INFLUENCE OF SMALL INTESTINE INTEROCEPTORS ON URINARY EXCRETION

M. S. Yaremenko

Institute of Normal Physiology of the Vinitskii Medical Institute (Head – Prof. N. K. Vitte)
(Presented by Active Member of the AMN SSSR V. N. Chernigovskii)
Translated from Byulleten' éksperimental'noi biologii i meditsiny Vol. 49 No. 3, pp. 17-20, March, 1960
Original article submitted December 22, 1958.

Many authors [1 - 7] have shown that a variety of reflex influences on urinary excretion may originate from receptors of the gastric mucosa.

The present work is a study of similar effects mediated by the small intestine.

METHOD

The experiments were carried out on three female dogs bearing ureteric fistulas established by I.P. Pavlov's method as well as Thiry-Vella intestinal fistulas. The latter were inserted 10 - 12 cm below the duodenum. The interoceptor was stimulated by perfusing an isolated loop of intestine with tap water at 36° and a rate of flow of 600 ml per 5 min. The water flowed evenly and silently from a graduated cylinder placed at a height of 1.5 m. As a control against possible absorption, the outflow was measured and found to be equal to the inflow.

The experiments were performed 16 hr after a meal. First a check was made to see whether the animals were thirsty; as a rule they refused water showing that they were not.

Urine was collected at 10 min intervals and the solid residue measured by a refraction method. In many experiments glomerular filtration and tubular reabsorption was measured by determining the endogenous creatinine.

During the first hour, no response from the animal occurred. The amount of urine secreted during this period was taken as the "spontaneous" excretion. At the end of the second hour the isolated intestinal loop was perfused, and measurements of urinary excretion continued.

In the first set of experiments, the effect of perfusion of the isolated loop on "spontaneous" excretion was determined. The animals were maintained on a constant food and water ration. The initial diuresis varied from 2.1 to 1.5 ml per kg per hr.

In the second set of experiments the effect on urinary secretion of perfusing the intestinal loop was observed while the animal was stimulated by food; the dogs were given 30 g of meat powder 10 min before the perfusion started.

In the third set of experiments, urinary excretion was measured during intestinal perfusion when there was a low initial diuresis. In Mushka and Nerka, the diuresis varied between 0.96 and 0.60 ml, and in Mirta between 0.60 and 0.42 ml per kg weight per hr. The low level was caused by restricting water intake 24 hr before the experiment.

In the fourth set of experiments, urinary secretion was measured after perfusing the intestinal loop with a 2% novocain solution.

RESULTS

The results of the first set of experiments showed that perfusion of an intestinal loop with tap water for 5 min causes a regular increase in diuresis which lasts, on average, for 30 – 50 min (Fig. 1). During the first 10 min after perfusion, diuresis was either increased or showed no change, and might even be reduced. After 20 min, as a rule, there was an increase in the diuresis and the maximum rate occurred 20 – 30 min after perfusion.

After the diuresis had increased, it usually returned to a level below the original value. The amount of solid substances was reduced with increased diuresis. There was also some reduction in the absolute amount of the solid residue after perfusion.

By measuring filtration rate and tubular reabsorption, it was shown that the increased diuresis occurs chiefly as a result of reduction in the latter.

In the second group of experiments, in which the animals were stimulated by feeding, perfusion had no stimulating effect on the diuresis (see Table). It must be noted that the act of eating dry substances itself reduces diuresis.

The results obtained in the second group of experiments show that under identical conditions the response may be very different according to the state of the animals.

In the third group, the influence of the intestine on diuresis was investigated when the initial urinary excretion rate was low. It was found that perfusion then caused only a very small increase in diuresis.

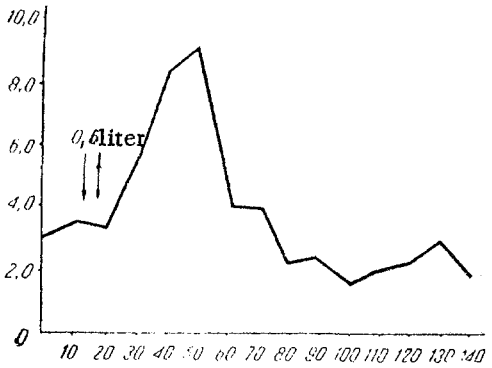

Fig. 1. Change in the spontaneous urinary excretion after perfusing an isolated loop of small intestine in the dog Nerka. Ordinate – diuresis in ml; abscissa – time in min. The arrows indicate the onset (↓) and end (↑) of perfusion; the figures over the arrows indicate the amount of water used.

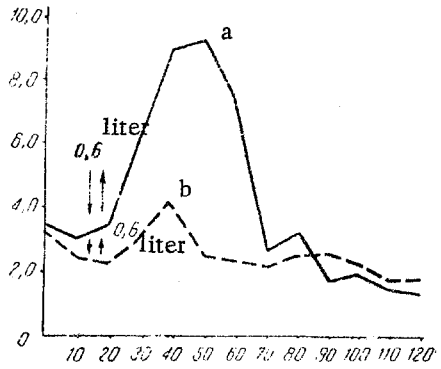

Fig. 2. Change in the spontaneous urinary excretion after perfusing an isolated loop of small intestine with (a) water and (b) a 2% novocain solution; dog Muska. Indications as in Fig. 1.

