Relationship Between Gastric Dysmotility and Severity of Dyspeptic Symptoms in Patients with Functional Dyspepsia

Hai-Ying Tang, Ying-De Wang, Yan-Jun Zhang, and Jing-Hui Xie

Abstract—Objective: To study the relationship between gastric dysmotility and severity of dyspeptic symptoms in patients with functional dyspepsia (FD). Methods: 55 FD patients and 25 healthy volunteers were enrolled in the study. Gastric emptying and intragastric food distribution were measured by using a standardized scintigraphic examination. The parameters including half-emptying time ($T_{1/2}$) and antral maximal fraction (AMF) were determined to represent gastric emptying and intragastric food distribution, respectively. The upper abdominal symptoms were evaluated by Rome criteria and the associated symptoms severity score was obtained by using a standardized questionnaire prior to the scintigraphic examination. Statistical analysis was conducted by Students' t- and t'-test. The correlation between symptoms severity score and abnormal gastric motility parameters was analyzed by Pearson's correlation. Difference was considered to be significant when $P<0.05$. Results: A delayed gastric emptying (33%) and abnormal intragastric food distribution (29%) were highly prevalent in FD patients. However, only a small overlap existed between the two pathophysiologic disorders (7%). Upper abdominal symptoms scores were not significantly different between the patients with normal and delayed gastric emptying ($P>0.05$), but the scores of early satiation were significantly different between the patients with normal and abnormal intragastric food distribution ($P<0.05$), a positive correlation between early satiation severity score and AMF ($P<0.05$). Conclusion: Delayed gastric emptying and/or abnormal intragastric distribution existed in some patients with FD. The severity of dyspeptic symptoms was not associated with the delayed gastric emptying time, but the severity of early satiation was associated with impaired intragastric food distribution.

I. INTRODUCTION

Functional dyspepsia (FD), defined as 'the presence of symptoms thought to originate in the gastroduodenal region, in absence of any organic, systemic, or metabolic disease likely to explain the symptoms' [1], is one of the most prevalent functional gastrointestinal disorders. In the 2006 Rome III criteria [2], the FD symptoms were classified as epigastric pain, epigastric burning, postprandial fullness and early satiation.

At present, FD is a very popular disease with a high prevalence throughout the world, adversely affecting the life quality of the patients. It is also a heterogeneous disorder in daily clinical practice. The etiology and pathophysiology of the FD are poorly understood and likely to be multifactorial [3]. Previous investigations have shown that many factors such as gastric dysmotility, visceral hypersensitivity, H. pylori infection, spirit and psychological factors were involved in the pathophysiology of FD. In recent years, gastric motility abnormalities have been showed as pathophysiological features of FD. It has been reported that gastric motility abnormalities include delayed emptying, impaired adaptive relaxation, abnormal food distribution, inadequate postprandial fundus motility, abnormal electrical activity, etc. A wide variety of techniques such as barostat testing, gastric scintigraphy, $^{13}$C breath testing, transabdominal ultrasonography and electro-gastrography, have been used to assess such abnormalities. Among them, gastric scintigraphy has been considered as the gold standard test due to its noninvasion and high reliability [4].

A number of investigations have reported that delayed gastric emptying and abnormal intragastric food distribution are associated with a specific symptom pattern, namely relevant postprandial fullness, vomiting and satiation [5,6,7]. However, quite a lot of studies have failed to identify a characteristic symptom profile in patients with delayed or normal gastric emptying and abnormal or normal intragastric food distribution [8,9,10]. The relationship between the gastric dysmotility and the FD symptoms is a matter of controversy.

Therefore, the aim of the current study is to assess gastric emptying and intragastric food distribution and to investigate the relationship between dysmotility of gastric and severity of symptoms. The rest of the paper is organized as follows. The materials and methods are presented in Sect. II. The results are shown in Sect. III. Further discussion is given in Sect. IV and Sect. V concludes the article.

II. MATERIALS AND METHODS

A. Subjects

Fifty-five (35 women, 20 men) FD patients (age 44.1±6.7years, mean±SD, range 23-68years) and twenty-five (15 women, 10 men) healthy asymptomatic volunteers (age 43.0±6.8years, range 21-65years) were enrolled in this study. Patients came from outpatient clinics of the Department of Gastroenterology in our hospital and were diagnosed according to Rome criteria. Healthy volunteers were also recruited from the volunteers among our hospital staffs and students of Dalian Medical University, who have no clinical history of gastroduodenal disease including clinical symptoms of FD. They were included as controls.

All patients and volunteers were investigated by anamnesis, clinical examination, lab tests, upper gastrointestinal endoscopy, abdominal ultrasound scanning in order to exclude systemic diseases, metabolic disease, gastroesopha-
eal reflux disease, peptic ulceration, malignancy, pregnancy, gallstones and pancreatic disorders. Patients and volunteers with previous abdominal surgery were excluded from the study. In addition, patients and healthy volunteers were also excluded if they were taking medication known to affect gastrointestinal motility. No significant difference in age and sex distribution was observed between patients and controls. The protocol was approved by the Ethics Committee of the first Affiliated Hospital of Dalian Medical University. All participants gave written informed consent for inclusion in the trial.

