Gastric Motility in Patients with Recurrent Gastric Ulcers

Takeshi KAMIYA¹, Yuka KOBAYASHI¹, Makoto HIRAKO¹, Naoko MISU¹, Toshihiro NAGAO¹, Michiko HARA¹, Eriko MATSUHISA¹, Takashi ANDO¹, Hiroshi ADACHI¹, Nagahiko SAKUMA¹, and Genjiro KIMURA¹

¹Department of Internal Medicine and Pathophysiology, Nagoya City University Graduate School of Medical Sciences, Nagoya 467-8601, Japan

Abstract

The existence of abnormal gastric motility in gastric ulcer disease remains controversial. The aim of this study was to characterize gastric motility in patients with recurrent gastric ulcers. Studies were performed in 10 control subjects and in 24 patients with recurrent active gastric ulcer disease as diagnosed by gastrointestinal endoscopy. Gastric motility was evaluated by cutaneous electrogastrography (EGG) and by gastric semi-liquid meal emptying. The EGG was recorded before and after ingestion of a test meal containing 20 mg/kg of acetaminophen. Patients with a dominant EGG frequency of greater than 0.06 Hz were defined as tachygastria, while those with a frequency of less than 0.04 Hz were defined as bradygastria. A transient frequency decrease, called postprandial dip (PD), was identified visually. The degree of gastric emptying was determined from the serum acetaminophen concentration 45 minutes after the meal. Control subjects showed no irregularity in their dominant EGG frequency in either fasting or postprandial states. PD was observed in 8 control subjects. In patients presenting with active gastric ulcers, abnormal patterns in the dominant EGG frequency (either as tachygastria or bradygastria) were observed in 14 of the 24 patients when fasting and in 15 of them in the postprandial state. After successful treatment, the number of patients with abnormal patterns in their dominant EGG frequency remained unchanged, while PD was observed in 11 patients. No significant difference was observed in the EGG power ratio as a result of successful treatment. Gastric emptying was significantly delayed compared with controls in both the active and healed stages. These findings suggest that abnormal gastric motility, including gastric electrical abnormalities and delayed gastric emptying, plays an important role in the pathophysiology of recurrent gastric ulcers.

Key words: recurrent gastric ulcer, gastric motility, electrogastrography, gastric emptying

Introduction

Various factors contribute to the onset and recurrence of gastric ulcer disease. Disturbance of the balance between gastric acid output and mucosal defense has been a widely favored...
etiological theory. Recently, abnormal gastrointestinal motor patterns have been described in gastric ulcer disease and as a result gastrointestinal motility has been attracting attention as a new contributory factor.

There have been some reports that assess gastric motility in patients with duodenal ulcers. In some reports, gastric emptying has been found to be accelerated particularly following the ingestion of a liquid meal (Stubbs et al., 1975; Harasawa et al., 1979; Maddern et al., 1985; Konturek et al., 1994), while in others it was either delayed in the healed stage (Kerrigan et al., 1991) or unchanged (Heading et al., 1976; Howlett et al., 1976; Malagelada et al., 1977). In contrast, there have been only a few studies of gastric motility in patients with gastric ulcers (Garrett et al., 1966; Miller et al., 1980; Fujimura et al., 1994). Furthermore, in those studies gastric motility was measured mostly during the active ulcerative stage of the disease. Therefore, there have been few comparisons of gastric motility between the active stage and the healed stage.

In the present study, we measured gastric myoelectrical activity and gastric emptying to characterize gastric motility in patients with recurrent gastric ulcers, and to investigate a possible relationship between gastric motility and ulcer recurrence.

**Methods**

**Subjects**

Studies were performed in 10 healthy volunteers and in 24 patients with active gastric ulcer disease as diagnosed by upper gastrointestinal endoscopy. From the detailed medical histories taken, all patients had experienced 2 or more previous gastric ulcer episodes. No patient had undergone previous gastric resection, cholecystectomy or colectomy, had diabetes mellitus or collagen disease, or had cardiovascular or pulmonary disorders. Informed written consent was obtained from all subjects. In all patients, gastric motility was measured during the active stage before treatment, and again after oral treatment for 8 weeks with a proton pump inhibitor and with mucosal protective agents.

