REFLEX EFFECTS ON ARTERIAL PRESSURE, RESPIRATION, AND LYMPH FLOW FROM STIMULATION OF THE PANCREATIC DUCT

L. É. Bulekbaeva

From the Laboratory of Lymph Circulation (Head – Candidate of Medical Sciences A. M. Beketaev) Institute of Physiology (Director – Academician of the AN Kazakh SSR A. P. Polosukhin) AN Kazakh SSR, Alma-Ata

(Received October 23, 1958. Presented by Active Member of the AMN SSSR V. N. Chernigovskii)

The pancreas is known to have both secretory and excretory functions. The abundant innervation of this gland has been repeatedly demonstrated [2, 3, 4, 6, 7]. Many authors [5] have supposed that the acinous and islet tissues are independently innervated. It has been shown physiologically [8] that stimulation of the intact pancreatic nerve and also the central and peripheral ends of the nerve after it has been divided, causes both pressor and depressor responses.

An increase or decrease of the pressure in the blood vessels of the pancreas has been shown [1] to cause general reflex changes in arterial pressure, and sometimes an increased respiration.

We have found no published accounts of work on interoceptor reflexes from the pancreatic ducts.

In the present work, we have attempted to study the effects of interoceptor stimulation of the pancreas on arterial pressure, respiration, and lymph flow.

METHOD

The experiments were carried out on adult dogs under morphine-urethane or morphine-pentothal anesthesia. The abdominal cavity was opened, and the lymphatic vessels and the small arteries from it were ligatured. The only remaining connection of the gland with the rest of the body was through the nerve and the large blood vessels. A cannula was inserted into one of the pancreatic ducts, and the other was tied off.

A study was made of reflexes induced by increasing the pressure in the duct with injections of Tyrode's solution heated to 37-38° and given through a Janet syringe. In some of the experiments, the pressure in the duct was recorded by a mercury manometer. The pressure was raised to 120-160 mm of mercury. In many of the experiments, the receptors were stimulated while the gland was perfused.

Recordings were made of the arterial pressure in the carotid artery, the respiration being registered by a Marey's capsule connected to a side tube of a cannula inserted into the trachea; traces of the stimulus were also made, and a time marker was used to indicate 5-second intervals. Lymph flow was recorded by inserting a cannula into the thoracic lymph duct, and counting the drops with a drop counter. An intravenous injection of 208 international units per kg body weight of heparin was given to prevent clotting.

Nineteen experiments were carried out, including 45 sets of observations, and 5 experiments were carried out during artificial respiration.

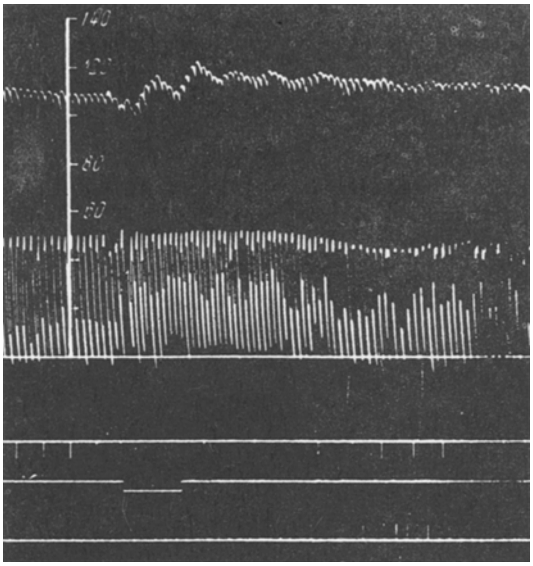

Fig. 1. Changes in the arterial pressure, respiration, and lymph flow on increasing the pressure in the pancreatic ducts. Curves, from above downwards: arterial pressure, respiration base line, lymph flow, stimulus marker, time marker (5 seconds).

RESULTS

Out of the 45 observations, after increasing the pressure in the duct to 120-160 mm of mercury, in 27 cases there was an increase in arterial pressure, in 4 a decrease, and in 2 cases the initial fall was rapidly followed by a rise; in 1 case there was an initial rise followed by a fall, and in 3 instances there was a reduction of the pulse amplitude, while in 8 it remained unchanged. The changes in the respiration rate were very varied. In 21 cases the amplitude increased, and in 3 of these , besides an increase in the thoracic movement there was also an increase in the rate, while in 2 others it slowed down; on 6 occasions the amplitude was decreased, and in 4 cases the rate was also reduced; on 2 occasions there was an increased rate of respiration, in 2 a decrease, and in 7 others there was no change.

Together with the changes in arterial pressure and respiration just described, a reduction in lymph flow was observed 35 times, an increase 3 times, while on 7 occasions there was no change.

Traces of some of the experiments are given in Figs. 1 and 2.

In Fig. 1 it can be seen that increasing the pressure in the ducts causes a rise in arterial pressure from 100-110 to 114-122 mm of mercury, as well as an increase in respiration rate and a marked rise in lymph flow. We assume that these three changes are reflex.

