THE PHYSIOLOGY OF THE LARGE INTESTINE

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Although there are many works studying the various aspects of digestive tract activity, there are only a few on the physiology of the large intestine. G. B. Berlatsky [2] indicates that the glands of the large intestine produce a small amount of juice. N. D. Strazhesko [6], D. L. Glinsky [4] and others have shown that the intake of food has little effect on the amount of juice secreted. O. V. Varnke and M. M. Levin [3], K. M. Bykov and G. M. Davydov [1] noted that the amount of juice secreted from a fistula of the large intestine fluctuates in both humans and animals. Due to the varying character of this secretion and the small amount of enzymes present, many researchers doubt that the juice secreted by the large intestine is important in the digestive process. How the glands of the large intestine are stimulated has not yet been determined.

EXPERIMENTAL

The experiments were done with dogs. A loop of the large intestine 15-20 cm long, 10-15 cm from the ileocecal valve was partially isolated (according to V. L. Gubar's method [5]). The operation we performed was a circular transection of the mucosa at both ends of the isolated loop, leaving the serous and muscular layers intact. The intestinal sections adjoining each end of the isolated loop were pulled together and anastomosed. A fistula was induced on the isolated loop of the intestine in order to collect the juice, record the motor activity and effect the stimulation of this loop. A fistula was also induced on the stomach. The advantage of this operation was that most of the intramural nerve links were preserved, since the muscular and serous layers of the large intestine's walls had been left intact.

The dogs were fed 16-18 hours before the experiment. Juice was collected from the loop of the large intestine for 4-6 hours; the amount of juice secreted was determined every 30 minutes. We used special stimulants in a series of experiments to stimulate secretion (a suspension of calomel in water, a decoction and paste made from a finely ground beet, a rubber tube and a rubber balloon).

We used a 0.5% solution of novocain with adrenalin added (2-3 drops of a 1 : 1000 solution) to anesthetize the mucous membrane. In most of the experiments, we recorded the movements of the isolated intestinal loop and the stomach (on a kymograph with an air transmission) while the juice was being collected.

A total of 165 experiments were done.

EXPERIMENTAL RESULTS

The amount of juice spontaneously secreted from the isolated loop of the large intestine in an hour was 0.1-2.5 ml, and 0.5-8.2 ml of juice were secreted in 4-5 hours (Fig. 1, 1).

Secretion did not increase when a small rubber tube was introduced into the cavity of the isolated loop. When a rubber ballon was inflated in the intestinal cavity, secretion increased to 3 ml per hour (Fig. 1, 2).

We anesthetized the mucosa of the isolated loop of the large intestine with 10-15 ml of a 0.5% solution

of novocain In order to determine how stimulation was transmitted from the intestinal cavity of the glands. Anesthetizing the mucosa stopped the secretion caused by the inflation of the balloon, but secretion was resumed (Fig. 1,3) when the anesthesia had passed (after an hour).

The use of natural conditioned and unconditioned stimulants (showing and feeding meat, black bread, etc.) had no material effect on the rate of juice secretion. The inclusion in the diet of rough food stimulants (400 g of boiled beet) did not effect the secretion in the isolated loop of the large intestine either. Nor did stimulating its mucosa with calomel, beet gruel with bouillon, lactose and other substances promote secretion.

We also investigated nocturnal secretion in the dog's large intestine. No nocturnal juice secretion was observed under laboratory conditions, although it was invariably observed under vivarium conditions. A rubber bottle was attached to a cannula in order to collect the juice secreted in the vivarium; up to 10 ml of juice, which had a foul odor and contained a great quantity of mucus, had collected in the rubber bottle after 16-18 hours.

Amylase was determined according to Wohlgemuth, and the amount of dense residue and sol in the intestinal juice was determined. Periodically, we calculated the dense residue of the stool.

The amount of amylase in the juice was not more than 5-10 units. The average dense residue of the juice in 10 experiments was 2.48% (1.28% organic substances and 1.2% inorganic substances). In the dog Foxy, the average dense residue in the stool was from 27.3% to 18.7%.

We found that the motor activity of the large intestine is extraordinarily complex. It consisted of a series of waves differing as to frequency, amplitude and configuration. The waves of the first order (individual contractions) usually occurred 1-2 times per minute (Fig. 2, a). They combined and together formed the complex wave of the second series (Fig. 2, b). The waves of the second order occurred 6-7 times an hour. The pauses between these waves disappeared when, as sometimes happened, the waves of the second order succeeded each other rapidly.

