MYOELECTRICAL ACTIVITY OF THE GASTRODUODENAL ZONE IN SEROTONIN-INDUCED ULCER FORMATION

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Serotonin participates in the process of ulcer formation [1, 3, 5, 7]. Meanwhile its ulcerogenic action is difficult to explain by secretory mechanisms, for this amine inhibits acid secretion and stimulates the alkaline secretion of the stomach [3, 6, 8, 10, 13]. It has been shown that serotonin can both stimulate and inhibit the motor function of the gastrointestinal tract [2, 4, 6, 8, 12, 15], but its action on smooth muscle activity in the gastroduodenal zone during ulcer formation has virtually not been studied.

The aim of this investigation was to study electrical activity of the smooth muscles of the gastroduodenal zone (body of the stomach, pyloric sphincter, and duodenum) in the process of ulcer formation induced by serotonin.

EXPERIMENTAL METHOD

Chronic experiments were carried out on 11 male rabbits weighing 2.6-3.5 kg. Silver loop electrodes were implanted into the smooth muscles of the body of the stomach, the pyloric sphincter, and the duodenum by the method described previously [6, 11, 12] 1-2 weeks before the experiment. Activity of smooth muscles of the gastropyloroduodenal zone was recorded on an encephalograph (recording speed 7.5 mm/sec, time constant 0.3). The rabbits received an ordinary diet (vegetables, oats, hay). The animals were taken from the animal house for the experiments after 10 a.m. without any preliminary restrictions on feeding. Ten experiments were carried out on each animal. For experimental ulcer formation [5, 7] serotonin creatinine-sulfate ("Reanal," Hungary) was injected subcutaneously into seven rabbits (experiments of series I) for 10 days in a dose of 10 mg/kg daily. In the experiments of series II (four rabbits) atropinc sulfate (0.3 mg/kg) was injected subcutaneously 30 min before the injection of serotonin. After the end of the experiments the presence of destructive lesions of the mucosa (ulcers, erosions, hemorrhages) was evaluated macroscopically [5, 7, 9] by inspection of the stomachs opened along the greater curvature. The amplitude of the action potentials (in μl) and their number in a burst before and after injection of serotonin were analyzed.

EXPERIMENTAL RESULTS

Subcutaneous injection of serotonin caused weakening of the myoelectrical activity of the stomach and pyloric sphincter of all seven animals (experiments of series I), manifested as a decrease in the amplitude and number of potentials by more than half compared with the control (Fig. 1; Table 1). Activity of smooth muscles of the duodenum, on the other hand, increased under these circumstances by 1.4-2.4 times (Fig. 1; Table 1). Consequently, serotonin weakened activity of the muscles of the stomach and sphincter while, at the same time, strengthening activity of the duodenal muscles. This is evidence of intensification of duodenal contractions at a time of relaxation of the pyloric sphincter and stomach. This disparity between the strengthened duodenum and weakened gastric activity is a manifestation of duodenogastric dyskinesia. In the animals of this series, at the end of the experiment areas of venous stasis were identified on the apices of the mucosal folds in the body

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TABLE 1. Effect of Serotonin on Electrical Activity of Smooth Muscles of Gastroduodenal Zone before and after Atropinization ($M \pm m$)

Structure	Experimental conditions			
	1	2	3	4
Body of stomach				
A	220±30	50±10*	100±30*	40±10*
B	14±3	6±3*	8±2*	3±1*
Pyloric sphincter				
A	240±40	80±30*	90±20*	90±40*
B	17±4	7±3*	6±3*	3±2*
Duodenum				
A	150±30	210±20*	90±30*	130±30
B	5±2	12±3*	3±1*	7±3

Legend. 1) Control; 2) serotonin (10 mg/kg); 3) atropine (0.3 mg/kg); 4) serotonin + atropine. A) Amplitude of potentials (in μV); B) number of potentials. *$p < 0.05$ compared with control.