It has already been shown that in certain cases an increase in arterial pressure and thoracic respiratory movements can cause a change in lymph flow. However, in the case described, and in most of our experiments, in spite of the observed changes in arterial pressure and respiration which might be expected to cause an increase in lymph flow, actually a decrease was obtained.

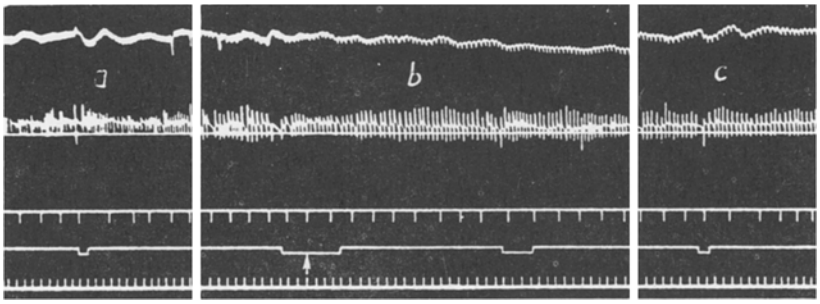

Fig. 2. Variation of arterial pressure, respiration, and lymph flow on increasing the pressure in the pancreatic duct to 140 mm mercury. a) Before injecting novocain into the duct; b) 2 minutes 5 seconds after the injection; c) 21 minutes after the injection . ↑) Moment of novocain injection (4 ml 0.25%). Curves as in Fig. 1 .

In many cases, it would appear at first sight that the change in lymph flow resulted from a reduction in the rate or in the depth of respiration. However, this explanation is probably not correct, because in our experiments, a reduction in lymph flow occurred during the operation of such important factors as increase in the arterial pressure, and sometimes by a motor reaction occuring together with an increased depth and frequency of respiration, factors which under certain conditions lead to an increased lymph flow.

Also, a reduced lymph flow was found in 18 cases to be associated with an increased depth of respiration, in 6 to occur without any respiratory change, in 2 to be associated with an increased respiration rate, while in 5 cases the respiration was maintained artificially.

To confirm that the changes in arterial pressure, respiration, and lymph flow in response to the stimuli used were reflex in nature, a number of experiments were arranged in which 3 ml of 0.25% novocain was injected into the duct. After the injection, no change in arterial pressure, respiration, or lymph flow occurred, as can be seen from Fig. 2.

After increasing the pressure in the duct to 140 mm, a small increase in arterial pressure was observed, after which it fell. The respiration became deeper, and the lymph flow became markedly reduced (Fig. 2, a). Increasing the pressure in the ducts immediately after injecting them with 4 ml 0.25% novocain solution caused no alteration in arterial pressure, respiration, or lymph flow (Fig. 2, b). After the effect of the novocain had worn off, the arterial pressure, respiration, and lymph flow once more responded to alteration of pressure in the duct (Fig. 2, c). It seems to us that the changes occur as follows.

From the classical work of I. P. Pavlov and his school, it is known that there is an increased secretion of pancreatic juice in response to the entry of chyme from the stomach into the duodenum. It may therefore be supposed that the gastric juice, which exerts a certain pressure on the sensitive elements of the duct, causes their stimulation. Impulses from the baroceptors exert what is evidently a reflex inhibitory effect on intestinal peristalsis. It is also known that intestinal movements have a considerable effect on lymph flow. Since approximately three quarters of the total amount of lymph entering the venous system from the thoracic duct is intestinal lymph, it may be supposed that the reduction in lymph flow observed in our experiments was not only the result of reflex change in the size of the lumen of the large lymphatic vessels, but also resulted from some inhibition of intestinal peristalsis. This idea certainly requires to be tested experimentally.

SUMMARY

The experimental result indicated that baroceptors were probably present in the pancreatic ducts, whose reflex stimulation caused changes in arterial pressure, respiration, and lymph flow. These reflexes were eliminated by injection of novocain into the ducts.

LITERATURE CITED

[1] V. A. Alekseev, Transactions of the Military and Naval Medical Academy,* 4, 1, 24-33 (Leningrad, 1944).

[2] V. M. Fodinov, Transactions of the Military and Naval Medical Academy,* 24, 121-127 (1950).

[3] D. M. Golub, Transactions of the Minsk State Medical Institute.* 10, 1, 3-16 (Minsk, 1940).

[4] L. Ya. Pines, The Nervous System and Internal Secretion.* (Leningrad, 1932).

[5] L. Ya. Pines and M. Toropova, Ztschr. mikr. anat. Forsch. Bd. 20, S. 20-50 (1930).

[6] A. E. Rabkina, Theses and Reports at the General Session of the All-Union Institute of Experimental Endocrinology* 81-82 (Moscow, 1954).

[7] A. E. Rabkina, Probl. éndokrinol. i gormonoter. 1, 92-97 (1955).

[8] N. P. Speranskaya, éndokrinol. i gormonoter. 3, 3-7 (1956).

* In Russian