PHYSIOLOGY

INTEROCEPTOR INFLUENCES OF THE CECUM ON URINE SECRETION

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Clinicians in our country have made a large number of observations which have established the presence of interoceptor reflexes and which have clarified their role in the etiology and pathogenesis of several forms of disease.

Physiologists [1, 2, 4, 7] are at present studying a large number of reflex influences of some internal organs on others, both within the framework of the same functional system and in different functional systems.

Among the experimental questions which have been insufficiently studied is the question of the interoceptor influences of the intestines, in particular the cecum, on renal function both in normal and pathological conditions. The cecum, an organ rich in interoceptors, is often affected by inflammatory processes, and therefore knowledge of the possible interoceptor influences on the function of other organs, in particular the kidneys, is of great practical importance. On this question we were able to find only one paper, that of E. P. Kuchinsky [3].

The object of the present paper is to explain the mutual relations between the cecum and the urine secretory function of the kidneys, both in normal and pathological conditions.

In the present communication the data given has been obtained on the basis of healthy animals.

EXPERIMENTAL METHODS

Our investigations were conducted in long-term experiments on 3 dogs (Rishik, Drushok and Astra) with an individual investigation of the ureters exposed on the skin of the animal, according to the method of Orbel-Zitovich, in the presence of a fistula of the cecum. During the entire experimental period observations were made on the general condition of the animals (pulse rate, breathing, weight, body temperature). The dogs were kept on a mixed diet.

First, the secretion of urine was studied in control experiments when the dogs received no food (after a sixteen-hour fast) and also with a water "load" (water-milk mixture, 50 ml per kg body weight). The urine was collected and measured every 15 minutes for 3-4 hours; as part of the experiment we studied the creatinine and chloride content and the specific gravity. Blood creatinine was determined and indices characterizing the filtration and reabsorption capacities of the kidneys calculated.

In order to stimulate the interoceptors of the cecum we stretched its walls by a rubber bulb filled with air under manometric pressure (30-80 mm mercury) and applied an induction current with the aid of a Sanni apparatus (distance between coils 80 - 120 mm, potential in first chain 4v). Stretching by the bulb was for 30-60 minutes, continuously; the stimulation by the current in the course of 15-30 minutes was rhythmic (with short breaks). In addition, we also used chemical and thermal stimuli (0.5-1.0 0% hydrochloric acid and lactic acid solutions, hot water at a temperature of 42-45°, cold water at 3-5°, and also fish oils. Irrigation of the cecum with the above-described stimuli was continued for 15-30 minutes without interruption.

EXPERIMENTAL RESULTS

The experiments with stretching of the cecum with a rubber air-filled bulb showed the presence of a functional mutual relationship between the large intestine and the kidneys. The stretching of the cecum rapidly produced a significant decrease in urine secretion, almost approaching total anuria. On withdrawal of the stimulation urine secretion quickly increased and attained the original levels. In the experiment of May 12, 1953 performed on the dog Drushok, represented in Fig. 1, the cecum was stretched twice for 30 minutes at a time, with a 45 minute interval. It is clear from the curve that during the first stimulation the secretion of urine by the right kidney (originally 32 ml) and by the left kidney (originally 38 ml) fell to 5-6 ml. 45 minutes after stretching, it returned to the original level. When stretched for the second time a more sharply expressed fall in diuresis of both kidneys was observed – to 0.5-4.0 ml – with a subsequent rapid rise in the curve after withdrawal of the stimulus.

Stimulation by an induction current for 15 minutes produced a similar inhibiting effect. During a 15 minute period the urine secretion fell from 55 to 5.5 ml from the right kidney and from 69-11 from the left, with subsequent restoration on withdrawal of the stimulus (experiment of December 26, 1952 on the dog Rishik).

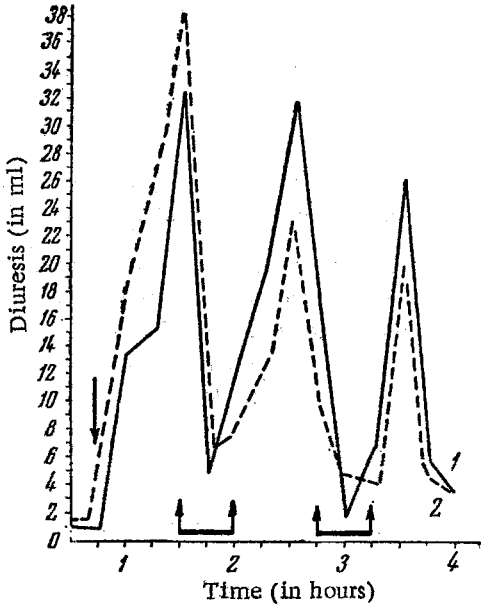

Fig. 1. Diuresis in dog Drushok with stretching (↑↑) of the cecum.
1) Right kidney; 2) left kidney. Water "load" (↓) = 700 ml.

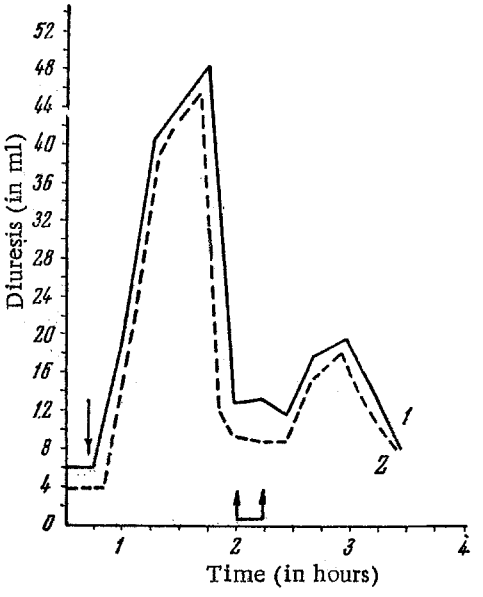

Fig. 2. Diuresis in dog Drushok with irrigation (↑↑) of the cecum with 0.5% hydrochloric acid solution.
1) Right kidney; 2) left kidney. Water "load" (↓) = 700 ml.

