# THE REFLEX INFLUENCE OF THE CHEMORECEPTORS OF THE EXCRETORY SYSTEM ON LYMPH FLOW

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The existence of chemoreceptors in the kidney and urinary bladder has long been known, and reflex effects from them on the blood pressure and respiration have been investigated [1-6].

However, we have found no references to reflex defects from such chemoreceptors on lymph flow, and we have therefore undertaken the following investigation.

## METHOD

The experiments were performed on dogs under morphine-pentothal anesthesia. In all, 216 experiments were made on 50 dogs. The chemoreceptors of the vessels of the kidney and urinary bladder were stimulated by perfusion with saline containing 0.5-200 $\mu$g of acetylcholine, adrenalin, or histamine. In addition to these substances, we also used Tyrode's solution containing an excess of $CO_2$, and pituitrin, while for the urinary bladder receptors a 10-50% urea solution was employed. In all the experiments a fistula was established in the thoracic duct to record the number of drops of lymph flow. Records were also made of blood pressure and respiration.

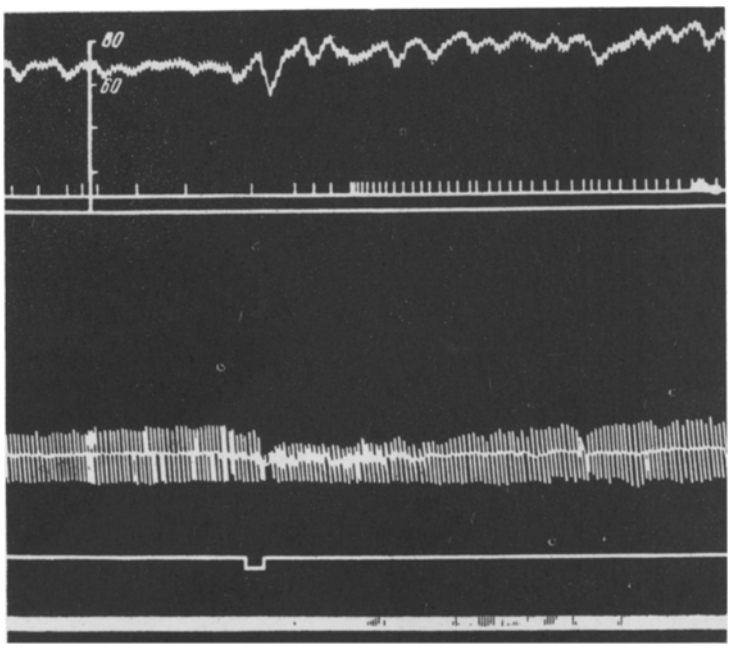


Fig. 1. Reflex change in blood flow in response to injecting 1 unit of pituitrin into the renal artery (experiment July, 12, 1949). Curves, from above downwards: blood pressure in carotid artery; marks made by lymph drops; zero line of blood pressure; respiration; stimulus marker; time marker (1 second).

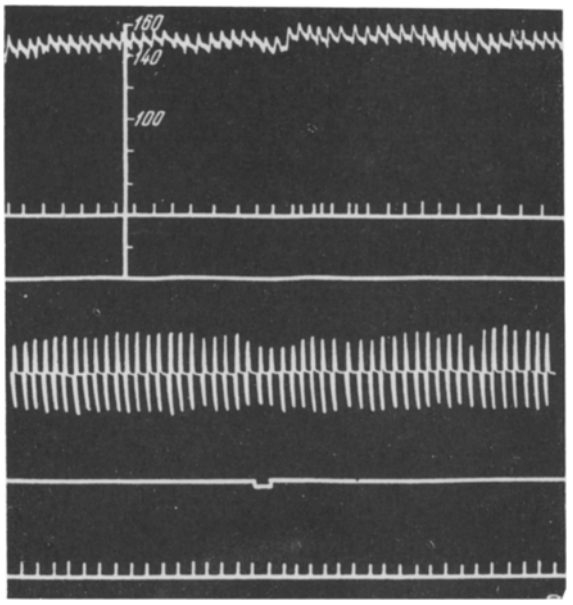


Fig. 2. Reflex changes in lymph flow in response to the injection of 0.5 μg of adrenalin (Exp. of Oct. 21, 1950). Curves as in Fig. 1.

