REFLEX VARIATIONS IN THE TONE OF THE SPLENIC VESSELS

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There are reports in the literature of the high reactivity of the vessels of the internal organs, and in particular of the splenic vessels [18], in relation to various factors [14].

Little attention has been paid to the question of the relationships between the variations in the tone of the arteries and veins of one particular vascular region. Changes in vascular tone are usually assessed collectively for a particular region or organ.

To compare the reflex reactions of the arteries and veins of one vasular region, it is advantageous to use the method of separate perfusion of each of these vessels, humorally isolated and retaining only its nervous connections with the rest of the body.

In this investigation the reflex variations in the tone of the splenic artery and vein were studied by separate perfusion.

EXPERIMENTAL METHOD

Experiments were carried out on 26 dogs. The animal was fixed and anesthetized, and the vessel to be investigated was then carefully isolated over as much of its length as possible, keeping its nerve supply intact. The isolated vessel was perfused with oxygenated Ringer-Locke solution (37-38°) under constant pressure. To drain off the perfusion fluid, a cannula fitted with a three-way tube, one end of which was joined to a water manometer and a small Marey's capsule for recording the tone of the vessel graphically, was inserted into the vessel. With a decrease in the tone of the vessel, the volume of fluid it could transmit increased, and the curve reflecting this tone graphically showed a rise. If the tone was increased the curve fell correspondingly. A visual control was maintained at the same time (from the number of drops of fluid flowing out through the 3-way tube.

The arterial pressure (in the carotid or femoral artery), the venous pressure (in the femoral vein), and the respiration were also recorded. The pressure in the splenic artery and vein was recorded in three animals not undergoing perfusion. The animals were exposed to the action of various factors causing pressor or depressor changes in the blood pressure: stimulation of the sciatic and vagus nerves or the carotid simus, asphyxia, and stimulation of the mechanoceptors of the small intestine, the urinary bladder, and the gall bladder.

EXPERIMENTAL RESULTS

More than 150 observations were made, in most of which clearly defined reflex variations in the tone of the splenic vessels were observed. In most experiments a simultaneous increase took place in the tone of the artery and vein, coinciding with either a rise or fall of blood pressure. However, the latent period, the intensity, and the duration of the reaction differed in the artery and veins.

During the pressor or pressor-depressor reaction of the arterial and venous pressure produced by electrical stimulation of the central end of the divided sciatic nerve and by brief asphyxia, in 39 of 57 experiments a simultaneous contraction of the splenic artery and vein was observed (Fig. 1, A).

Stimulation of the carotid sinus led to an increase in the tone of the splenic artery but had little effect on the tone of the humorally isolated splenic vein (Fig. 1, B).

In response to stimulation of the peripheral end of the divided vagus nerve, in 16 of 20 cases considerable variations were seen in the tone of the splenic vessels (Fig. 1, C and D), indicating that the vagus nerves play a role in the regulation of the vascular tone of the internal organs [11].

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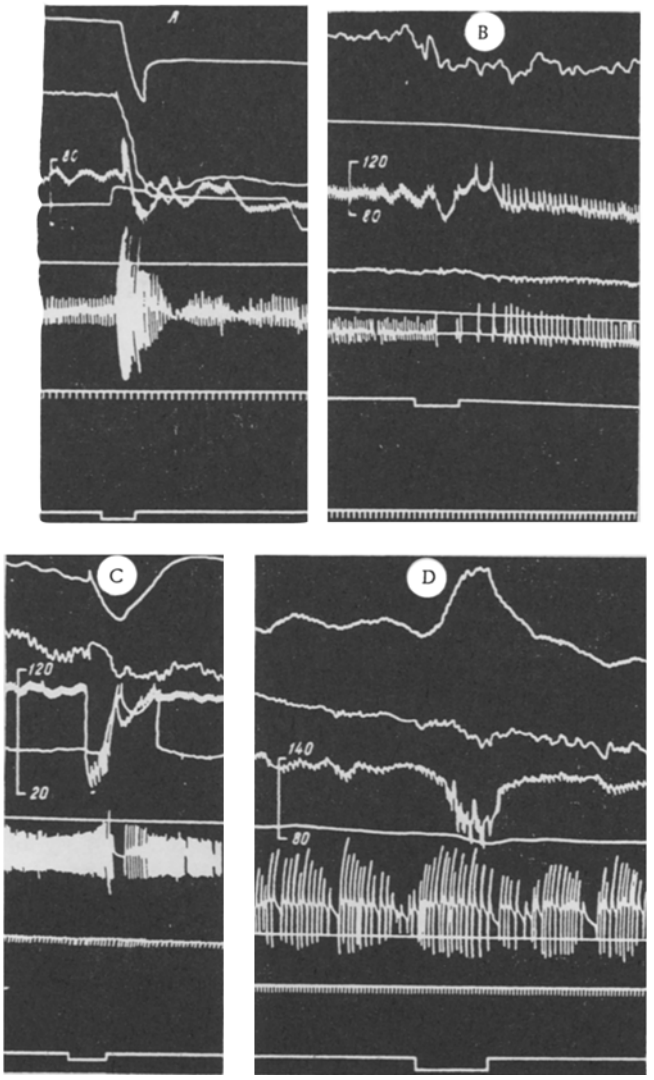

