REFLEX INFLUENCES FROM THE RECEPTORS OF THE ABDOMINAL ORGANS ON THE BLOOD FILLING OF THE SPLEEN (IN CHRONIC EXPERIMENTAL CONDITIONS)

I. P. Krichevskaya

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Despite many investigations [9, 11, 20] of the neuro-humoral regulation of the reservoir action of the spleen, the problem of interoceptive influences on the storage of blood in this organ has received little study. In earlier investigations [4, 7, 8] in acute experimental conditions the author demonstrated interoceptive influences from the receptors of the abdominal and thoracic organs on the oncogram of the spleen.

Bearing in mind the well-known disadvantages of vivisection techniques (general anesthesia, trauma, etc.), in the present investigation of effects of interoceptive reflexes on the reservoir function of the spleen were studied in chronic experimental conditions.

EXPERIMENTAL METHOD

To record the volume of the spleen, the method of exteriorizing the spleen under the skin of the abdominal wall (after K. M. Bykov) was used, for it enables continuous recordings to be made of the volume of blood in the spleen over a long period of time.

Four dogs (Pal'ma, Belka, Kukla, and Ryzhaya) were prepared by an aseptic operation in which the spleen was exteriorized under the skin of the abdominal wall and chronic fistulas created into the stomach, small intestine, and urinary bladder (two of these three fistulas were formed in each animal).

The experiments were carried out as soon as the animals had recovered and become accustomed to the experimenter, and had learned to stand quietly in the frame. Usually the experiment lasted not more than 1 h, for after this period the animal began either to move about or to become sleepy. The oncogram of the spleen and the pneumogram were recorded on a kymograph. In some experiments the changes in the skin temperature of the animal's forelimb were recorded at the same time by means of an electrothermometer with thermistor detectors to estimate the blood filling of the cutaneous vessels.

Various stimuli were used in the experiments and were applied through the fistulas: stimulation of the mechanoceptors of the stomach and small intestine by filling small balloons introduced into the cavity of these organs with fluid (37-38°); stimulation of the mechanoceptors of the urinary bladder by injecting sterile physiological saline (37-38°); stimulation of the chemoceptors (40° alcohol, 0.5-3% hydrochloric acid solution), and the thermoceptors of the stomach by injecting water (2-5° and 42-45°) in a small volume so as not to stimulate the mechanoceptors. The time of action of one stimulus was from 2 to 12 min. The intensity of stimulation was moderate; it did not produce a pain reaction, as judged by the absence of dyspnea, restlessness, or generalized movement of the animal. Altogether about 100 experiments were performed from October, 1963, until June, 1964.

EXPERIMENTAL RESULTS

Stimulation of the mechanoceptors of the stomach evoked a constant reaction in the experimental animals: contraction of the spleen lasting for 5-30 min after removal of the stimulus. The threshold of the reaction was injection of 150-200 ml of fluid (Pal'ma) and 100-120 ml (Kukla and Belka). The latent period of the reaction was 5-15 sec, or sometimes longer (Fig. 1A).

Stimulation of the mechanoceptors of the small intestine (20-40 ml of water at a temperature of 37-38°) in most cases also led to a reduction in the blood filling of the spleen.

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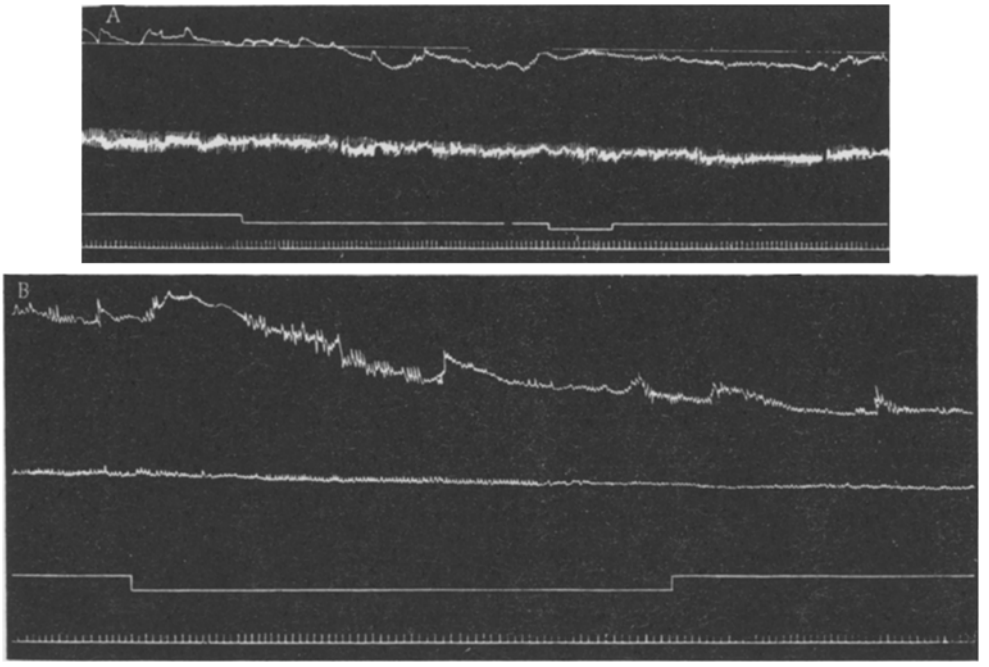

Fig. 1. The dog Ryzhaya with chronic fistulas of the small intestine and urinary bladder and with the spleen exteriorized beneath the skin of the abdominal wall. Changes in the volume of the spleen following injection of 200 ml physiological saline into the stomach (A) and 150 ml into the urinary bladder (B). From top to bottom: oncogram of the spleen, pneumogram, marker of stimulation, time marker (5 sec).