**Experimental procedure**

Gastric motility was assessed by cutaneously recorded electrogastrography (EGG) and by measurement of the rate of gastric semi-liquid meal emptying using the acetaminophen method. After fasting for 2 hours or more, EGG was recorded for 30 min. Then the subject ingested 20 mg/kg of acetaminophen powder mixed with a semi-liquid test meal (Okunos-A, 200 ml of the diet contained 9.8 g protein, 5.8 g fat, 28.6 g carbohydrate, and 200 kcal; Okuno Co, Tokyo, Japan). The EGG was recorded again for 30 min after the meal. The EGG was taken with bipolar leads, using Ag-AgCl electrodes placed on the right and left midclavicular lines along the long axis of the stomach over the surface of the upper abdomen. The EGG signals were filtered with a high frequency cut-off at 0.1 Hz, and a time constant of 3 seconds, and were recorded on a FM data recorder (MR-30, TEAC, Tokyo, Japan). The data obtained were digitized at 1 KHz using an analog/digital converter (ADX-98E, Canopus Electronics, Kobe, Japan). The dominant frequency and power of the EGG were obtained by autoregressive power spectral analysis. The power ratios were then calculated as the ratios of the power before and after the meal. Subjects
with a dominant frequency of greater than 0.06 Hz were defined as tachygastria and those with a dominant frequency of less than 0.04 Hz were defined as bradygastria. A transient frequency decrease, called postprandial dip (PD), which is usually found in EGG of normal subjects immediately following ingestion of a meal, was identified visually. Serum acetaminophen concentration was determined by fluorescence polarization immunoassay (TDX system; DAINABOT CO, LTD, Tokyo, Japan). The degree of gastric emptying was determined by measuring the serum acetaminophen concentration 45 minutes after intake of the test meal.

Statistical analysis

EGG data (the percentage with normogastria and the occurrence of postprandial dip) were compared using a chi-squared test. In those cases where there were less than 10 data entries, a Yates chi-squared test was used. Values of EGG power ratio and serum acetaminophen concentration were expressed as the mean ± standard deviation (S.D.) for each group. Intra group differences were analyzed using a paired t-test. Inter group comparisons were performed using an unpaired t-test. A probability of less than 0.05 (P<0.05) was considered to be statistically significant.

Results

Background factors (Table 1)

Table 1 shows an analysis of the clinical details of all subjects. The patients had one to five ulcers each. All patients had had two or more recurrences. Helicobacter pylori infection was diagnosed by microscopy, culture, and by rapid urease test of biopsy specimens taken during endoscopy. Twenty patients were positive for such an infection while 4 were negative, with three of the latter being treated with an oral nonsteroidal anti-inflammatory drug (NSAID).

Electrogastrography

Endoscopic examination after 8 weeks of oral medication revealed that in all 24 patients the ulcers had healed. In controls, no abnormality in the dominant EGG frequency was observed in either the fasted or postprandial state. In patients, during the active stage, abnormal patterns in

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Analysis of the clinical histories of Subjects</th>
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<tbody>
<tr>
<td></td>
<td>Control group (n=10)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>37.2 ± 15.9</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>7 / 3</td>
</tr>
<tr>
<td>Number of ulcers (/person)</td>
<td>2.04 ± 0.97</td>
</tr>
<tr>
<td>Ulcer history (times)</td>
<td>3.28 ± 1.47</td>
</tr>
<tr>
<td>Location of ulcers</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>14</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>Helicobacter pylori</td>
<td></td>
</tr>
<tr>
<td>Status (+/-)</td>
<td>20 / 4</td>
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<tr>
<td>Values are mean ± SD. GU, gastric ulcer; A, lower body; B, angulus; C, pyloric part.</td>
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the dominant EGG frequency such as tachygastria and bradygastria were observed in 14 of the 24 patients while fasting and in 15 after ingesting a meal. When the ulcers had healed after treatment, the number of patients with abnormal patterns in their EGG frequency remained almost unchanged (Table 2, Fig. 1, Fig. 2). The EGG power ratios in gastric ulcer patients were significantly lower compared with those in controls. In the gastric ulcer patients, no significant difference was observed between the before and after treatment EGG power ratios (Fig. 3). Postprandial dip (PD) was observed in 8 controls. During the active gastric ulcer stage, PD was observed in 8 patients. After the ulcers had healed, PD was observed in 11 patients with no significant difference between the before and after treatment stages (Fig. 4).

**Gastric emptying**

In gastric ulcer patients, gastric emptying was significantly delayed compared with that in controls in both the active and healed stages. No significant difference was observed between the active and healed stages (Fig. 5).
Gastric ulcer and gastric motility

Fig. 2 The proportion of control subjects and patients presenting with gastric ulcers demonstrating normogastria after a meal. Patients are grouped as those in the active ulcer stage, GU(A) or as those in the gastric ulcer healed stage, GU(H). *, P<0.01 versus control.

Fig. 3 The EGG power ratio in each group. Error bars indicate the mean ± SD. GU(A), gastric ulcer active stage, GU(H), gastric ulcer healed stage. *, P<0.01 versus control.

