REFLEXES FROM THE RECEPTORS OF THE URINARY SYSTEM ON THE VOLUME OF BLOOD PRESENT IN THE SPLEEN

I. P. Krichevskaya

From the Department of Normal Physiology (Head – Prof. A. P. Polosukhin) of the Kazakh State Medical Institute, Alma-Ata

(Received July 22, 1958. Presented by Active Member AMN SSR V. V. Parin)

One of the main tasks in the study of the reservoir function of the spleen is the investigation of the nervous regulation of this function.

A considerable amount of research has been done on the study of the reaction of the spleen as a reservoir of blood to stimulation of various nerves by the action of pain, temperature and other agents.

The development of the exteroceptive regulation of the reservoir function of the spleen in ontogenesis has been studied in detail [10]. The role of the cerebral cortex in the regulation of the volume of the spleen has been established [2, 4, 10].

The reservoir function of the spleen is intimately connected with other organs, and above all with the circulatory system [6].

In some of the more recent papers by foreign workers [15, 17] it is asserted that during contraction of the spleen vasoactive substances, affecting the level of the arterial pressure, are secreted into the blood stream. This research, involving the injection of various sympathomimetic drugs into the splenic artery, is not sufficiently convincing, since it does not take into consideration the possibility of stimulation of the receptors of the spleen, first discovered by V. N. Chernigovskii [13], and of the reflex action from these receptors on the arterial pressure.

Insufficient attention has been paid to the interoceptive regulation of the blood content of the spleen; the only reflexes which are known to affect the spleen arise from receptors in the carotid sinus [16, 10] and the vessels of the lungs [9].

We have found no details in the literature of changes in the blood volume of the spleen in response to stimulation of the interoceptors of organs of the peritoneal cavity, and in particular of the urinary system.

Reflex effects are nevertheless known from the receptors of the urinary bladder on several functions [14, 12, 5 3, 1, 11]. There are also reports of the presence of pressure receptors in the renal vessels and the renal pelves [5, 7, 8, 12].

The aim of the present research was to study the influence of impulses from the mechanoreceptors of the organs of the urinary system (kidneys, renal pelves, urinary bladder) on the degree of filling of the spleen with blood.

EXPERIMENTAL METHOD

Experiments were carried out on 18 dogs under morphine-hexobarbital anesthesia. In all the experiments simultaneous recordings were made of the pressure within the carotid artery, by means of a mercury manometer, respiration, and the volume of the spleen (by means of an oncograph connected to a Marey's capsule).

Stimulation of the mechanoreceptors of the urinary bladder and of the renal pelves was carried out by an injecting warm (37°) physiological saline into the lumen of these organs, and the pressure thus created was mea-

sured by a mercury manometer included in the system. Stimulation of the vascular receptors of the kidneys was acheived by temporary engorgement of the kidneys with blood as the result of the application of a clamp to the renal veins.

EXPERIMENTAL RESULTS

The effect of stimulation of the mechanoreceptors of the urinary bladder on the volume of the spleen was investigated in 48 experiments (on 17 dogs). A varying volume of physiological saline (80-300 ml) was introduced into the lumen of the bladder, under a pressure of 30 to 80 mm of mercury.

In 24 cases stimulation of the receptors of the urinary bladder led to an increase in the arterial pressure, although from time to time, after a preliminary fall; in 9 cases the pressure was lowered, and finally, in 15 cases there were no marked changes in the pressure, and only a reduction in the amplitude of the pulse waves was observed.

G. N. Aronova [1] has pointed out a relationship between the reaction of the arterial pressure and the position of the urinary bladder. In her experiments stimulation of the receptors of the urinary bladder when situated outside the peritoneal cavity caused a rise in the arterial pressure; if the organ was within the peritoneal cavity, stimulation of its receptors led to an insignificant rise or to a fall in the pressure.

We were unable to confirm this relationship. Our findings agreed with those of M. I. Kokhanina [5], who usually observed a fall in the arterial pressure in response to the introduction of a small volume of physiological saline into the urinary bladder, and usually a rise in the pressure when a larger increase in the intravesical pressure was produced.

In the majority of our experiments the introduction of fluid into the urinary bladder led to contraction of the spleen (33 observations), although in 11 cases, after a brief contraction, a dilatation of the spleen took place, sometimes considerable. In 7 cases dilatation of the spleen was observed without preliminary contraction, and in 8 no reaction was present.

The respiration was variously affected: usually there was a slowing of the respiratory movements, sometimes a quickening, and in some cases there was no change.

After introduction of 80 ml of physiological saline into the lumen of the urinary bladder (Fig. 1, a) a reduction in the amplitude of the pulse waves was observed. The spleen was slightly contracted, then became dilated, and rhythmic waves appeared. The respiration was unaffected.

