EFFECTS OF STIMULATION OF SPLENIC MECHANOCEPTORS ON CEREBRAL CIRCULATION

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Until now very little work has been done on the influence on the cerebral circulation of stimulation interoceptors, in particular the interoceptors of the spleen. It is known that as an interoceptor organ related by numerous reflex connections with other organs and systems the spleen is very sensitive to internal and external stimuli (1, 2, 6-11,13].

Here we report an investigation into the relationship between the vessels of the spleen and those of the brain.

EXPERIMENTAL METHOD

The experiments were carried out on 21 dogs under light morphine-chloroform anaesthesia. We recorded the pressure in the circle of Willis, the intracranial and arterial pressure, and we made a plethysmogram of the spleen [3]. The method we used was developed in this department and has been used several times by our colleagues in the department [4, 5].

The splenic mechanoceptors were stimulated by increasing or decreasing the extent to which the organ was filled with blood; this effect was produced by pressing either on the vein or on the artery. First a dissection was made to display the nerves. The vessels were clamped by means of a tourniquet previously placed in position, and this could be done without opening the abdominal cavity.

As a control and as a means of revealing the mechanisms of the reactions involved, in 7 experiments we denervated the spleen. For this purpose we carefully divided all nerve fibers running to it. The splenic vessels were then treated with a 10% solution of phenol or with 3-5% cocaine.

EXPERIMENTAL RESULTS

An increase in the extent of engorgement of the spleen with blood caused an increase in general arterial pressure of 12-16 mm in 64.7% of the experiments, an increase in the pressure in the circle of Willis of 4-9 mm in 58% of the experiments, and in 44.5% of the tests there was an increase of intracranial pressure.

In these reactions there was a long latent period of 3-15 sec and a long-lasting after-effect of several tens of seconds.

In 2 of the tests the increased filling of the spleen with blood was associated with a reduction in general arterial pressure, in 4 there was a reduction in the pressure within the circle of Willis, and in 1 there was some tendency for the intracranial pressure to fall. In our experiments we did not always observe a parallelism between changes in the general arterial pressure and in the indices of cerebral circulation.

In some experiments the increased engorgement of the spleen caused no changes in the indices recorded.

A reduction of splenic engorgement caused an increase in arterial pressure of 10-15 mm in 90.5% of the cases, an increase in pressure in the circle of Willis of 3-27 mm in 90.5% of the tests, and in 77.4% of the cases an increase in intracranial pressure was recorded.

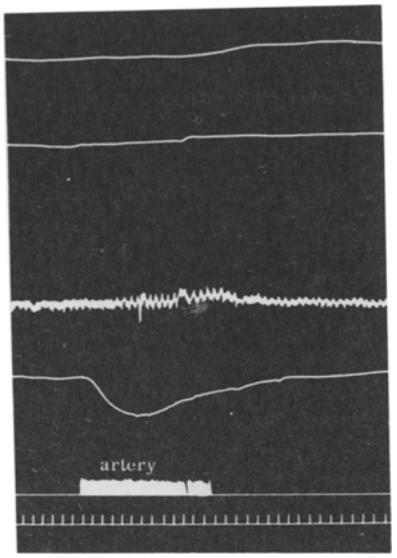

Fig. 1. Effect on general arterial pressure and on the pressure in the circle of Willis of a reduction in the degree of engorgement of an intact spleen. Curves, top to bottom: changes in the volume of the spleen, intracranial pressure, pressure in the common carotid artery, pressure in the circle of Willis, stimulus marker, time marker (5 sec).

A reduction of arterial pressure in response to reduced splenic engorgement was observed in 1 case, and a reduction in pressure in the circle of Willis occurred in 4 out of the 42 tests. No reduction in intracranial pressure was observed. In 3 experiments we recorded a reduction in pressure in the vessels of the circle of Willis occurring together with a rise of general arterial pressure (Fig. 1).

In 3 experiments there was no change in general arterial pressure in response to compression of the splenic artery, and no change in intracranial pressure in 7 tests. Changes in pressure in the circle of Willis occurred in all experiments.

