岩手医科大学
審査学位論文
（博　士）

M Sato, *et al.*
www.hepato-gastroenterology.org
DOI 10.5754/hge11602
2012; 59(117): Ahead of print.

Hepato-Gastroenterology

GI, Original Open Access, Ahead of Print

Gastric Motility and Emptying in Cirrhotic Patients with Portal Hypersensitive Gastropathy

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KEY WORDS: Liver cirrhosis; Portal hypersensitive gastropathy; Gastric motility Gastric emptying.

ABBREVIATIONS: Portal Hypersensitive Gastropathy (PHG); Liver Cirrhosis (LC); Electrogastrography (EGG); Gastric Antral Vascular Ectasia (GAVE); Gastric Emptying (GE); Diabetes Mellitus (DM); Glycated Hemoglobin (Hb A1C).

ABSTRACT

Background/Aims: Our aim was to clarify gastric motility and emptying in LC patients with PHG. **Methodology:** A total of 30 LC patients (18 with mild gastropathy type, 12 with severe gastropathy type) with a mean age with 65.8 yr were enrolled and 17 healthy participants were recruited as the control group. Electrogastrography was performed to examine gastric motility in the fasting, nocturnal and 2 hr postprandial phase. Subsequently, patients with LC and control were performed to measure gastric emptying of solids with the breath test using 13C for labeling the octanoic acid. Breath samples were obtained every 15 to 30 minutes for 5 hours. **Results:** The mean frequency of the EGG while fasting with severe PHG was significantly increased compared to mild PHG (p<0.05). The mean frequency of the EGG at 1-hr and 2-hr postprandially with severe PHG was significantly increased compared to mild PHG. The half time of GE with both mild and severe PHG was significantly increased compared to controls. **Conclusions:** Postprandial EGG and GE in LC patients would be affected by PHG.

INTRODUCTION

Portal hypersensitive gastropathy (PHG) has been considered to be related to congestive or hyper dynamic blood flow in patients with liver cirrhosis (LC) (1) and it is divided into the degree of gastro endoscopic findings such as mild or severe (2,3). Severe PHG is associated with an increase in portal venous pressure gradient (1).

In patients with LC, abnormal gastric motility has been noted (4-6) and the power ratio of electrogastrography (EGG) was less in LC than in normal subjects and dysrhythmic EGG waveforms for LC were demonstrated (7). In LC, there is an abnormal antral motor response to a meal, which has a different pattern over time in patients with or without gastric antral vascular ectasia (GAVE) (8). Altered small bowel motility, a prolonged duration of the migrating motor complex was revealed, the frequency and amplitude of contraction was increased from grade A to C according to Child-Pugh classification. These findings might be related to a delayed small bowel transit time (9). A delayed small bowel transit has been related to bacterial overgrowth in LC (10,11). Then, a decrease in the amplitude of small bowel contractions was reported (12). Portal hypertension might be significantly related to small bowel abnormalities observed in patients with LC (13). Furthermore, esophageal motility in patients with LC but no endoscopic evidence of varices was no significant motility differences compared to healthy volunteers (14). However, LC patients presented esophageal motor disorders; mixed acid and bile reflux was the main pattern (15).

Gastric emptying (GE) time of a semisolid meal and a semi liquid meal was significantly prolonged in patients with LC compared to the control (5,7,16,17); then, GE of the liquid meal was accelerated in LC patients compared to controls (18). Furthermore, no significant difference in GE was observed between normal subjects and PHG patients (19). However, it is still unknown whether patients with LC on gastric motility and emptying are associated with the degree of PHG. Our aims of this study were to clarify gastric motility and emptying in LC patients with PHG.

METHODOLOGY

Patients

A total of 30 patients with LC were performed (16 of men, 14 of women; mean age

65.8), 17 healthy individuals without liver disease (8 of men, 9 of women; mean age 60.5) as the control group were precipitated to measure EGG. LC was diagnosed by biochemical examinations including fibrosis markers, imaging methods such as sonography and computer tomography and/or liver biopsy. The severity of liver dysfunction was according to the Child-Pugh classification (20). In patients with LC, the severity of liver dysfunction showed 14 in Child A, 11 in Child B and 5 in Child C. Nine patients with LC (6 of men, 3 of women; mean age 62.2) had complications with diabetes mellitus (DM). DM is diagnosed by 2010 WHO Diabetes criteria demonstrating any one of following: fasting plasma glucose level greater than 126mg/dL, plasma glucose level exceeding 200mg/dL two hours after a 75g oral glucose load as in a glucose tolerance test or glycated hemoglobin (HbA_{1C}) measurement above 6.1 %. Healthy individuals have no abdominal symptoms and without liver disease and DM. Clinical and laboratory characteristics in patients with LC were shown in **Table 1.**

The protocol of this trial was approved by the Human Ethics Review Committee of Iwate Medical University and informed consent was obtained from each patient.