In the same experiment, when 200 ml of physiological saline was introduced into the urinary bladder (Fig. 1, b), an insignificant and brief fall in the arterial pressure and a simultaneous reduction in the amplitude of the pulse waves were produced. Respiration was slowed. The spleen contracted, and its volume then began to increase, and 30 seconds after cessation of stimulation it began to contract once more. After $3\frac{1}{2}$ minutes the volume of the spleen reached its original value.

In 44 observations on 15 dogs we studied the interoceptive effects on the spleen arising from the pressure receptors of the renal vessels after interruption of the blood flow through them by clamping the renal veins.

In the majority of the experiments (23) a fall in the arterial pressure was observed, in 16 the pressure rose and in 5 it remained unchanged. Contraction of the spleen was observed in 28 experiments, in 7 dilatation took place and in 9 there was no change in the blood volume of the spleen. Respiration was variously affected.

Temporary interruption of the blood flow through the renal veins (Fig. 2, a) led to a fall in the arterial pressure, although after the stimulus was discontinued the pressure rose above its original value. The amplitude of the respiratory excursions was diminished. A "biphasic" contraction of the spleen took place.

In another observation clamping of the renal veins (Fig. 2, b) caused a moderate rise in the pressure in the carotid artery. The respiratory movements were slightly increased, after which a brief arrest of breathing ensued. The volume of the spleen was reduced.

A decrease in the volume of the spleen was observed both in association with a rise and a fall in the arterial pressure.

In 27 observations (on 12 dogs), physiological saline, warmed to 37°, was introduced into the renal pelves through the ureters. The pressure in the renal pelves was increased to 100-200 mm of mercury.

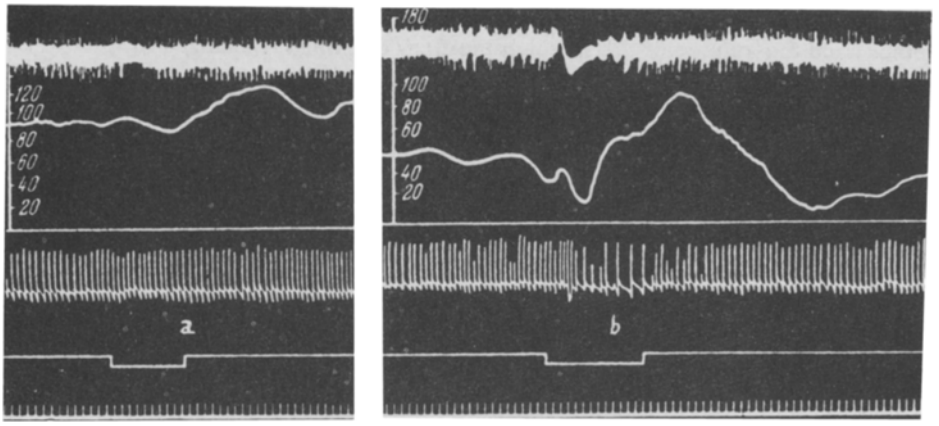

Fig. 1. Changes in the volume of the spleen after introduction of 80 ml (a) and 200 ml (b) of physiological saline into the urinary bladder. Significance of the curves (from above down): 1) pressure in the carotid artery; 2) oncogram of the spleen; 3) zero line of the mercury manometer; 4) respiration; 5) stimulation marker; 6) time marker (5 seconds).

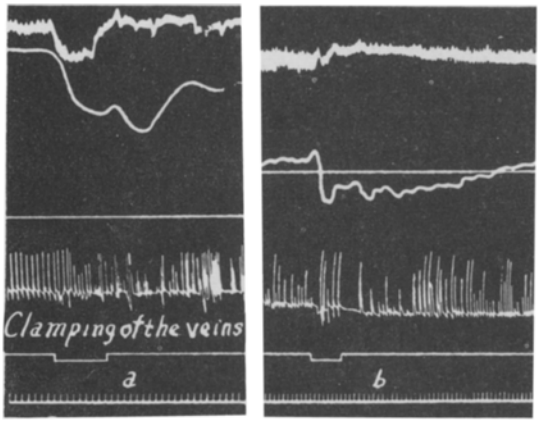

Fig. 2 Changes in the blood volume of the spleen after clamping the renal veins. a) With a fall in the arterial pressure; b) with a rise in the arterial pressure in the carotid artery. Legend as in Fig. 1.