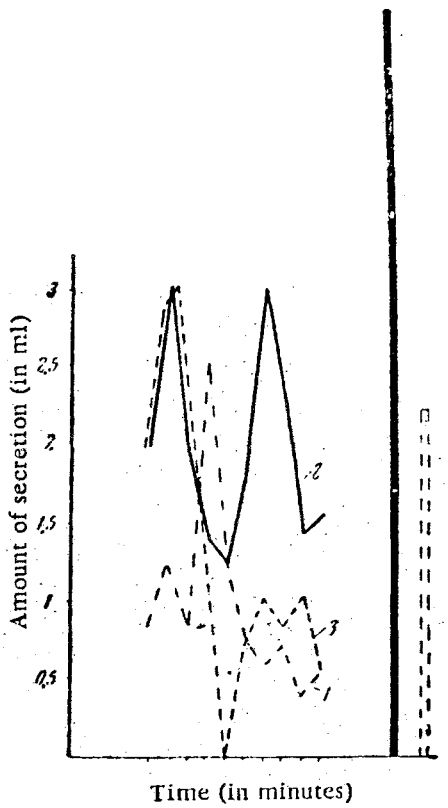

Fig. 1. Secretion from the isolated loop of the large intestine. 1) spontaneous secretion; 2) secretion caused by inflation of a balloon in the cavity of the isolated loop; 3) secretion when mucosa was anesthetized with novocain .

One could also often see small waves of peristalsis on a background of intestinal loop tonic contractions (Fig. 2, c); these could be superimposed upon the waves of the first order.

Motor activity stopped when the mucosa was anesthetized. The contraction waves mentioned, which were recorded by means of a rubber bulb, disappeared.

Comparison of the curves simultaneously recorded from the contraction of the large intestine loop and of the atomach did not allow us to establish any definite interrelation between them.

We injected atropine and pilocarpine in order to find how the secretion and motor activity of the large intestine were influenced by the parasympathetic system.

After an intravenous injection of 1-2 mg of atropine, secretion and motor activity in the isolated loop of the large intestine ceased simultaneously and immediately. When the atropine was injected subcutaneously, a similar effect occurred after 10 minutes. The effect of the atropine lasted $1\frac{1}{2}-2\frac{1}{2}$ hours.

When 3-4 mg of pilocarpine was injected

subcutaneously, the secretory and motor activities of the large intestine became intensified. The contractions increased in frequency, and the amount of juice secreted reached 3.5-8.4 ml an hour.

We then attempted to develop a motor or secretory conditioned reflex of the large intestine to the introduction of atropine into the blood or subcutaneously. We used the sound of a metronome and the injection procedure as the conditioned stimuli and atropine as the unconditioned reinforcement. We could not obtain a conditioned reflex after 60 combinations. However, secretion ceased for a long time after these experiments, and the frequency and amplitude of the contractions were reduced.

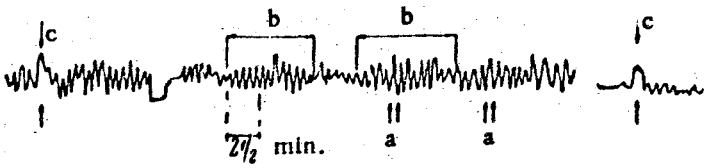

Fig. 2. Motor activity of the isolated loop of the large intestine. a) waves of the first order; b) waves of the second order; c) tonic contractions.

Therefore, mechanical stimulation of the large intestine mucosa is the chief activator of secretion and motor activity in the large intestine. Chemical stimulants have no effect. The parasympathetic nervous system is very important to the realization of the secretory and motor activities of the large intestine.

SUMMARY

It was established in experiments on dogs that secretion of the juice in the large intestine is not constant. The most pronounced reaction is observed on stimulation of intestinal mechanoreceptors. Chemical stimulants, such as calomel, lactose, etc., do not promote secretion. Secretion is present during the night when animals are kept in conditions of vivarium. The motor activity of the large intestine consists of a series of waves which vary in frequency, amplitude and configuration. More rapid contractions (waves of the first order) appear 1-2 times a minute, while the slower ones (waves of the second order) 6-7 times per hour. Secretion and motor activity of an isolated intestinal loop is arrested after novocain anesthesia of its mucous membrane. Contractions increase under the influence of pilocarpine, while the effect of atropine causes their reduction.

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