NERVOUS AND HUMORAL PATHWAYS OF TRANSMISSION OF HYPOTHALAMIC INFLUENCES ON SECRETORY ACTIVITY OF THE GASTRIC GLANDS

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Excitatory influences on gastric secretion during stimulation of the anterior and middle parts of the hypothalamus travel along the vagus nerves, and inhibitory influences along the splanchnic nerves. During stimulation of the posterior part of the hypothalamus excitatory influences on gastric secretion are transmitted as a rule by the humoral route, and inhibitory influences along the splanchnic nerves. The nervous route is the principal mode of transmission of influences from the hypothalamus on gastric secretion.

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The pathways by which influences from the hypothalamus on gastric secretion are transmitted have received little study. In the present investigation an attempt was made to shed light on this problem.

EXPERIMENTAL METHOD

Chronic experiments were performed on dogs with fistulas of Basow-type into the fundal portion of the stomach and with 4-pole platinum electrodes implanted into the hypothalamic region by a technique developed previously [1]. Different parts of the hypothalamus were stimulated by pulses from a GZ-34 audiofrequency generator (50 cps, 0.5 mA) for 1 min. The gastric juice was collected every 15 min and analyzed. To study the nervous and humoral pathways of transmission of influences from the hypothalamus on secretory activity of the gastric glands, the extramural nerves were divided and bilateral adrenalectomy was performed on these animals subsequently.

EXPERIMENTAL RESULTS

Stimulation of the anterior (supraoptic and paraventricular nuclei) and middle (ventromedial and dorsomedial nuclei) portions of the hypothalamus in dogs with bilateral vagotomy but with intact splanchnic nerves caused no secretion of acid gastric juice; only gastric mucus was secreted (Fig. 1). Stimulation of the posterior (mammillary nuclei) portion of the hypothalamus in these dogs was accompanied by no changes in the secretion of gastric mucus.

Since stimulation of the anterior and middle portions of the hypothalamus after vagotomy caused no secretion of acid gastric juice, it may be considerd that the transmission of influences from these parts of the hypothalamus on the gastric glands takes place along the vagus nerves.

Stimulation of the posterior part of the hypothalamus after vagotomy had no effect on the secretion of gastric mucus. It follows, therefore, that the vagus nerves do not participate in the transmission of influences from the posterior part of the hypothalamus on gastric secretion. Subsequent bilateral splanchnicotomy and extirpation of the abdominal sympathetic chains, performed on the vagotomized dogs, had the result that stimulation of the anterior and middle parts of the hypothalamus caused a considerable decrease in the secretion of gastric mucus. Stimulation of the posterior part of the hypothalamus in these animals caused a negligible decrease in the secretion of gastric mucus, and in some experiments the secretion of acid gastric juice was observed. This demonstrates that inhibitory influences from the posterior part of the hypothalamus on gastric secretion may be transmitted along the splanchnic nerves. Abolition of these influences by division of the splanchnic nerves leads to activation of the humoral mechanisms of transmission of hypothalamic influences, and these bring about the secretion of active gastric juice. Additional bilateral adrenalectomy abolished the secretion of gastric juice and only small amounts of gastric mucus were secreted.

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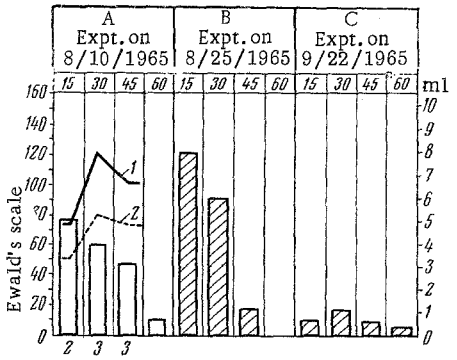

Fig. 1. Changes in gastric secretion during stimulation of anterior portion of hypothalamus with electrical pulses (50 cps, 0.5 mA) for 1 min before division (A) and after division of vagus (B), and of vagus and splanchnic nerves (C) in the dog Chernomor. 1) Total acidity (Ewald's cale); 2) free HCl. Unshaded columns represent volume of gastric juice (in ml in each 15 min). Numbers below denote digestive power (in mm albumin column /day by Mett's method), numbers above indicate min.