B. Upper Abdominal Symptoms Score

Clinical symptoms of FD were evaluated according to Rome criteria and must include at least one of the following, bothersome postprandial fullness, early satiation, epigastric pain, or epigastric burning, which occurred for the last 3 months and the onset of symptoms occurred at least 6 months prior to diagnosis. Each patient completed a dyspepsia questionnaire. The intensity of four symptoms was scored on a Likert scale as previously reported and validated [9,11,12]. Severity was scored on a 0 to 5 scale, with 0=none, 1=very mild: awareness of symptoms but easily tolerated. 2=mild: tolerated without interference with usual activity. 3=moderate: enough to cause some interference with usual activity. 4=severe: enough to cause significant interference with usual activity. 5=very severe: incapacitating with inability to work or do usual activity. Patients were eligible if the total score was 3 or greater, or one symptom scored 2 or greater.

C. Assessment of Gastric Motility by Scintigraphy

Fifty-five FD patients and twenty-five healthy volunteers underwent a standardized scintigraphic examination to study gastric motility after overnight fasting. Gastric motility was evaluated after ingestion of a standardized test meal in 6 minutes consisting of 3 scrambled eggs (about 175 g ) labeled with 1.5mCi$^{99m}$Tc-EC and 300 ml 5% glucose liquid. The total caloric content of the meal was 420 kcal. Immediately after meal ingestion, the patient was told to lie in a supine position for anterior images (128×128 pixels). The total number of radioisotope counts in the abdominal cavity was recorded, this value was 100% of the food retained in the stomach at time 0. Radioactivity emitted by the radioisotope was measured by a gamma camera (GE Starcam 3200 XRT/1) with a medium-energy collimator, linked to an image processing system. The activity distributions of $^{99m}$Tc was recorded on the 140keV peaks with a 10% window. Images were taken for one minute each at 0, 5, 10, 15, 30, 45, 60, 75, 90, 105, and 120 minutes. In the intervals between image acquisition they sat comfortably in a chair or walked suitably near the camera. All images were stored on magnetic tape for analysis after completion of the study.

D. Data Analysis

Regions of interest (ROIs) were drawn around the total stomach, proximal and distal stomach (at the lowest point of small curve) at each time interval. After correction for decay, counts were input to the computer. From the time-activity curves, both gastric half-emptying time ($T_{1/2}$, namely the time taken for the total counts to fall by 50%) and distal maximal fraction(AMF, namely distal gastric maximal activity at any time during the study) were calculated.

E. Statistical Analysis

All data were presented as mean ± SD. Statistical analysis of gastric motility parameters, was by paired t-test between FD patients and healthy controls. Upper abdominal symptoms scores were compared between FD patients with normal or delayed gastric emptying or normal or abnormal intragastric food distribution, using t' test. The relationship between symptoms severity score and gastric emptying time or intragastric distribution variable was studied using a Pearson’s correlation. Statistical significance was accepted at a P value of less than 0.05.

III. RESULTS

A. Total Gastric Emptying and Intragastric Distribution

A delayed gastric emptying, namely prolonged $T_{1/2}$ with a normal intragastric distribution was found in 33%. Abnormal intragastric distribution, namely increased AMF with a normal gastric emptying was observed in 29% of patients. In 31% of all patients, neither motility disorders were found. Finally, only a small overlap existed between the two motility disorders (7% of patients) (Figure 1 (a), (b). Figure 2).

B. Relationship Between Severity of Dyspeptic Symptoms and Gastric motility

Cases of severity grading for each of four dyspeptic symptoms in 55 FD patients was shown in Table I. According to the $T_{1/2}$ and AMF, we divided the FD patients into two subgroups, normal- or delayed gastric emptying group and normal- or impaired intragastric food distribution group. And Table II displays each symptom scores in FD subgroups. Figure 3(a) shows the upper abdominal symptoms scores in FD patients with normal or delayed gastric emptying. No difference was observed in any of the upper abdominal symptoms severity score between these groups, neither did we find any correlation between symptom severity score and $T_{1/2}$ (all $P > 0.05$). Figure 3(b) shows the upper abdominal symptoms scores in FD patients with normal or impaired intragastric distribution. We found that the early satiation severity score in FD with impaired intragastric food distribution was significantly higher than those patients with normal intragastric food distribution ($P < 0.05$). There was a positive correlation between early satiation and AMF ($r=0.641, P < 0.05$, Figure 4). We did not find correlation between other three symptoms and AMF ($P > 0.05$).

IV. DISCUSSION

In order to better understand the symptoms of FD patients, the FD patients were examined using gastric scintigraphy. It was observed that 33% of FD patients had a delayed gastric emptying, and 29% of FD patients had impaired intragastric food distribution, which was in agreement with previous experimental results in the literature[7,9,13]. The relatively
Figure 1. Gastric emptying and AMF time-activity curve. Data points show group mean. $T_{1/2}$ and AMF were significantly different in patients and controls ($P < 0.05$).