Fig. 1. Changes in the tone of the splenic vessels and the arterial and venous pressure in response to electrical stimulation of the sciatic nerve (A), the carotid sinus (B), and the vagus nerve (C and D). From the botton: tone of the splenic artery, tone of the splenic vein, arterial pressure, venous pressure, zero line of arterial pressure, respiration, time marker (5 sec), marker of stimulation.

The results of the experiments in which the mechanoceptors of the small intestine and the urinary and gall bladder were stimulated demonstrated the high reflex excitability of the splenic vessels. Changes in the tone of the vessels were often observed in the almost complete absence of changes in arterial pressure. For instance, distention of a loop of the proximal part of the small intestine with air (pressure 50-60 mm Hg) led to a prolonged reduction in the lumen of the splenic artery and vein, although the arterial pressure remained almost unchanged and the venous pressure showed a transient rise (Fig. 2, a).

Injection of 100 ml physiological saline into the urinary bladder caused a marked increase in the tone of the splenic vessels, without any variations in the arterial pressure and the pressor-depressor reaction of the venous pressure (Fig. 2, C).

In 15-18% of cases the application of the various stimuli was accompanied by changes in the opposite direction in the tone of the artery and vein (see Fig. 1, D and Fig. 2, B).

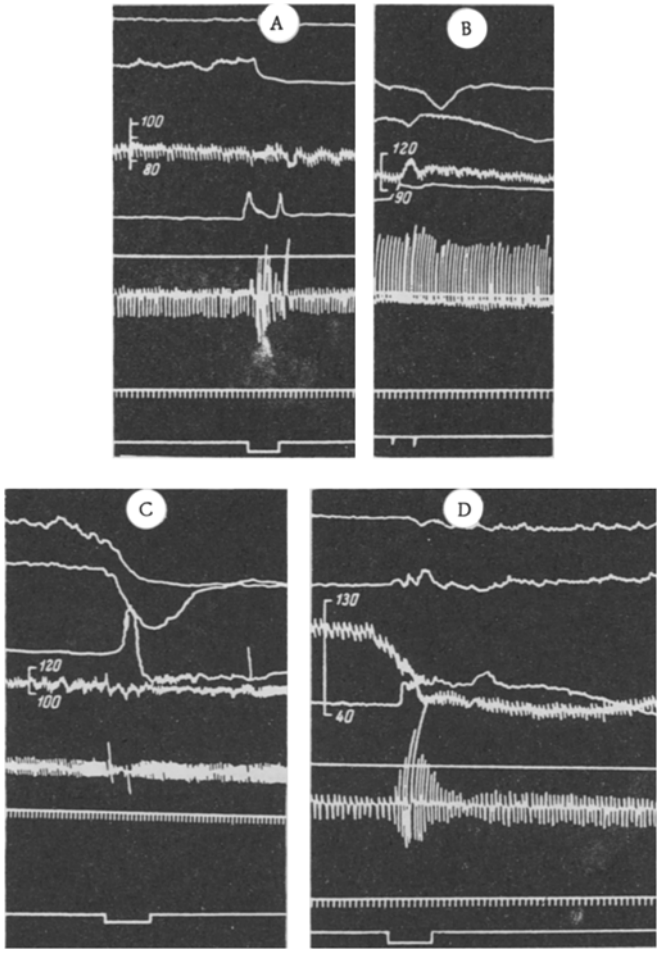

Fig. 2. Changes in the tone of the splenic vessels and the arterial and venous pressure in response to stimulation of mechanoceptors of the small intestine (A and B) and the urinary bladder (C) and gall bladder (D). A, B, and D: significance of the curves the same as in Fig. 1. C (from top to bottom): tone of the splenic vein, venous pressure, arterial pressure, respiration, time marker (5 sec) marker of stimulation.

