# Incoordination of Gastroduodenal Myoelectric Activity Caused by Immobilization Stress in Rabbits

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Incoordination of gastroduodenal myoelectric activity in rabbits under immobilization stress was manifested, first, in an earlier resumption of spike activity in the duodenum than in the stomach and pyloric sphincter after its simultaneous suppression in these three parts of the gastrointestinal tract and, second, in the subsequent considerable increase of duodenal spike activity over its baseline level, while stomach and pyloric sphincter activities remained reduced. The incoordination of gastroduodenal myoelectric activity, which developed during the first hour of immobilization, was accompanied by the formation of erosive lesions in the gastric mucosa. The results of this study suggest that incoordination of gastroduodenal motor activity may be implicated in stress-induced gastric ulcers as a factor that damages the gastric mucosa by slowing down the evacuation of stomach contents and promoting duodenogastric reflux.

**Key Words**: *gastroduodenal myoelectric activity; immobilization stress; gastric ulcer formation*

We have shown previously that stress associated with arterial blood loss impairs the coordination of gastroduodenal myoelectric activity (GMA) by stepping up activity of the duodenum and weakening that of the stomach [7]. Gastroduodenal incoordination of this type also occurs in rabbits administered ulcerogenic doses of serotonin [6] or pentagastrin [8]. The existence of a correlation between gastric mucosal lesions and incoordination of gastric and duodenal activity suggests a pathogenic role of gastroduodenal incoordination in gastric ulcer formation. Hence the interest in the study of GMA under stress. One of the stressors that lead to gastric ulcer formation in animals is their immobilization [3,13,14]. The aim of this study was to measure GMA in rabbits under immobilization stress.

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## MATERIALS AND METHODS

The study involved a chronic experiment on 13 male rabbits (body weight 2.5-3.0 kg) implanted with looped silver electrodes under the serous coat in smooth muscles of the stomach, pyloric sphincter, and duodenum by a method we described previously [5]. The rabbits were maintained on an ordinary diet (vegetables, oats, hay). Prior to the tests, which were started 7 days postsurgery, they were conditioned to the experimental setting 1 to 2 h daily for a few days, without any limitations on food intake.

GMA was recorded with an electroencephalograph at a speed of 7.5 mm/sec and a time constant of 0.3 sec. After a 1-hour recording of baseline GMA, each rabbit was immobilized for 1 h or, in some tests, for 3 h in the supine position by fixation of the paws. The parameters measured included the frequency of action potential bursts (APB) from the stomach, pyloric sphincter, and duodenum and the heart rate (the latter was determined from the electrocardiogram) before the immobilization and every 2 min during it. In 6

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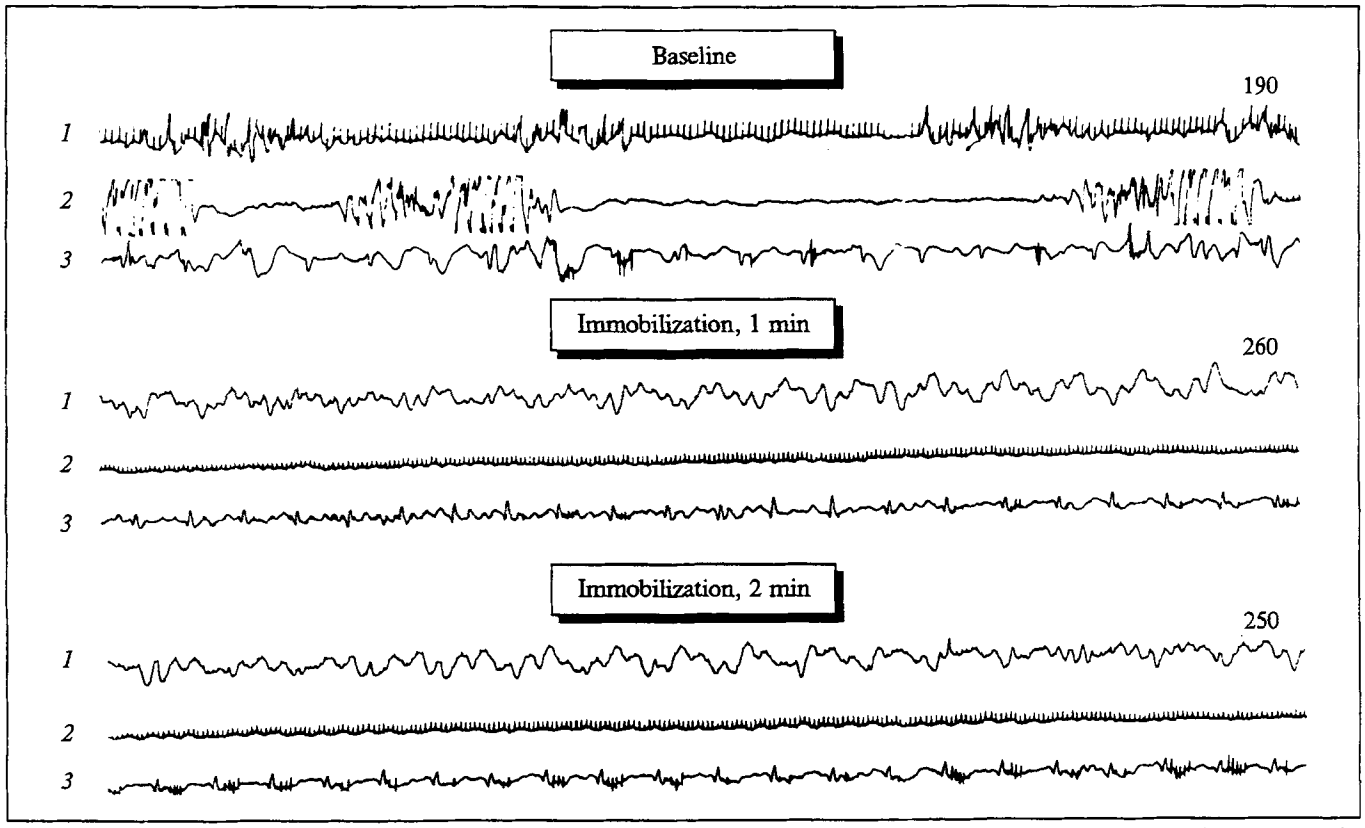