Figure 2. Gastric dysmotility in FD patients. 33% of patients have a delayed gastric emptying and normal intragastric distribution, 29% of patients have an abnormal intragastric distribution and a normal gastric emptying, 31% of patients have neither motility disorders, and 7% of patients have both disorders.

Table I. Cases of severity grading of each of four symptoms in 60 FD patients

<table>
<thead>
<tr>
<th>Symptom</th>
<th>0(None)</th>
<th>1(Very mild)</th>
<th>2(Mild)</th>
<th>3(Moderate)</th>
<th>4(Severe)</th>
<th>5(Very severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postprandial fullness</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Early satiation</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Epigastric pain</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>12</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Epigastric burning</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>

Table II. Symptom scores subdivided according to the $T_{1/2}$ and AMF

<table>
<thead>
<tr>
<th>Symptom</th>
<th>$T_{1/2}$</th>
<th>AMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (n=33)</td>
<td>Delayed(n=22)</td>
<td>Normal(n=35)</td>
</tr>
<tr>
<td>Postprandial fullness</td>
<td>3.1±1.5</td>
<td>3.9±1.3</td>
</tr>
<tr>
<td>Early satiation</td>
<td>3.2±1.5</td>
<td>3.8±1.8</td>
</tr>
<tr>
<td>Epigastric pain</td>
<td>2.9±2.2</td>
<td>3.4±1.2</td>
</tr>
<tr>
<td>Epigastric burning</td>
<td>2.8±1.6</td>
<td>3.2±1.3</td>
</tr>
</tbody>
</table>

Note: data were presented as mean±SD. *$P < 0.05$ compared with normal intragastric food distribution.

Figure 3. Symptoms severity score in the different subgroups. Symptoms severity score in FD patients with normal and delayed gastric emptying (A) and normal and impaired intragastric food distribution (B). Only early satiation severity score in patients with normal and impaired intragastric distribution was significantly different ($P < 0.05$).
small overlap existed in both of the two motility disorders. 69% of these patients had evidence of impaired gastric motor function (either delayed gastric emptying or impaired intragastric food distribution, as shown in Figure 2), which indicated that dysfunction of gastric motility was a major pathophysiologic feature of FD.

Delayed gastric emptying is a common feature in FD. Investigation had been attempted to determine if factors other than a delayed gastric emptying time were involved in FD gastric dysmotility. In an earlier study, abnormal intragastric distribution of a radiolabeled meal in FD patients was found [10,14]. In the present study, both gastric emptying time and intragastric food distribution were simultaneously measured. Analysis of the intragastric food distribution of solids demonstrated abnormally increased antral maximal fraction (AMF) values. The presence of alterations suggested a disturbance of motor activity in the antral, as well as in the fundal region. 29% of FD patients had increased AMF with normal gastric emptying, which suggested that impaired intragastric distribution was another common abnormality of gastric motility in FD patients. Our findings support such opinion that scintigraphy can be used in analysis of the intragastric distribution of the test meal between the fundus and the antrum, which can be helpful in defining pathophysiology and in explaining dyspeptic symptoms, especially when gastric emptying time was normal [15,16].

Recently, FD has been subclassified into new disease categories under the Rome classification, epigastric pain syndrome (EPS) and postprandial distress syndrome (PDS). In Rome criteria, only four symptoms (bothersome postprandial fullness, early satiation, epigastric pain, or epigastric burning) were used to categorize patients. In order to elucidate the prevalence and severity of FD symptoms, the occurrence and severity of symptoms in 55 FD patients were quantified systematically. Although not every symptom occurred in all patients, all patients reported more than one symptom, most patients had moderate to very severe severity grading. Gastric half-emptying time is the most common parameter used to record the results of scintigraphic gastric motor function. However, there are not any difference in symptoms severity score between FD patients with delayed or normal gastric emptying time for solids. Our study also showed $T_{1/2}$ did not correlate with any of the symptoms. Data on the relationship between symptoms and gastric emptying provide inconsistent results. A weak correlation between them was reported by Talley et al. [17]. Others had reported a correlation between specific symptoms (such as fullness) with delayed emptying [5]. A recent research suggests that stomach fullness, bloating, and abdominal pain recorded during gastric emptying scintigraphy was higher in patients with delayed gastric emptying than in patients with normal gastric emptying [12]. A more recent study also reported a correlation between symptoms such as fullness, early satiation and delayed gastric emptying [18].

It was observed that the severity score of early satiation was significantly higher in patients with normal intragastric distribution than those patients with impaired intragastric distribution in our study. And there was a positive correlation between early satiation and AMF, but other three symptoms were not different. A previous study showed an association between symptoms of early satiety, abdominal distention and intragastric distribution [16]. At present, few studies have evaluated intragastric distribution and there have been fewer studies correlating symptoms to the parameters of intragastric distribution. As the recognition of its potential clinical significance is growing, it is necessary to assess intragastric food distribution, which may have a role in symptom production in some FD patients.

V. CONCLUSION

Delayed gastric emptying and/or abnormal intragastric distribution exist in some FD patients. The severity of dyspeptic symptoms are not associated with the delayed gastric emptying time, but the severity of early satiation is associated with impaired intragastric food distribution.

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REFERENCES