At the same time, as the results of experiments in which the blood pressure in the splenic artery and vein was recorded simultaneously revealed, the direction of these variations showed a large measure of agreement (Fig. 3, A, B, first stimulation). In some cases the changes in the blood pressure in the artery and vein also took place in opposite directions (Fig. 3, B, second stimulation).

The reservoir function of the spleen is largely dependent on the extremely high elasticity of the splenic vessels [15]. The vascular tone and contractile ability of the spleen are interrelated indices.

By recording the vascular tone graphically as was done in this investigation, in some curves (Fig. 1, D, and Fig. 2, A and D) characteristic periodic variations of tone could be observed, analogous to the rhythmic variations in the splenic blood volume, known as splenic waves. The origin and significance of these waves have not yet been finally settled. The results of these investigations suggest that the appearance of splenic waves may be associated with the periodic onset of variations in the tone of the blood vessels. Like the waves on the oncogram of the spleen, periodic variations in vascular tone sometimes appeared after application of a stimulus evoking a marked reaction of the systemic blood pressure. For example, in Fig. 2, D periodic variations of tone may be seen to appear against the background of a sharp

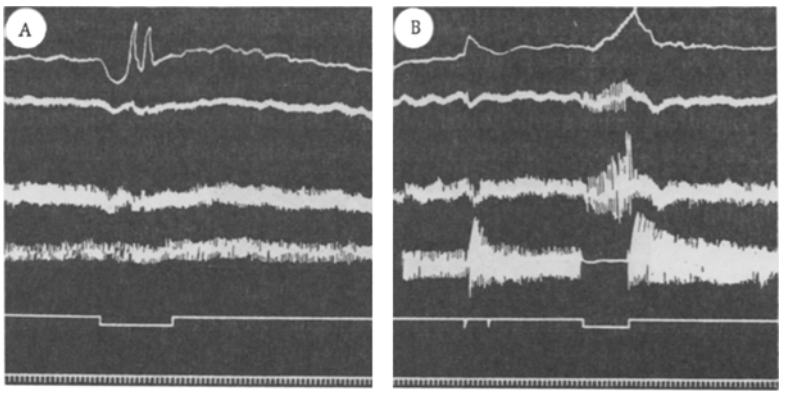

Fig. 3. Changes in blood pressure in the carotid artery, the splenic artery, and the splenic vein in response to electrical stimulation of the carotid sinus (A) and to mechanical stimulation of the sciatic nerve and asphyxia (B). From top to bottom: pressure in the splenic vein, pressure in the splenic artery, pressure in the carotid artery, respiration, marker of stimulation, time marker (5 sec).

decrease in the arterial and an increase in the venous pressure, caused by injection of 40 ml of physiological saline into the animal's gall bladder.

Further comparison of the variations in the tone of the blood vessels with the changes in the splenic blood volume emphasizes that, in accordance with data in the literature and the authors' observations [1, 3-6, 10, 18], nearly all stimuli—electrical stimulation of the sciatic and vagus nerves, asphyxia, stimulation of the mechanoceptors of the small intestine and urinary bladder—lead as a rule to emptying of the spleen.

During the action of these factors, an increase in the tone of the splenic vessels is usually observed. This is important in the mechanism of the prolonged decrease in the splenic blood volume and decrease in the blood flow in the splenic vessels during the contractile reaction of the spleen.

As long ago as in 1932 the view was expressed that the rate of flow and the amount of blood escaping from the spleen during contraction depend primarily on the tone of the veins [7]. The role of the venous tone in the active contraction of the spleen has been demonstrated in experiments on the spleen perfused with blood [15].

The variations in opposite directions in the tone of the artery and vein served by the authors in many cases evidently play a particularly important role in the reservoir function of the spleen. In some combinations they may facitlitate the storage of blood in the spleen, while in others they may bring about its emptying.

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