As a rule the increase in pressure in the circle of Willis was smaller than was the rise in general arterial pressure. In this set of experiments, as in the experiments in which pressure in the splenic arteries was increased, the rise in pressure in the circle of Willis and the increase in intracranial and general arterial pressure was observed throughout the whole time for which the splenic artery was compressed. However, the extent of the pressure rise was gradually reduced before the time at which the ligature applied to the artery was released. As a rule the blood pressure returned to the original value when pressure on the vessels was released. The after effects of these reactions lasted a few tens of seconds, and the latent period was 10-15 sec.

It appears that the variations in the latent period (3-10-15 sec) and its duration may be attributed to the variation in size of the spleen in the dogs; the size is not always strictly proportional to the size of the animal. The essential feature is that when the vein of a small spleen is compressed, the threshold pressure and the required degree of distension of the intrasplenic vessels are attained more rapidly than when the spleen is large. The same relationship applies to reduction in the degree of engorgement of a spleen. It appears that the unequal initial levels of the thresholds of excitability of the splenic receptors among the different dogs is significant. In studying interoceptor influences exerted by the spleen on blood pressure and respiration V. N. Chernigovskii [11, 12] repeatedly noticed a latent period of some tens of seconds in the reflex reactions.

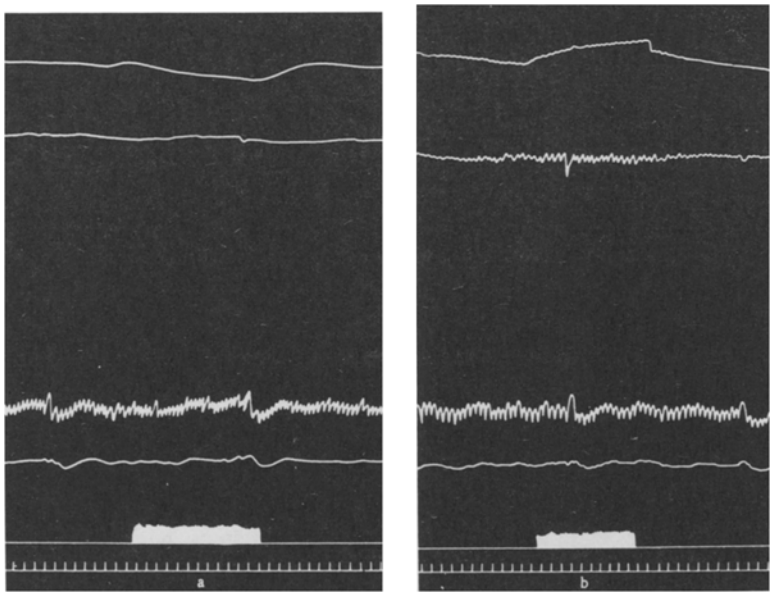

Fig. 2. Effect on general arterial pressure and pressure in the circle of Willis of (a) a reduction and (b) an increase in the degree of engorgement of a denervated spleen.

In most cases pressure changes in the circle of Willis and changes in the intracranial pressure occurred together with a change in the general arterial pressure. However, in certain cases we observed changes in the reverse direction. Such cases indicate that the alteration to the blood flow to the cerebral vessels is not passive, and they indicate the involvement of a reflex mechanism controlling such changes.

As confirmation of the reflex nature of the reactions which we have studied we may note that compression of the vessels of a denervated spleen cause no change in the quantities we have investigated (Fig. 2).

SUMMARY

A study was made of the effect on certain cerebral circulation indices of stimulationof splenic mechanoceptors. The experiments were performed upon dogs under light morphine-chloroform anaesthesia. Records were made of the pressure in the circle of Willis, intracranial pressure, the general arterial pressure, and splenic volume. In most experiments a pressor response followed stimulation of the splenic mechanoceptors. These experiments showed that there was no parallelism between the changes in the general arterial pressure and changes in the cerebral circulation; this result suggests that reflex control of cerebral circulation is autonomous, and that splenic interoceptors may influence the circulation.

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