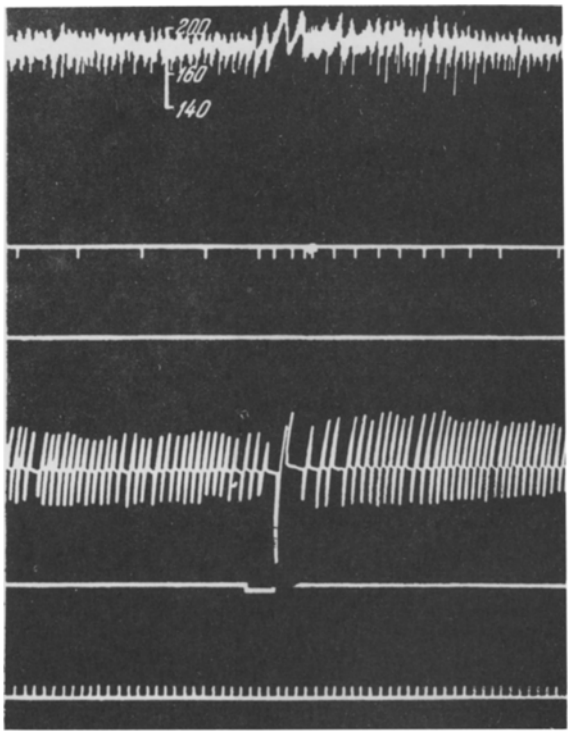


Fig. 3. Reflex change in lymph flow in response to the injection of 200 μg acetylcholine into the bladder (Exp. of Aug. 5, 1952). Curves as in Fig. 1, except for time marker (5 seconds).

## RESULTS

We carried out 23 experiments in which pituitrin was injected into the renal artery, and in 14 of them lymph flow increased four to five times. We were not able to determine any relationship between the increase in lymph flow and blood pressure change: of the 14 experiments in which lymph flow was increased, blood pressure only rose in one case, in two it was reduced and in eleven it remained unchanged. The results of one of these experiments is shown in Fig. 1.

We performed 25 experiments in which adrenalin was injected into the renal artery. In ten, lymph flow was increased, in ten there was no change, and in five it was reduced. In most of the experiments there was a transient drop in blood pressure of 10-30 mm mercury at the moment of injection, after which the pressure rapidly returned to its original value. In some experiments the blood pressure did not change at all. Usually the respiration too remained unaltered, and only in few experiments was there some breathlessness, which usually occurred during the fall of arterial pressure.

Figure 2 shows the results of one of these experiments. In response to the injection of 0.5 μg of adrenalin into the renal artery, the lymph flow increased from 9 to 13 drops per minute, while there was no significant change in blood pressure, and there was a temporary reduction in the amplitude of respiration.

Acetylcholine and histamine were injected into the renal vessels in 54 experiments. Of the 24 experiments with acetylcholine, in 15 lymph flow was increased, in eight it was reduced and in one it remained unchanged. In half the experiments the blood pressure was increased, and in half there was no change. Respiration was also altered in half of the experiments.

Histamine was used to stimulate the renal chemoreceptors in 30 experiments. In 15, lymph flow was increased, in 7 it was reduced, and in 8 it remained unchanged. In half the experiments, the blood pressure in the carotid artery was increased. In both cases respiration was unchanged; occasionally there was some increase in the frequency of respiration, and in some an apnea, or a slight reduction in the rhythm occurred.