In some experiments no increase was found.

In the fourth set of experiments, it was shown that the receptors of the mucosa were concerned in the observed perfusion effects. Here the perfusion was carried out not with water but with a 2% novocain solution.

Figure 2 shows the results of an experiment in which an isolated loop of intestine was irrigated (a) with tap water, and (b) with a novocain solution.

As can be seen from the results, irrigation with novocain causes an increase in diuresis which is very small in comparison with the control experiment. There is no doubt that the reduced stimulant effect in this case is due to partial elimination of the mucosal receptors. The increased diuresis in the first group of experiments must be interpreted as a reflex reaction on the kidneys originating in the mucosal receptors of the irrigated section.

The second and third sets of experiments indicate that alteration in the functional condition of the body caused by reducing the water supply on the day of the experiment and by food stimulation inhibits the reflex stimulation of diuresis by the upper portion of the small intestine.

TABLE 1. Change in the Diuresis (in ml) in Dogs Measured at 10 min Intervals During Perfusion of the Mucosa of an Isolated Loop of Small Intestine With Water During Excitation by Feeding

Date of experiment	Name of animal	Before perfusion						After feeding		After perfusion									
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
1957																			
11/12	Nerka	3,9	3,7	4,1	3,6	3,1	3,0	1,5	0,9	1,9	2,1	1,7	1,6	2,0	1,8	1,4	1,1	1,3	1,6
11/13	"	5,0	3,9	3,5	3,8	3,3	2,9	0,7	1,6	1,3	1,9	1,7	2,4	1,8	2,0	1,9	1,9	1,6	1,2
11/19	"	4,4	4,2	5,0	3,9	3,7	3,0	1,0	1,3	1,7	1,6	2,1	2,5	2,0	1,8	1,6	1,4	—	—
11/12	Mushka	3,3	3,4	3,0	2,7	2,9	2,6	0,9	0,8	1,1	1,0	1,6	1,4	1,5	1,2	1,3	1,1	0,9	1,1
11/13	"	4,0	4,3	3,6	3,4	3,0	2,5	1,3	1,0	0,9	1,6	1,9	2,0	1,7	1,2	1,1	0,9	0,8	1,0
11/15	"	4,1	3,5	3,2	3,3	3,0	2,7	1,6	0,7	0,9	1,3	1,5	1,3	1,7	1,6	1,4	1,2	1,1	1,2
11/19	"	3,4	3,2	2,7	3,0	2,9	2,4	1,2	0,9	1,2	1,1	1,6	1,4	1,3	1,7	1,6	1,0	0,9	1,2
11/14	Mirta	2,0	2,4	2,1	1,9	2,0	1,7	0,6	0,9	1,0	0,9	1,3	1,2	0,9	1,0	1,5	1,4	1,0	0,8
11/15	"	2,6	2,7	2,4	2,1	2,0	1,9	1,0	0,8	0,9	1,4	1,6	1,2	1,1	1,0	1,1	1,0	0,9	1,1
11/20	"	3,0	2,6	2,5	2,3	2,4	2,1	1,3	0,9	0,8	1,3	1,1	1,6	1,5	1,7	1,0	1,2	0,9	1,0

SUMMARY

The effect of water perfusion of a Thiry-Vella loop of small intestine was studied in three dogs in chronic preparations. As a rule, when urinary excretion was at the rapid rate of 2.1 - 1.5 ml per kg body weight per hr, it was increased by perfusion. The reaction was reflex in nature and was mediated from the mucous membrane of the perfused intestinal loop. This finding was confirmed by perfusing with a 2% novocain solution, when no rise in diuresis occurred.

The reflex from the mucous membrane of the small intestine on the kidneys depends largely on the initial functional condition of the drinking and food centers. Water perfusion of the isolated portion of the small intestine had no stimulating effect on diuresis either under conditions of food excitation or when the water content of the body was reduced.

LITERATURE CITED

[1] E. B. Berkhin, Physiol. Zhur. SSSR 43, 8, 785 (1957).

[2] Z. G. Kislyakova, Trudy Inst. Fiziol. AN Belrus SSSR 1, 65 (1956).

[3] E. P. Kuchinskii, Byull. Éksptl. Biol. i Med. 41, 3, 5 (1956).

[4] A. A. Lebedev, Byull. Éksptl. Biol. i Med. 38, 11, 7 (1954).

[5] N. A. Myasoedov, Byull. Éksptl. Biol. i Med. 24, 6, 450 (1947).

[6] N. A. Myasoedov, Byull. Éksptl. Biol. i Med. 36, 1 (7), 4 (1953).

[7] N. N. Pronina, and Ya. A. Al'tman, Byull. Éksptl. Biol. i Med. 37, 6, 11 (1954).