A distinct and constant reaction was produced by stimulation of the mechanoceptors of the urinary bladder (80-150 ml fluid). A prolonged and gradual decrease in the blood filling of the spleen was observed, sometimes after a preliminary and transient dilation (see Fig. 1B).

In some experiments during prolonged stimulation of the mechanoceptors of the stomach and urinary bladder, the spleen contracted so much that after removal of the oncograph the organ could hardly be palpated through the skin.

Stimulation of the thermoceptors of the stomach caused varied and inconstant changes in the blood filling of the spleen, sometimes of a wave-like character. Stimulation of the chemoceptors of the stomach with 0.5-3% hydrochloric acid was accompanied by an increase in the volume of the spleen followed by a decrease (Fig. 2A).

Injection of 40° alcohol into the stomach led to a decrease in the blood filling of the spleen, sometimes considerable, as shown in Fig. 2B. However, in almost half the observations the fluctuations in blood filling of the spleen during stimulation of the chemoceptors of the stomach were absent or indefinite in character.

The skin temperature was measured in experiments with stimulation of the mechanoceptors of the stomach and urinary bladder, which by comparison with the other stimuli gave a most constant and well marked reaction of the spleen. In most cases, a definite pattern was observed: an increase of temperature by 0.1-0.2° at the beginning of stimulation followed by a decrease by 0.1-0.3° compared with the initial level which was maintained after removal of the stimulus.

The results of these experiments showed that in normal physiological conditions, during stimulation of the interoceptors of the abdominal organs, changes arise in the storage of blood in the spleen.

These observations are in general agreement with the results obtained earlier in acute experiments.

The most commonly observed reaction of the spleen was one of contraction. An important factor in the mechanism of this reaction was evidently the increase in the blood concentrations of adrenalin and noradrenalin, found during stimulation of the mechanoceptors of the gastro-intestinal tract during chronic experiments on dogs [1]. Emptying of the spleen has a definite physiological meaning. In natural conditions stimulation of the receptors of any organ usually acts as a stimulus for an increase in the activity of that organ, which in turn is associated with the need for an increase in its blood supply. The discharge of an additional mass of blood from the spleen, rich in

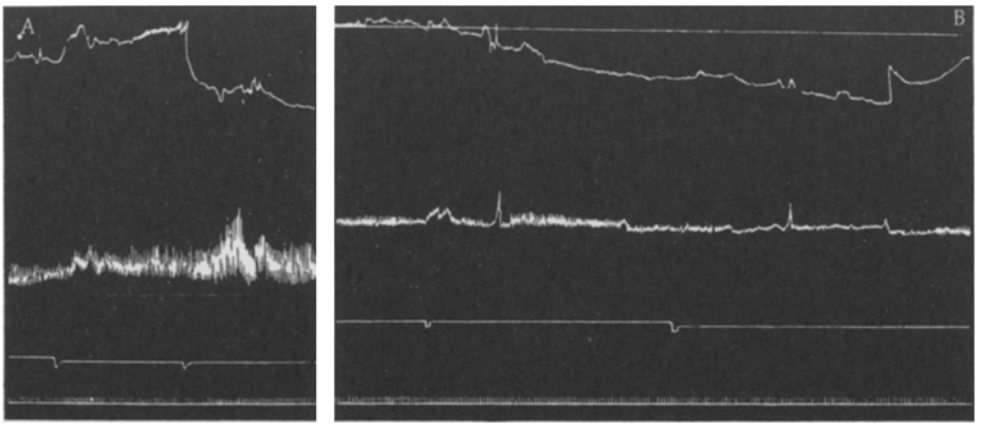

Fig. 2. Changes in the volume of the spleen following introduction of 40 ml of 3% hydrochloric acid (A) and 40 ml 40° (B) into the stomach. Legend as in Fig. 1.

erythrocytes, brings about an improvement in the blood supply mainly of the abdominal organs. The spleen is a very important regulator of the blood flow in the splanchnic region, especially in the system of the portal vein [17, 18]. There are reports in the literature of a decrease in the volume of the spleen after feeding, and also in dogs stimulated by the sight of food [14, 19]. The fluctuations observed in the skin temperature show that during contraction of the spleen caused by stimulation of the mechanoceptors of the stomach and urinary bladder, the blood filling of the cutaneous vessels not only did not increase, but showed a tendency to decrease.

The results obtained confirm the view that wide reflex connections exist between the different internal organs. Evidently an important part in the mechanism of these connections is played by local or peripheral reflexes [13], the reflex pathways of which relay in the peripheral ganglia of the abdomen.

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