We will quote one experiment by way of illustration. When 10 μg of histamine were injected into the renal artery, lymph flow increased from 5 to 10 drops per minute, and by the second minute it had returned to its original level. During the first minute blood pressure had fallen by 2 mm of mercury, and in the second it had risen by 4 mm above its original value. The increase in lymph flow due to histamine did not exceed 100%; when acetylcholine was injected into the renal

vessels, lymph flow occasionally increased by as much as 200-300%.

In 14 experiments, the renal chemoreceptors were stimulated by perfusion of the vessels for 3-5 minutes with solutions containing large amounts of $CO_2$.

In these experiments, lymph flow increased in 12 out of 14 cases, although the increase was very small (1-2 drops per minute), and only in a few of the experiments did it increase by as much as 3-5 drops per minute or more. In two experiments, lymph flow was reduced. In ten, there was no change in blood pressure, and in four it was reduced by 10-50 mm mercury. A reduction in amplitude occurred at the end of the first minute. Respiration remained almost unchanged, apart from some deep expirations in a few cases.

In 20 experiments, a urea solution was used to stimulate the chemoreceptors of the bladder. In half of the experiments there was a change in lymph flow. It should be noted that the change did not result from alteration in blood pressure, which usually (in 15 experiments) was increased, though in three it was reduced, and in two unchanged.

In 30 cases, to excite the bladder chemoreceptors we used acetylcholine solutions, and found an increase in lymph flow in 50% of the tests. Usually there was an increase in blood pressure of 5-10 mm mercury, and no change in respiration. However, in some experiments there was quite a prolonged apnea and a short period during which the frequency of respiration was increased. Results of one of these experiments are shown in Fig. 3.

The changes in lymph flow which we observed were reflex: in a control series in which the kidney and bladder were denervated in no single case did we observe any change in lymph flow, blood pressure, or respiration.

In order to determine the paths of the unconditioned reflexes from the renal and bladder receptors, we introduced the same substances into the renal vessels and bladder after ligaturing various nerves. It was found that the lymph flow changes were not entirely eliminated by ligaturing the splanchnic nerves and vagi, but were merely reduced. The greatest reduction in the reflex, as affecting lymph flow and blood pressure, was produced by ligature of the splanchnic nerves; ligature of the vagi caused only a small reduction. The change in lymph flow in response to stimulation of the chemoreceptors was eliminated only by removal of the solar plexus. The reaction initiated in the bladder disappeared after ligature of both inferior splanchnic nerves.

We consider the changes in lymph flow described to result from reflex influences originating in renal chemoreceptors and acting on contractile elements of the walls of the lymphatic vessels.

## SUMMARY

The experiments were performed on dogs under morphine-pentothal anesthesia. Stimulation of the urinary bladder and kidneys was made by perfusing with acetylcholine, adrenalin, histamine, pituitrin, solutions containing excess $CO_2$, and urea solutions; in each case, lymph flow from the thoracic duct was measured.

In most cases, there was an increase in lymph flow, which occurred independently of any changes in blood pressure or respiration. They disappeared when the kidney and bladder were denervated, and were therefore reflex in nature. Section of the splanchnic nerves and vagi considerably decreased the extent of the reflex change in lymph flow, and the reflex was entirely abolished by removal of the solar plexus.

## LITERATURE CITED

1. V. A. Lebedeva and V. M. Khayutin, in book: Problems of the Physiology of Interoception [in Russian] (Moscow, Leningrad, 1952), No. 1, p. 305.
2. O. S. Merkulova, Izv. AN SSSR, Ser. Biol., 4, 493 (1948).
3. I. P. Nikitina, Byull. Eksptl. Biol. i Med., 27, 5, 329 (1949).
4. B. I. Novikov, in book: Collection of Works from the Department of Normal Anatomy of the Voronszhsk. Med. In-ta, [in Russian](1949) Vol. 20, p. 57.
5. V. N. Chernigovskii, Studies on the Receptors of the Internal Organs. Dissertation for Doctorate. [in Russian] (Leningrad, 1940).
6. V. N. Chernigovskii, The Afferent Systems of the Internal Organs. [in Russian](Kirov, 1943).