PATHS OF TRANSMISSION OF EFFECTS FROM DUODENAL RECEPTORS ON MOVEMENTS OF THE LARGE INTESTINE

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UDC 612.367-06 : 612.815.1 : 612.33

Transmission paths of effects from duodenal receptors on movements of the large intestine were studied in chronic experiments on four dogs with fistulas of both these portions of the bowel. The vagus, splanchnic, and pelvic nerves were cut, and the intestine also was divided at the level of the ileocecal sphincter, so that the significance of each of these structures could be examined. The results obtained indicate that influences from the duodenal mechanoreceptors and chemoreceptors on movements of the large intestine are effected through the external nerves of the gastro-intestinal tract (the splanchnic, vagus, and pelvic nerves), and also through an intramural mechanism located in the intestinal walls.

The mechanisms and paths of transmission of influences on the motor function of the large intestine from the distant reflexogenic zones of the gastro-intestinal tract have so far received only little study.

The object of the present investigation was to study the pathways of transmission of influences from the duodenal receptors on movements of the large intestine.

EXPERIMENTAL METHOD

Chronic experiments were performed on four dogs with fistulas of the duodenum and large intestine.

To study the role of the extramural nerves of the gastro-intestinal tract in the transmission of influences from the duodenal receptors on movements of the large intestine, operations were performed to divide the vagus, splanchnic, and pelvic nerves, and the intestine itself (1.5-2 cm orally to the ileocecal sphincter).

Stimulation of the duodenal mechanoreceptors was carried out by inflating a balloon (up to 30-50 ml) introduced into the duodenum through the fistula, and the duodenal chemoreceptors were stimulated by injecting natural chemical stimuli (food substances and their breakdown products).

The movements of the large intestine were recorded graphically, using a rubber balloon, a combined pneumatic and hydraulic transmission system, and a Marey's capsule.

EXPERIMENTAL RESULTS

Mechanical stimulation of the duodenal receptors produced by inflating the balloon to 50 ml, while the large intestine was in a state of rest, in dogs subjected to transdiaphragmatic vagotomy led to brief motor responses of the large intestine, characterized by a small increase in tone and by contractions of types I and II (Fig. 1a). The latent period of the motor responses was 15-120 sec.

Stimulation of the duodenal mechanoreceptors and chemoreceptors of the dogs during motor activity of the proximal part of the colon caused an increase in amplitude of the intestinal contractions and an increase in tone of the intestine. Division of the vagus nerves alone thus did not stop the transmission of excitatory effects from the duodenal receptors on movements of the large intestine.

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(Presented by Academician V. V. Parin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 69, No. 1, pp. 13-16, January, 1970. Original article submitted December 20, 1968.

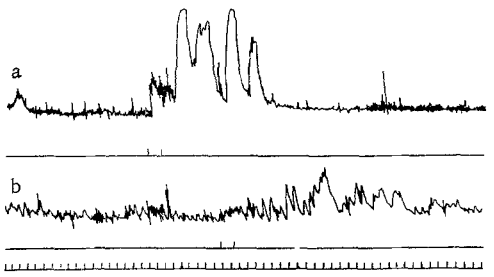

Fig. 1. Effect of stimulation of duodenal mechanoreceptors on movements of large intestine after division of vagus nerves (a), splanchnic nerves, and intestine at the level of the ileocecal sphincter (b). Significance of curves from top to bottom: 1) movements of large intestine, 2) marker of stimulation of duodenal receptors; 3) time marker,15 sec.

After vagotomy and additional division of all layers of the intestinal wall near the ileocecal sphincter (1.5-2 cm orally to it), stimulation of the duodenal mechanoreceptors by inflation of the balloon to 30-50 ml at a time when the large intestine was in a resting state or giving only weak contractions stimulated its contractions and increased its tone. However, the intestinal responses observed under these circumstances were less regular and weaker than in vagotomized dogs with an intact intestine. This weakening of the effects was due to the fact that under normal conditions, with the intestine intact, excitation is transmitted from the duodenum along the wall of the intestine.