**Fig. 1.** Myoelectric activity of stomach (*1*), pyloric sphincter (*2*), and duodenum (*3*) in an immobilized rabbit. Figures at right indicate the number of heartbeats per minute.

rabbits, the stomach was examined macroscopically for ulcer formation immediately after the test. The significance of differences between mean parameter values was evaluated by Student's *t* test.

## RESULTS

Immobilization led to a 25% increase in heart rate on average (from 227±12 to 284±11 beats/min), and the heart rate remained increased throughout the immobilization period, indicating a stress-induced activation of the adrenergic system.

The changes in GMA in the stressed animals were biphasic. In the first phase, spike activity became completely and simultaneously suppressed in all parts of the gastroduodenal region (Fig. 1). This inhibitory phase lasted 4.9±2.0 min (range, 2-14 min) in the duodenum, 8.9±4.3 min (2-33 min) in the pyloric sphincter, and 9.7±6.1 min (2-43 min) in the stomach. Thus, the mean time during which duodenal spikes remained suppressed was about half that observed for the stomach and pyloric sphincter.

In the second phase, gastroduodenal spike activity was resumed - first in the duodenum and then in the pyloric sphincter and stomach (Figs. 1 and 2). The frequencies of APB recorded from the stomach and pyloric sphincter remained lower than the baseline throughout the immobilization period, while the duodenal spike activity fell to the baseline and then exceeded it considerably (Fig. 2). The phase of duodenal activation was observed in 17 out of the 18 tests: it began at 12.7±5.9 min (range, 2-42 min) after the onset of immobilization and continued for 33.5±19.0 min (range, 2-138 min); in one test, enhanced duodenal spike activity was recorded right from the start of immobilization and continued for 3O min.

This experiment showed that immobilization of rabbits disturbs the normal ratio of spike activity in the stomach and pyloric sphincter to that in the duodenum by enhancing , particularly in the activation phase, duodenal activity and reducing

**TABLE 1.** Frequency of APB ($min^{-1}$) in the Stomach, Pyloric Sphincter, and Duodenum before Immobilization of Rabbits (Baseline) and during Duodenal Activation after Their Immobilization ($M \pm m$, $n = 17$)

| Location of electrodes | Baseline | Immobilization |
|---|---|---|
| Stomach | 3.2±0.3 (100) | 1.5±0.4* (46) |
| Pyloric sphincter | 2.8±0.3 (100) | 1.7±0.2* (62) |
| Duodenum | 7.8±2.0 (100) | 12.6±2.2* (175) |

