Fig. 3.** Course of the regional vascular reactions of the internal organs to interceptive stimulation in experimental hypertension. a, b) During stimulation of the mechanicoreceptors of the stomach in a dog with experimental renal hypertension; c) during stimulation of the mechanicoreceptors of the stomach in a rabbit with reflexogenic hypertension. The thick vertical lines mark the beginning and end of stimulation.

The pressor reaction from the mechanicoreceptors of the carotic sinuses in hypertension is associated with spasm of the renal vessels, as reported in our previous communications, although no significant changes in the blood flow in the internal organs compared with normal could be observed. During the depressor reaction from the lungs in animals with hypertension, as in normal animals, a tendency was observed for the blood vessels of the internal organs to dilate, a feature most often seen in the small intestine and spleen. It should be noted that the blood pressure of the animals with hypertension fell slightly during the experiment, although the character of the vascular reaction remained hypertensive in all the experiments.

## SUMMARY

The results of experiments indicate that the reflex changes appearing in the arterial pressure are composed of varied (by manifestation and combination) regional vascular reactions, often opposite in direction. The simultaneous comparative study of vascular reactions in several internal organs, namely in the kidney, liver, small intestine, and spleen, may shed light on the peculiarity of each of the interoceptive reflexes studied.

As distinct from normal animals, in the animals with experimental hypertension, vasoconstrictor reactions developed in internal organs (particularly in the kidneys and liver) in response to reflex influences from the receptor zones.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.

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