The next object of the investigation was to study the role of the splanchnic nerves in the transmission of influences from the duodenum on movements of the large intestine. Experiments were accordingly conducted on dogs after bilateral retroperitoneal splanchnicotomy with removal of the sympathetic chains in the lumbar region, but leaving the vagus nerves intact, and also after bilateral transdiaphragmatic vagotomy and retroperitoneal splanchnicotomy in the same animal.

Stimulation of the duodenal receptors in dogs with intact vagus nerves, but with divided splanchnic nerves, evoked the same motor responses of the large intestine as before splanchnicotomy. Additional division of all layers of the intestinal walls 1.5-2 cm orally to the ileocecal sphincter in dogs after bilateral retroperitoneal splanchnicotomy and removal of the sympathetic chains in the lumbar region did not abolish the excitatory influences from the duodenal receptors on movements of the large intestine.

Stimulation of the duodenal mechanoreceptors and chemoreceptors at a time of rest or weak contractions of the large intestine initiated or strengthened such contractions. The movements of the large intestine were smaller in amplitude and shorter in duration than when the intestine was intact (Fig. 1b).

The experiments on vagotomized and splanchnicotomized dogs showed that stimulation of the duodenal mechanoreceptors by inflation of the balloon to 50 ml (the pressure inside the balloon was than 25-30 mm Hg), or the introduction of food substances (10-20% peptone solution containing traces of amino acids) into the duodenum in most experiments stimulated contractions of the hitherto resting large intestine. However, the motor responses appeared as a rule after a longer latent period (2-2.5 min). In some experiments no excitation of the large intestine followed stimulation of the mechanoreceptors and chemoreceptors. Consequently, the motor responses of the large intestine to stimulation of the duodenal mechano- and chemoreceptors in dogs after bilateral vagotomy and splanchnicotomy were usually weaker and appeared after a longer latent period than in dogs with intact splanchnic nerves.

Observations on the vagotomized and splanchnicotomized dogs showed that the aplanchnic nerves are an important pathway for the transmission of influences from the duodenum on movements of the large intestine. However, in these experiments the integrity of the intestinal tube was preserved, and because of this, despite the blocking of transmission of influences along the splanchnic and vagus nerves, excitatory influences from the duodenum on movements of the large intestine could be transmitted along the intestinal wall.

To study the role of the pelvic nerves in the transmission of duodenal influences on movements of the large intestine, experiments were carried out in which the duodenal mechano- and chemoreceptors were stimulated in dogs after bilateral division of the pelvic nerves and division of the intestine near the ileocecal sphincter. These experiments showed that division of the pelvic nerves greatly weakens excitatory influences from the duodenal mechano- and chemoreceptors on the large intestine. Stimulation of the duodenal mechano- and chemoreceptors in these dogs led (in 2 of the 20 experiments) to only a slight increase in tone and the development of weak contractions of the large intestine. These results indicate that the pelvic nerves play an important role in the transmission of excitation from the duodenum to the large intestine, stimulating its contractions, but also that these nerves are not the only efferent pathways of transmission of such excitation.

Additional vagotomy in dogs after division of the pelvic nerves and of the intestine near the ileocecal sphincter abolished excitatory influences from the duodenal mechano- and chemoreceptors on the large intestine. This fact is evidence of the important role of the vagus nerves in the transmission of excitatory influences from the duodenal receptors on movements of the large intestine.

It can be concluded from these results that duodenal excitation of contractions of the large intestine is transmitted via the extramural nerves of the gastro-intestinal tract (splanchnic, vagus, and pelvic nerves) and also via an intramural mechanism located in the intestinal wall. In the transmission of reflex influences from duodenum to large intestine, afferent impulses pass along fibers contained in the splanchnic and vagus nerves, and efferent impulses along fibers contained in the pelvic and, to some extent also, the vagus nerves.

This is also confirmed by the results of the writer's study of nervous pathways of transmission of influences of the act of eating and of reflex influences from the stomach. Excitatory influences of the act of eating on the motor activity of the large intestine are transmitted via the splanchnic and, partly also, by the vagus nerves. Ordinary feeding has an additional excitatory influence from the stomach and duodenum via the splanchnic, vagus, and pelvic nerves, and also through the spread of excitation along the wall of the intestine with the participation of the intramural nervous system.

These experimental results reveal some of the mechanisms for regulation of the motor activity of one of the most important sections of the gastro-intestinal tract.