RECONSTRUCTIVE JEJUNOGASTROPLASTY AS A METHOD OF STUDYING THE INTESTINAL PHASE OF GASTRIC SECRETION

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The effect of reconstructive jejunogastroplasty after Billroth II resection of the distal two-thirds of the stomach on the secretory and motor activity of the stomach was studied in experiments on dogs. Restoration of the passage of food materials along the duodenum may in some cases lead to restoration of hydrochloric acid production lost after the Billroth II gastrectomy. These findings agree with clinical observations on patients with duodenal ulcer after treatment by the corresponding operations. It is evident that the renewal of gastric secretion took place through activation of the intestinal phase of secretion.

Uncertainties regarding the degree and even the actual existence of an intestinal phase of gastric secretion are due chiefly to the fact that existing methods [3, 7-9, 11-13], for several reasons, have proved partially or totally unsuitable for the study of this phase of secretion [9].

Jejunogastroplasty combined with gastrectomy is a variant of the Billroth I operation, from which it differs by the fact that a segment of small intestine is inserted between the gastric and duodenal stumps [2]. The term "reconstructive jejunogastroplasty" (RJGP) signifies a repeat operation to include the duodenum after a previous Billroth II gastrectomy. It is an effective surgical method of treatment of severe forms of certain post-gastrectomy disorders; the dumping syndrome, the afferent loop syndrome, and, in particular, nutritional disturbances [6].

In the course of observations on patients undergoing RJGP in the Professorial Surgical Department the writers found that the production of free HCl was restored in eight of 27 patients treated for duodenal ulcer. Before RJGP for many years no free hydrochloric acid could be detected in the gastric contents of these patients. It was postulated that the restoration of HCl production is connected with restoration of the passage of food through the duodenum and to the resulting activation of the intestinal phase of gastric secretion [5].

The object of the present investigation was to demonstrate experimentally the role of the duodenum in the formation of the gastric secretion and to evaluate RJGP as a method of investigating its intestinal phase.

EXPERIMENTAL METHOD

Isolated gastric pouches of the Pavlov type and Basow fistulas in the upper third of the stomach were formed in preliminary experiments on five dogs. Two of the animals, in addition, had duodenal fistulas. After the basal values had been obtained for the dogs in the same order as in man, the distal two-thirds of the stomach was resected by the Billroth I technique, after which the animals remained under observation for 35-150 days; in the three animals which survived RJGP was performed (period of observation 70-470 days) (Fig. 1). Food was given to the animals either by mouth or by injection into the gastric and duodenal

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TABLE 1. Acid Production (in % of background level) after Gastrectomy and RJGP

Dog	Stimulus							
	meat				milk			
	by mouth		via fistula		by mouth		via fistula	
	after resection	RJGP	after resection	RJGP	after resection	RJGP	after resection	RJGP
Nadira	3	20	0	0	20	31	20	50
Pal'ma	0	ca	0	0	ca	ca	ca	ca
Két	0	0	Not determined		0	0	0	0

Legend: ca) contact acidity, determined in films stained with dimethylamidoazobenzene if the volume of juice could not be ascertained.

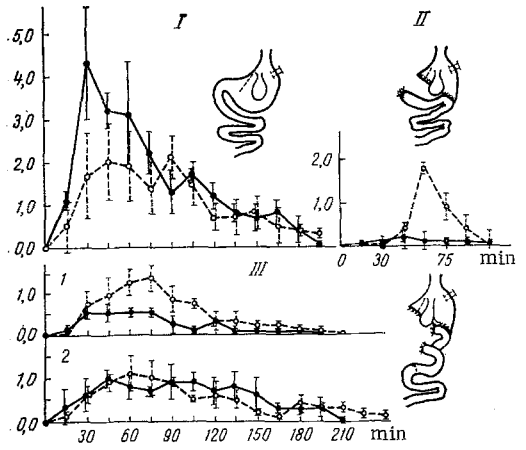

Fig. 1. Gastric secretion in response to meat (continuous line) and milk (broken line): I) before operation, II) after resection of distal two-thirds of the stomach, III) after RJGP; 1) during 1st year after operation, 2) 1 year after operation. Abscissa, time; ordinate, volume of juice (in ml).

stumps through the fistulas. The volume of juice produced in 15 min, the free acid, the total acid (in titration units), and the hydrochloric acid production (in meq) were determined; movements of the stomach or its stump were recorded simultaneously. More than 500 experiments were performed.