The specific gravity of the urine and its creatinine and chloride content did not change perceptibly in the experiments with stimulation of the cecum and no changes in blood creatinine were recorded.

The experimental data on the study of the filtration and reabsorption capacities of the kidneys showed that the stimulation of the interoceptors of the cecum affects mainly the filtration processes, which diminish. No perceptible change was found in reabsorption.

On comparing the character of the reflex influences of the cecum on the kidneys with changes which occur in urine secretion when the rectum was stimulated [5,6] we found a resemblance in that in both cases the inhibition of urine secretion appeared rapidly and markedly; return to the original levels after withdrawal of the effect of the stimulus also occurred swiftly.

On the basis of the findings of our investigations it can be assumed that the influence which the cecum, and equally the rectum, exert on the kidneys when the intestinal wall is subject to stretching or electrical stimulation is a particular case of painful-reflex anuria.

Both in dogs with intact kidneys and in those with transplanted kidneys (on application of painful exteroceptor and interoceptor stimulation of the wall of the cecum or rectum) we observed a diminution in diuresis to the point of its full cessation.

The painful character of the stimulation applied to the intestinal wall can be judged by the presence of an increase in arterial blood pressure, dyspnea, increased pulse rate, and occasional pupil dilation.

In subsequent investigations we irrigated the mucosa of the cecum with 0.5-1.0% solution of hydrochloric acid, at a temperature of 38°, which induced a fall in secretion of urine in Astra in the experiment performed on February 12, 1955 from 43 to 27 ml from the right kidney and from 17 to 15 ml from the left, and in Drushok in the experiment of May 20, 1953 from 50 to 12 ml and from 47.5 to 8 ml, and there was no full restoration of diuresis after irrigation (Fig. 2).

Irrigation by 1.0% lactic acid solution produced a slowly developing diminution in urine secretion from 32-35 ml to 15 ml during a 15 minute period (experiment of May 29, 1953, on dog Drushok) and from 30 to 20 ml (experiment of June 3, 1953). After completion of irrigation the secretion of urine continued to fall and rose only at the end of the experiment (Fig. 3). Irrigation of the cecum with fish oils at a temperature of 38° did not change the course of urine secretion. It developed in the same sequence as in the control experiments with a water load. We obtained a less marked inhibition of urine secretion as compared with other stimuli when the cecum was irrigated with hot and cold water. Irrigation for 30-60 minutes with hot water produced a small inhibition of diuresis, for example, in the experiment of May 27, 1953, on the dog Drushok from 37 to 28 ml from right kidney and from 37 to 30 ml from the left. Irrigation with cold water produced a general reaction of lowered body temperature (the dog shivered), accompanied by an increased pulse. Moreover, a certain reduction in secretion of urine was noticed,especially in winter in a cool room. For example, in the experiment of February 8, 1955, on Astra diuresis from the right kidney fell from 35.5 to 23 ml, and from the left from 30 to 17 ml. After completion of irrigation urine secretion rose and within 15-30 minutes attained the levels prior to stimulation.

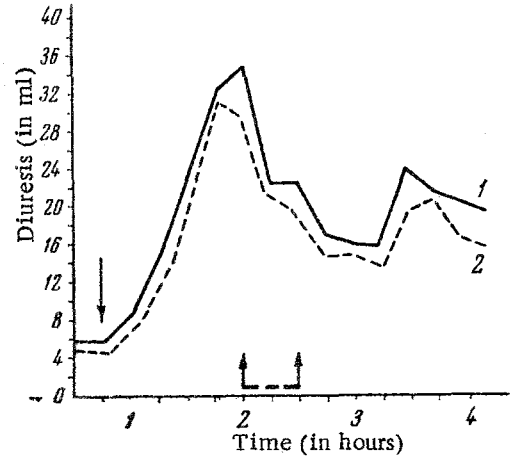

Fig. 3. Diuresis in dog Drushok with irrigation (↑↑) of the cecum with a 1.0% lactic acid solution. 1) Right kidney; 2) left kidney. Water "load" (↓) = 700 ml.

The experimental investigations undertaken confirm the remarks of clinicians concerning the possible presence of reflex influences of the cecum on the kidneys. Our findings confirm the presence in the cecum not only of mechanoreceptors, but also of chemo- and thermoreceptors, which when stimulated can induce reflexes in the various organs and systems, including the kidneys.

In subsequent experiments, we attempted to exclude, if only partially, the receptor zone of the cecum by a 15 minute irrigation of its mucosa with 2% novocain solution at a temperature of 38°. After irrigation we immediately applied the stimuli as described above. As a result of this type of experiment we are convinced that novocain does not remove the reflex influences of the cecum when it is stretched by a rubber bulb and stimulated by an induction current. These stimuli give rise to inhibition of urine secretion to the same degree as in absence of novocain treatment. We obtained the opposite effect in experiments with chemical and thermal stimuli. Irrigation of the cecum, carried out following preliminary novocain irrigation of the mucosa with 0.5-1.0% solutions of hydrochloric and lactic acids did not produce a reflex on the part of the kidneys. In the same type of experiment (with novocain treatment) we did not obtain a reflex of the kidneys on irrigating the cecum

with hot and cold water. In these experiments the course of urine secretion was the same as in the control experiments with a water "load"

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