ELECTROPHYSIOLOGICAL STUDY OF DUODENAL MOTOR ACTIVITY BEFORE AND AFTER STOMACH OPERATIONS

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Bioelectrical activity of the duodenum is reduced after resection of the stomach, the reduction being greater in cases when the duodenum is bypassed (Billroth II).

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It has been stated [1, 10, 13-15] that the duodenum contracts regularly at a mean rate of 15-19/min. Other investigators [2] have recorded regular waves at the rate of 10-12/min, and some workers actually deny that the duodenum contracts regularly at all [3, 4, 6-8]. These conflicting views are evidently due to differences between the methods used. Some are insufficiently sensitive for recording duodenal contractions of low amplitude (x-ray method), while others cause stimulation of mechanoreceptors (the balloon-kymographic method), and do not provide a true picture of the state of the duodenum [9].

Operations on the stomach [5, 12] have a marked effect on the mechanisms of nervous regulation of the duodenum, causing disturbances of its motor function in the postoperative period.

The object of this investigation was to study the duodenal motor activity before and after operations of the stomach using the method of electrographic recording of its action potentials [11].

EXPERIMENTAL METHOD

Experiments were carried out on dogs weighing 10-15 kg.

Duodenal motor activity was studied in 10 dogs for 3 months under conditions of physiological hunger and without operations on the stomach. Gastrectomy was performed on 6 dogs without bypassing of the duodenum (Billroth I), and on 6 dogs with bypassing the duodenum (Billroth II).

For a long time before the experiment all the animals received a mixed diet, and this was continued in the postoperative period. Duodenal potentials of all experimental dogs were recorded under conditions of physiological hunger (20 h after the last meal), at the same time of day, and under the same conditions. Each recording continued for at least 2 h.

Duodenal potentials were recorded on the first day after operation, then every 3-5 days for the first month, and thereafter monthly. The dogs were sacrificed after 3 months.

The electroduodenograms were assessed visually and by histographic analysis. Visual assessment revealed periods of increased ("work") and decreased ("rest") electrical activity of the duodenum and showed their duration. Segments of the duodenograms covering intervals of 10 min at the middle of each period of "rest" and "work" were subjected to histographic analysis.

The following parameters were used to assess bioelectrical activity of the duodenum: 1) frequency of regular waves per minute and their amplitude; 2) frequency of peristaltic waves per minute and their amplitude; 3) duration of periods of "rest" and "work" (in minutes).

It was previously shown [11] that potentials greater than 4 mV are recorded against a background of clearly visible peristalsis. For this reason, these waves were considered separately during analysis of the duodenograms.

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TABLE 1. Chief Parameters of Duodenal Bioelectrical Activity before and after Operations on the Stomach

Experimental conditions	Frequency of regular waves/min		Amplitude of regular waves, mm		Frequency of peristaltic waves/min			Amplitude of peristaltic waves/min				
	period				"rest period"			"rest period"		"work period"		
	rest	work	rest	work	$M \pm m$	P		$M \pm m$	P	$M \pm m$	P	
Control group	19	19	2	0,5	3,5± 0,2	$P<0,001$		20,4± 0,9	$0,02<P<0,05$	34,2± 1,7	$0,1<P<0,2$	
Billroth I	19	19	6	0,5	2,6± 0,1	$P<0,001$		17,9± 0,8	$P<0,001$	30,3± 2,1	—	
Billroth II	18	—	1	—	2,4± 0,2			12,9± 0,9		—		

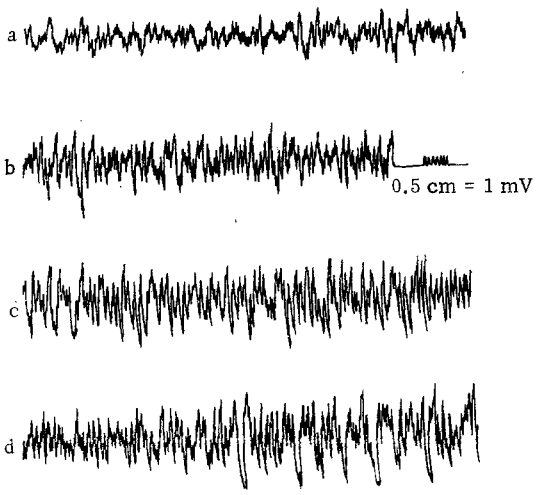

Fig. 1. Duodenograms of dog at different times after implantation of electrodes. a,b) 1st and 8th days after operation (hunger rhythm not visible); c,d) 14th and 19th days after operation (period of "rest" – stabilization of indices of duodenal bioelectrical activity observed).

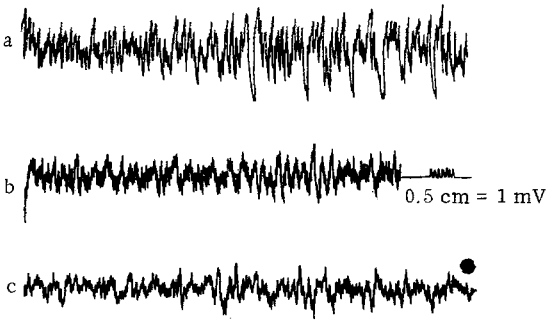

Fig. 2. Duodenograms of dogs before and 3 months after operation on stomach. a) control group ("rest" period); b) after Billroth I gastrectomy ("rest" period); c) after Billroth II gastrectomy (hunger waves not seen).

EXPERIMENTAL RESULTS

For the first 20 days after implantation of the electrodes, duodenal action potentials were recorded from all 22 dogs periodically in order to study the effect of the inflammatory process in the neighborhood of the electrodes.

On the first day after implantation of the electrodes, the course of the postoperative period being normal, bioelectrical activity of the duodenum was reduced (Fig. 1). A period of stabilization of the main parameters of duodenal electrical activity developed 15-20 days after the operation.

Operations on the stomach were performed in this period.

Results of an investigation of duodenal bioelectrical activity in the late period (90 days) after the operation are shown in Fig. 2. In the control group of animals the periods of "rest" and "work" began to be recorded clearly on the 8th-15th day after implantation of the electrodes. The mean duration of the "rest" period was 46.5 min, and of the "work" period 26.5 min.

After Billroth I gastrectomy, hunger waves did not begin to be recorded in the duodenum until the 25th-34th day, the mean duration of the "rest" period being 39 min, and of the "work" period 23 min.

After the Billroth II gastrectomy, no hunger waves could be detected in the duodenum throughout the period of observation.

The results of histographic investigation of duodenograms of dogs of all three groups are shown in Table 1.

Differences between the control and experimental groups of animals as regards frequency of the peristaltic waves are significant. So far as amplitudes of the peristaltic waves are concerned, in the "rest" period the differences between the control and experimental groups are significant, but in the "work" period no significant differences could be found ($0.1 < P < 0.2$).

The frequency of regular waves in the duodenum remained virtually unchanged after operations on the stomach, but the amplitudes of these waves varied depending on the nature of the operation. The total number of peristaltic waves exceeding 4 mV during the 10-min interval of recording was 17 in the control group of animals, 7 in the animals undergoing Billroth I gastrectomy, and 2 in those undergoing Billroth II gastrectomy.

Resection of the stomach in dogs thus disturbed their periodic hunger contractions in the duodenum and lowered the frequency and amplitude of the peristaltic waves, these changes being more marked in cases when the duodenum was bypassed (Billroth II).

Considering that the extent of duodenal denervation was the same in the two operations, it can be concluded that the smaller decrease in duodenal bioelectrical activity following the Billroth I operation is due to preservation of natural passage of the food along the duodenum.

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