EXPERIMENTAL RESULTS AND DISCUSSION

Resection of the distal two-thirds of the stomach by the Billroth II method in all the dogs led to a sharp decrease or even to the cessation of secretion of juice after eating and after introduction of food substances through the fistulas (Table 1; Fig. 1), in agreement with clinical observations on the effectiveness of this operation as a method of producing anacidity in the gastric stump. In one dog RJGP produced an immediate increase in gastric secretion on account of a decrease in the latent period of secretion and an increase in the acidity of the juice, the duration of the secretory period, and the hydrochloric acid production during the experiment. A second increase of secretion was observed after 1 year in this same animal as the result of lengthening of the secretory cycle. In a second dog with achylia, contact acidity appeared as the result of RJGP, while the state of achylia persisted in a third animal.

Introduction of 100 or even 200 g raw meat, cut into pieces so that it acted as a mechanical stimulus, into the stomach through the fistula did not evoke secretion, although it had a marked stimulant effect on movements of the gastric stump (Fig. 2). Chemical stimuli (milk, meat broth, meat chyme) effectively stimulated gastric secretion when injected into the gastric stump of the dogs' Nadira and Pal'ma. Natural gastric juice (pH 0.9-1.2) and 5% glucose solution did not evoke secretion. Feeding was always followed by a greater secretory response than introduction of the same solids or liquids through the fistulas. Sham feeding (50 g raw meat in pieces followed by their rapid removal through the gastric fistula) combined with introduction of substances through the fistula into the gastric stump gave a much greater secretory effect than sham feeding and introduction through the fistula separately (Fig. 3).

The results of these experiments confirm the hypothesis based on clinical observations that after RJGP the production of hydrochloric acid can be resumed through activation of the intestinal phase of gastric secretion. This three-stage investigation (obtaining the basal data, resection of the distal two-thirds of the stomach, RJGP, especially if the dogs have gastric and duodenal fistulas in addition) creates

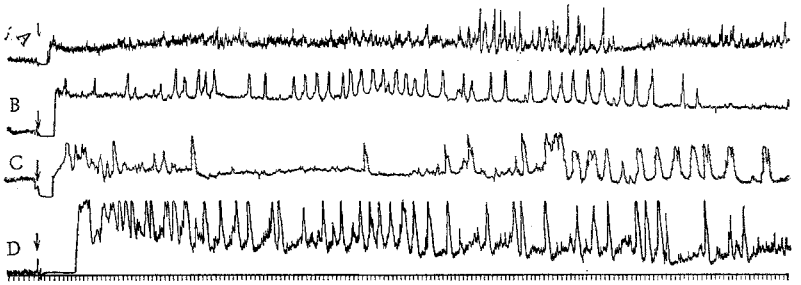

Fig. 2. Movements of stomach and its stump in response to introduction of 100 g (A, B, C) or 200 g (D) raw meat cut into pieces: A) background, B and D) after gastrectomy, C) after RJGP. Time marker 30 sec. In experiment before gastrectomy 0.748 meq acid was secreted in 3 h; after gastrectomy and RJGP secretion was absent.

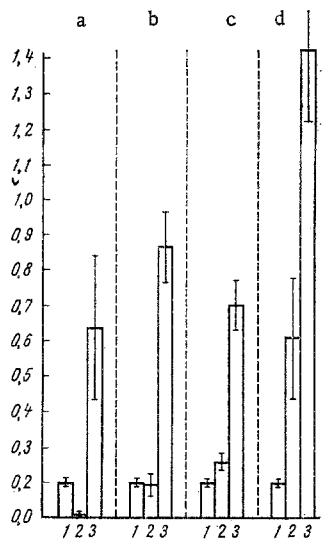

Fig. 3. Production of hydrochloric acid by isolated gastric pouch per experiment after RJGP: 1) secretion to sham feeding; 2) to injection of broth (a), meat chyme obtained from another dog (b), milk (c), or sunflower oil (d) into stomach through fistula; 3) secretion to sham feeding with simultaneous introduction of the same substances into the stomach. Ordinate, HCl production (in meq).