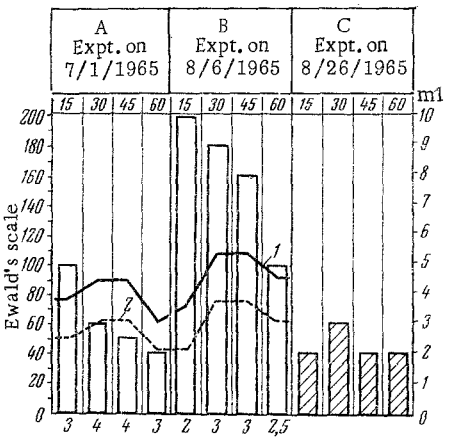

Fig. 2. Changes in gastric secretion during stimulation of anterior part of hypothalamus by electrical pulses (50 cps, 0.5 mA) for 1 min before division (A), and after division of the splanchnic (B) and the splanchnic and vagus (C) nerves of dog No. 18. Legend as in Fig. 1.

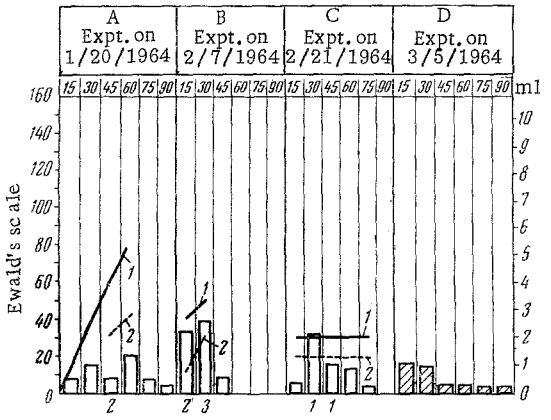

Fig. 3. Changes in gastric secretion during stimulation of posterior part of hypothalamus by electrical pulses (50 cps, 0.5 mA) for 1 min before division (A), and after division of the splanchnic (B) and the splanchnic and vagus (C) nerves, and division of the splanchnic and vagus and bilateral adrenalectomy (D). Legend as in Fig. 1.

To determine the role of the splanchnic and vagus nerves in the transmission of influences from the hypothalamus on gastric secretion, experiments were performed in which various parts of the hypothalamus were stimulated in dogs on which splanchnicotomy had been performed, leaving the vagus nerves intact, and these animals were then subjected to an additional vagotomy.

The secretion of gastric juice in splanchnicotomized dogs with intact vagus nerves showed the following changes. During stimulation of the anterior and middle parts of the hypothalamus an increase in the volume of gastric secretion and in the acidity of the gastric juice was observed. After vagotomy, stimulation of the anterior and middle parts of the hypothalamus of these animals led in most cases to the secretion of a very small amount of neutral gastric mucus (Fig. 2). Sometimes in response to stimulation of the middle parts of the hypothalamus after division of the splanchnic and vagus nerves secretion of acid gastric juice with low digestive power was observed, and only after additional bilateral adrenalectomy was stimulation of these parts of the hypothalamus not followed by secretion of acid gastric juice; in this case a small volume of neutral gastric mucus was secreted. In most experiments stimulation of the posterior part of the hypothalamus in intact animals was accompanied by secretion of gastric mucus only. After splanchnicotomy and subsequent vagotomy on these animals, no change took place in the quality of the gastric secretion, but merely a decrease in the volume of gastric mucus secreted. In those cases when stimulation of the posterior part of the hypothalamus of intact animals caused the secretion of small volumes of gastric juice, after splanchnicotomy an increase was found in the secretion of gastric juice, and this persisted after vagotomy. This effect was only abolished after bilateral adrenalectomy (Fig. 3).

The results of the experiments described above show that inhibitory influences on gastric secretion evoked by hypothalamic stimulation are transmitted along the splanchnic nerves. Division of the splanchnic nerves abolishes these inhibitory influences on gastric secretion evoked by stimulation of the anterior, the middle and, to a lesser degree, the posterior parts of the hypothalamus. Cessation of the secretion of acid, digestively active gastric juice during stimulation of the anterior and middle parts of the hypothalamus in vagotomized animals indicates that excitatory influences on gastric secretion are transmitted principally along the vagus nerves.

Consequently, the transmission of excitatory influences on gastric secretion during stimulation of the anterior and middle parts of the hypothalamus takes place along the vagus nerves, and inhibitory influences on gastric secretion are transmitted along the splanchnic nerves. During stimulation of the posterior part of the hypothalamus, excitatory influences on gastric secretion are transmitted mainly by the humoral route, and inhibitory along the splanchnic nerves. The vagus nerves play no part in the transmission of influences on gastric secretion evoked by stimulation of the posterior part of the hypothalamus.

LITERATURE CITED

1. P. G. Bogach and A. F. Kosenko, Fiziol. Zh. SSSR, No. 11, 989 (1965).