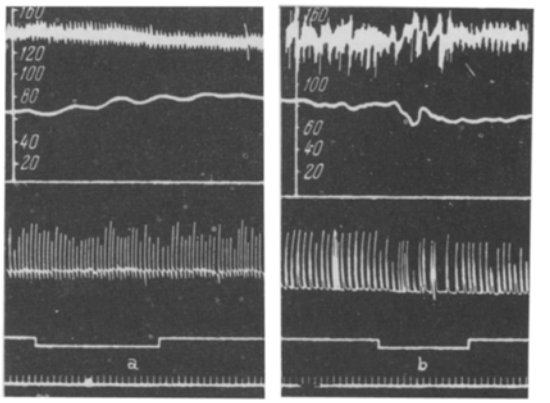

Fig. 3. Changes in the volume of the spleen after introduction of physiological saline into the renal pelves. a) At a pressure of 120 mm of mercury; b) at a pressure of 200 mm of mercury. Legend as in Fig. 1.

The arterial pressure was variously affected and in more than half the cases only slightly. Usually (18 cases) the spleen was contracted, in 4 observations it was dilated and in 5 there was no change in its size.

It may be seen from Fig. 3, a that stimulation of the receptors of the renal pelves at a pressure of 120 mm of mercury elicited no changes in the arterial pressure. Only a slight increase in the amplitude of the pulse waves was observed. Respiration also was unchanged. The spleen gradually underwent a rhythmic dilation.

Stretching the renal pelves with a pressure of 220 mm of mercury led to an insignificant rise in the blood pressure and to a brief, moderate contraction of the spleen (Fig. 3, b).

The experiments showed that stimulation of the interoceptors of the organs of the urinary system elicited, in the overwhelming majority of cases, obvious changes in the blood volume of the spleen.

The changes arose rapidly and could be regarded as reflex. In some cases a reaction of the spleen to stimulation of the receptors of the urinary organs was observed in the total absence of changes in the arterial pressure. Contraction of the spleen, as also its dilation, took place in some cases in association with an increase in the arterial pressure and in others with a fall in the pressure.

On the other hand the volume of the spleen sometimes remained unchanged in spite of the changes in the arterial pressure. Often an increase in the amplitude of the rhythmic waves of the spleen was observed which, in V. V. Parin's opinion [9], is a reflection of the functional changes in the state of the vegetative nervous system.

SUMMARY

Acute experiments were performed on dogs. The author studied the effect of stimulation from the receptors of the urinary system (kidneys, pelvis, urinary bladder) on the intensity of blood accumulation in the spleen. The data obtained demonstrate the presence of interoceptive influence from the above receptors on blood deposition in the spleen, thus confirming the existence of complicated reflex associations between internal organs.

LITERATURE CITED

[1] G. N. Aronova, Byull. Eksptl. Biol. i Med., 35, No. 4, 20-24 (1953).

[2] K. M. Bykov, M. A. Gorshlov, Vestnik Khir. im. Grekova, 27, 80-81, 46-50, (1932).

[3] V. A. Erenkov, Fiziol. Zhur. (Ukrain.), No. 2, 92-98 (1955).

[4] Kh. B. Kel'man, Byull. Vsesoyuz. Inst. Éksptl. Med., No. 5, 13 (1937).

[5] M. I. Kokhanina, Fiziol. Zhur. SSSR, No. 5, 369-375 (1956).

[6] I. P. Krichevskaya, E. G. Skipina, Fiziol. Zhur. SSSR, No. 10, 861-867 (1956).

[7] O. S. Merkulova, Izvest. Akad. Nauk SSSR, Ser. Biol., No. 4, 493-504 (1948).

[8] I. P. Nikitina, Byull. Éksptl. Biol. i Med., 27, No. 5, 329-332 (1949).

[9] V. V. Parin, Byull. Éksptl. Biol. i Med., 15, No. 1-2, 46-48 (1943).

[10] A. P. Polosukhin, Izvest. Akad. Nauk Kazakh. SSR, Ser. Fiziol., No. 45, 1, 7-48 (1948).

[11] M. V. Salikova, Fiziol. Zhur. SSSR, No. 3, 322-328 (1951).

[12] E. G. Skipina, Byull. Éksptl. Biol. i Med., 40, No. 8, 10-14 (1955).

[13] V. N. Chernigovskii, Afferent Systems of the Internal Organs, Kirov, 1943 [In Russian].

[14] V. N. Chernigovskii, Fiziol. Zhur. SSSR, No. 5, 657-672 (1947).

[15] D. Granaat, J. Physiol., 1953, v. 122, p. 209-219.

[16] C. Heymans, T. Bouckaert, p. Regniers. Le synus caratidien et la zone homologue cardio-aortique, Paris, 1933.

[17] H. Rein, Arch. ges. Physiol., 1951, Bd. 253, S. 435-458.