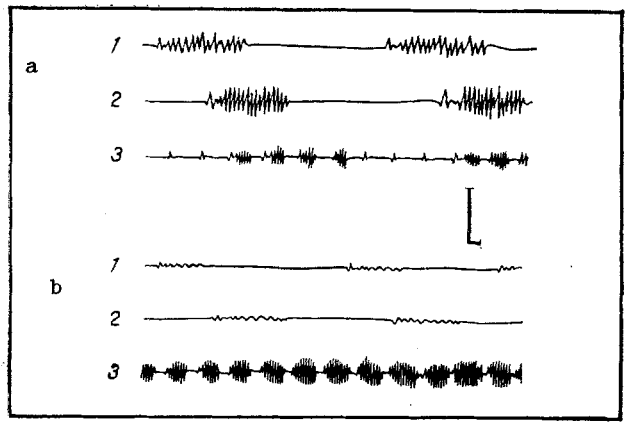

Fig. 1. Myoelectrical activity of gastroduodenal zone before (a) and after injection of serotonin (b). Here and in Fig. 2: 1) stomach, 2) sphincter, 3) intestine. Calibration: 50 μV, 1 sec.

and fundus of the stomach, and bile was found in the gastric contents, and hyperemia of the duodenum was observed. On the lesser curvature of the stomach ulcers up to 3 mm in diameter were found in five of seven rabbits, and two of the five animals each had two ulcers.

Injection of serotonin into rabbits thus caused duodenogastric dyskinesia, reflux of bile into the stomach, and ulcer formation. The results are in agreement with the view that duodenogastric reflux is one of the basis factors of ulcer formation in the stomach [7, 9, 14].

Subcutaneous injection of atropine in a dose of 0.3 mg/kg led to a fall by almost half in the amplitude of the potentials and a decrease in their number in the burst (Fig. 2) in the smooth muscles of the stomach, pyloric sphincter, and duodenum. This result is evidence of a general weakening of activity of the smooth muscles in all parts of the gastroduodenal zone studied during muscarinic cholinoceptive blockade (Table 1).

Injection of serotonin into the atropinized rabbits (experiments of series II) caused weakening of the myogenic activity of the stomach and sphincter. This weakening was more marked, so far as the number of potentials is concerned, was more marked than in response to injection of serotonin alone (Table 1). Consequently, atropinization potentiated the inhibitory action of serotonin on the body of the stomach and the pyloric sphincter. The myogenic activity of the duodenum under the influence of serotonin, preceded by atropinization, did not change statistically significantly compared with the control.

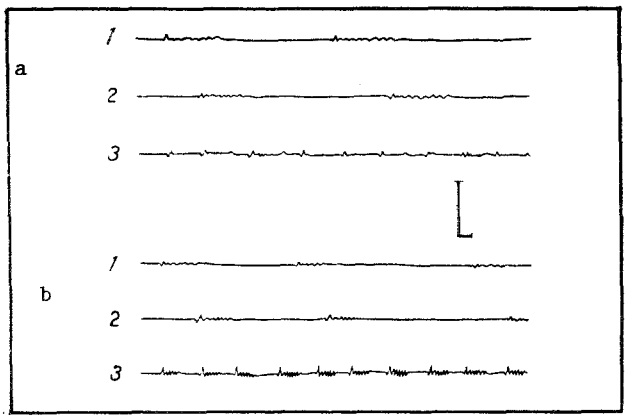

Fig. 2. Myoelectrical activity of gastroduodenal zone before (a) and after injection of serotonin (b) accompanied by atropinization.

Since against a background of atropinization serotonin weakened the myogenic activity of the stomach and sphincter but caused no significant change in this parameter in the duodenum, it can be concluded that under these conditions serotonin did not cause any marked duodenogastric dyskinesia.

In the animals in the experiments of series II bile was not found in the gastric contents, nor were any ulcers observed, although in two rabbits there was hyperemia at the apices of the folds of the gastric mucosa. Consequently, the action of serotonin, superposed on atropinization, did not lead to marked duodenogastric dyskinesia, was not accompanied by reflux of bile into the stomach, and did not induce ulcer formation.

It can thus be concluded on the basis of the fact that injection of serotonin induced duodenogastric dyskinesia and ulcer formation, whereas preliminary atropinization reduced the intensity of this dyskinesia and prevented ulcer formation, that duodenogastric dyskinesia is one of the mechanisms of serotonin-induced ulcer formation.

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