Discussion

The findings of this study indicate that abnormal gastric myoelectrical activity and delayed gastric emptying occurs in patients with recurrent gastric ulcers. The pathophysiology of the onset of peptic ulcers and their recurrence has been extensively investigated, but no clear explanation has yet been obtained for either the onset or the recurrence. Also the possibility that there is a correlation between the onset and recurrence of gastric ulcer and gastrointestinal motor function is uncertain.
Fig. 4 The proportion of control subjects and patients presenting with gastric ulcers demonstrating postprandial dip. Patients are grouped as those in the active ulcer stage, GU(A) or as those in the gastric ulcer healed stage, GU(H). *, P<0.01 versus control.

Fig. 5 Gastric emptying expressed as the serum acetaminophen concentration 45 minutes after the intake of a test meal for each group. GU(A), gastric ulcer active stage, GU(H), gastric ulcer healed stage. *, P<0.01 versus control.

In this study we used electrogastrography (EGG) and gastric emptying determined by the acetaminophen method to assess gastric motility. Stomach muscle has a myogenic mechanism that modulates its motility, and thus there is myoelectrical activity involved in stomach movement. Electrogastrography is a method which enables gastric myoelectrical activity to be recorded using abdominal surface electrodes (Alvarez, 1922; Smout et al., 1980; Hamilton et al., 1988; Chen et al., 1993). EGG is becoming widely accepted as a simple, non-invasive method for investigating gastric motility in both fasting and postprandial states.
Gastric ulcer and gastric motility

The acetaminophen absorption method is a reliable and simple test to evaluate gastric emptying. Heading et al. (1973) reported a significant correlation between the half time of gastric emptying by the scintiscanning technique and both the maximum plasma acetaminophen concentration and the time taken to reach the peak. Gastric emptying has been measured in patients with peptic ulcers (Harasawa et al., 1979; Kamiya et al., 1998) and also with gastritis and gastric cancer (Tatsuta et al., 1990) using this method.

From the present findings, it is suggested that in some gastric ulcer patients, the abnormalities in gastric motility were not only a result of the gastric ulcer but that they may also be a factor in the onset and recurrence of the condition. After the ulcer has healed, the number of patients with abnormal patterns in their dominant EGG frequency remained almost unchanged, with no significant improvement in the EGG power ratio compared with that in the active stage. The postprandial dip (PD), which was reported to appear in the EGG of normal subjects after food intake (Geldof et al., 1986; Kaneko et al., 1995) was observed in only 11 patients when their ulcers had healed. Furthermore Morguelan et al. (1978), using a scintigraphic technique, reported that delayed gastric emptying was observed in patients with active type 1 ulcers, and that normal emptying occurred in patients with documented healed type 1 ulcers. Geldof et al. (1989), using electrogastrography, reported that abnormal gastric myoelectrical activity was found in patients with an active gastric ulcer but that this disappeared with healing of the ulcer. Discrepancies between these findings and those in the present study may be due to differences in the patients’ backgrounds, i.e., ulcer location and whether recurrent or not.

In the present study, it was suggested that abnormal gastric hypomotility, with the associated gastric electrical abnormalities and delayed gastric emptying, plays an important role in the pathophysiology of recurrent gastric ulcers. It has been reported that antral hypomotility occurs in patients with gastric ulcers (Garrett et al., 1966; Stanghellini et al., 1992), and that there was an increase in the duodenogastric reflux associated with gastric ulcers (Miranda et al., 1985; Fujimura et al., 1994). As abnormally strong contractions of the stomach reduce blood flow in the gastric mucosa, causing mucosal damage, and because the retention of gastric contents may stimulate gastric acid secretion, the disturbed gastric myoelectrical activity and delayed gastric emptying are suggested to be factors in gastric ulcer recurrence.

Recently, a correlation between H. pylori infection and the onset and recurrence of peptic ulcers was reported. In the present study, 20 of the 24 patients with gastric ulcer were H. pylori positive. The effect of H. pylori infection on gastric motility is unclear. Some studies have suggested that there appears to be little direct relation between H. pylori infection and gastric motility (Rokkas et al., 1987; Kao et al., 1997; Pfaff nachenbach et al., 1997). However, Tuggi et al. (1992) reported that H. pylori-negative patients with idiopathic dyspepsia had gastric emptying times significantly slower than those of both H. pylori-positive patients and controls. In contrast, Fock et al. (1997) indicated that gastric emptying was significantly slower in H. pylori-positive dyspeptic patients than in H. pylori-negative patients. Further investigation is required to determine whether there is a possible correlation between abnormalities in gastrointestinal motility and the onset and recurrence of ulcers and with H. pylori infection.

In conclusion, in some patients with gastric ulcers, gastric electrical abnormalities and delayed gastric emptying appeared to be possible factors in the recurrence of gastric ulcers.
References

Gastric ulcer and gastric motility


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