**Note.** Figures in parentheses are percentages; *$p<0.05$ in comparison with baseline.

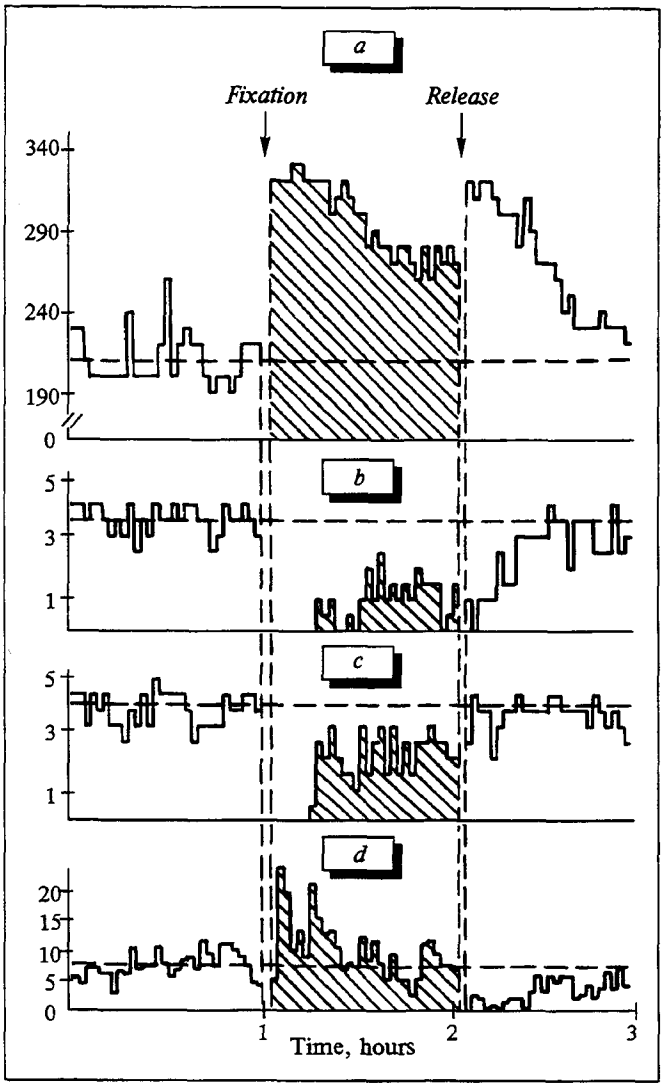


**Fig. 2.** Variation in the frequency of APB in the gastroduodenal region of a rabbit during 1–hour immobilization. Ordinate: heart rate, beats/min (*a*) and frequency of ABP recorded from stomach (*b*), pyloric sphincter (*c*), and duodenum (*d*). Hatched areas mark the duration of immo-bilization and horizontal dashed lines mark mean values at baseline.

stomach and pyloric sphincter activity (Table 1). Analysis of the APB frequencies during the 3-hour immobilization (which was used in 4 tests) showed that intensified duodenal activity persisted throughout that period, as did lowered activity of the stomach and pyloric sphincter, although gastroduodenal incoordination became less marked with time; thus, the difference between activity levels recorded from the stomach, pyloric sphincter, and duodenum reached almost 60% of the baseline value during the first hour of immobilization and decreased to about 40% in the next two hours.

Gross morphological examination demonstrated mucosal lesions in the stomach and/or pyloric sphincter in 5 of the 6 rabbits from which specimens were taken. These lesions appeared as multiple hemorrhages located at the apexes of mucosal folds in the stomach (their total area ranged from 165 to 262 $mm^2$) and/or as hemorrhagic mucosal erosions in the pyloric part of the stomach (they ranged from 1 to 21 in number and from 0.3 to 4.0 mm in diameter). Pronounced mucosal lesions in the stomach and/or pyloric sphincter occurred after 1-hour immobilization in 4 rabbits and after 3-hour immobilization in 1 rabbit (no evidence of mucosal damage was present in 1 rabbit after the 3-h immobilization).

Thus, the immobilization-induced stress caused both incoordination of GMA and gastric mucosal lesions. Currently, the duodenogastric reflux, whereby bile enters the stomach from the duodenum, is regarded as an important factor in ulcer formation [1-3,6,8]. This reflux is believed to result from weakened motoricity of the gastric antrum [10] or impaired patency of the duodenum because of its increased peristalsis [2]. Our study has indicated that gastroduodenal incoordination in rabbits under immobilization stress involves a combination of both these factors, i.e., weakened motoricity of the stomach and intensified contractile activity of the duodenum. This conclusion is consistent with the reported differences between the responses of gastric and small intestine smooth muscles to stressors [4,10,12] and with the finding that evacuation of stomach contents and chyme transit through the small intestine are both slowed in immobilized rats [9]. Our results suggest that incoordination of gastroduodenal motor activity may well be implicated in stress-induced ulcer formation in the stomach.

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