satisfactory conditions for the experimental study and, in particular, the analysis of the intestinal phase of gastric secretion. In the writers' opinion such an investigation has the following advantages:

1. The operation preceding RJGP, with the formation of a Billroth II anastomosis, preventing the passage of food along the duodenum, makes it possible to perform a series of control experiments, for all the changes in gastric secretion arising after RJGP must be ascribed entirely to restoration of contact between the food masses and the duodenum.

2. The extensive resection, insuring reliable removal of the zone producing gastrin, leads to loss of the gastric phase of secretion [8]. Under these circumstances favorable conditions are created for the isolated study of influences from the intestine on gastric secretion, which are usually hidden and masked by the psychic and gastric phases. In the presence of gastric and intestinal fistulas, in the experiments in which food substances were introduced directly into the organs a direct action of the vagus nerve on the gastric glands during the act of eating can be ruled out. There is no risk of the regurgitation of the intestinal contents into the gastric stump because the mucus membrane of the proximal portions of the stomach is insensitive to chemical stimuli, and the results of the present investigation show that mechanical stimulation was ineffective. All these conditions are naturally disturbed after sparing resections of the stomach leaving behind the zone producing gastrin.

3. The gastric stump together with the inserted portion of small intestine constitute a reservoir for food masses which allows the chyme to pass gradually in portions into the intestine [2], thus enabling it to remain longer in contact with the intestinal mucus membrane and allowing adequate stimulation of its sensory surfaces after natural food substances are eaten. The passage of food along the duodenum restores to normal the pancreatic and hepatic function, which is severely disturbed after the Billroth II operation [1], and thus leads to corresponding improvement in the digestion and absorption of food substances in the small intestine, which also promotes the manifestation of the intestinal phase.

The results of this investigation show that the gastric secretion arising after eating is unquestionably the intestinal component. Contrary to the observations of Sirkus [14], mechanical stimulation of the intestine by undigested food did not evoke gastric secretion in the present experiments. Only its chemical stimuli had a stimulant effect, but by contrast with Razenkov's findings [4], gastric juice was not among them.

Differences in the techniques used by different investigators must be borne in mind when these differences are accounted for. In the present experiments the conditions were close to natural, for the substances tested were able to move along the duodenum from its very beginning, whereas Sirkus, in his experiments, used an isolated loop of intestine while Razenkov injected gastric juice directly into the jejunum, bypassing the duodenum. The stimulant effect of stimulation of the small intestine could conceivably not be manifested under normal conditions, being masked by the powerful inhibitory flow of impulses from the duodenum. In the present experiments the act of eating also had a potentiating effect on the intestinal phase of gastric secretion similar to the well-known potentiating effect of the vagus nerve on the action of gastric gastrin. Comparison of the results of experiments on the different dogs showed clear individual differences as regards the role of the intestinal phase in the general balance of gastric secretion, a conclusion confirmed by the clinical observations mentioned above. Even if a history of duodenal ulcer is present, gastric secretion is restored after RJGP in only some of the patients so treated.

However, the writers are aware that this experimental model has its disadvantages. It was impossible to calculate the relative contribution of the intestinal phase to the total secretory response of the stomach, as has been done in certain investigations [10], because the normal physiological conditions are undoubtedly modified after these operations. By analogy with the interaction between the psychic and intestinal phases which the writers have demonstrated, the existence of interaction can also be postulated between the intestinal and gastric mechanisms of secretion, which in this case are intentionally disturbed. Gregory's view that some reflexes from the intestine on the stomach may be mediated by gastrin is very probably correct. Finally, there is reason to suppose that the natural pathways of transmission of excitatory and, in particular, inhibitory impulses to the stomach from the intestine are disturbed through division of the gastro-intestinal tract.

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