Endoscopic definition of portal hypertensive gastropathy

Gastrointestinal endoscopy was performed by two skilled endoscopic physicians, each with at least 10 years experience in gastrointestinal endoscopy, evaluated PHG to avoid possible observer bias. Endoscopic signs were classified in the antrum and corpus of the stomach as follows: (a) mild PHG showing fine pink speckling, superficial reddening, snake skin patterns or all three and (b) severe PHG showing cherry-red spots, spontaneous bleeding or both. The reviewers determined 18 patients with mild PHG and 12 patients with severe PHG.

Experimental procedure for EGG

EGG studies were performed in the semi-reclining position and patients were requested to avoid any major movements. For recording of EGG waveforms using a polygraph (Nipro EG, Nipro, Osaka, Japan), 5 cutaneous electrodes were placed on the abdominal surface. Two active electrodes were attached to the upper abdomen at one-quarter of the distance from the xiphoid process to the umbilicus along the right and left midclavicular lines and two more active electrodes were attached to the upper abdomen at three-quarters of the distance from the xiphoid process. The fifth electrode (reference lead) was placed halfway between the xiphoid process and the umbilicus. The electrodes were connected to an EGG recording unit. After a 1 hour fasting study, the patients had a standard meal for dinner at 6:00p.m. (560kcal, 60% carbohydrate, 20% protein, 20% fat). This was immediately followed by postprandial recording for 2 hours. A nocturnal recording was also made for 1 hour after a fast of 6 hours or longer. EGG data were transferred to a DOS/V computer and the dominant frequency was calculated using running spectral analysis (21). The mean frequency of the EGG waves and the rate of normogastria were calculated during the fasting, nocturnal and 2 hour postprandial phases. Normogastria was defined as 2.4-3.6cpm, bradygastria as <2.3cpm and tachygastria as >3.7cpm.

Experimental procedure for GE

After an overnight fast, breath samples were taken at baseline before the meal, every 15 minutes for 3 hours and every 30 minutes for the following 2 hours. The test meal consisted of two egg whites and one yolk dosed with 100mg ^{13}C octanoic acid (Shoko-Tsusho Co., Tokyo, Japan). The egg meal was placed on a slice of whole wheat bread and given with a glass of skimmed milk for a total caloric value of 240kcal and nutrient composition of 35% protein, 40% carbohydrate, 25% fat and 2.6g fiber. Each breath sample was collected in a 25mL aliquot in the breath sample bag, then $^{13}CO_2$ was measured using an inferred mass spectrometer (Otsuka, UBit-IR 200). The results of the breath test were presented as a percentage of $^{13}CO_2$ recovery per hour and as a cumulative value over 5 hours to evaluate the influence of altering the duration of sampling on gastric emptying estimates; then the GE half-time ($t_{½}$) was calculated based on the method of Ghoos *et al.* (22).

Statistical analysis

In EGG study, statistical comparisons were performed with Student's *t*-test and a *p* value of less than 0.05 was considered statistically significant. In GE study, the estimated parameters by breath test assessment (*e.g.* $t_{½}$) were plotted, statistical comparisons were performed with Student's *t*-test and a *p* value of less than 0.05 was considered statistically significant. Data are presented as the mean ±SD.

RESULTS

Electrogastrography (EGG) study

The mean frequency of fasting and nocturnal EGG had no significant differences between LC patients and controls. The mean frequency of the EGG at 1 hour and 2 hours postprandially had also no significant differences between LC patients and controls. The rate of normogastria of the fasting and nocturnal EGG waves had no significant differences between LC patients and controls. Also, the normogastria EGG wave rate at 1 hour and 2 hours postprandially had no significant differences between LC patients and controls.

The mean frequency of the EGG while fasting with severe gastropathy was significantly increased compared to that with mild gastropathy ($p<0.05$). The nocturnal EGG wave rate had no significant differences among the grade of gastropathy. The mean frequency of the EGG at 1 hour and 2 hours postprandially with severe gastropathy was significantly increased compared to that with mild gastropathy ($p<0.05$) **(Table 2)**. The rate of normogastria of the fasting and nocturnal EGG waves had no significant differences among the grade of gastropathy. Also, the normogastria EGG wave rate at 1 hour and 2 hours postprandially had no significant differences among the grade of gastropathy **(Table 2)**.

The mean frequency of the fasting and nocturnal EGG waves had no significant differences among the grading of the Child classification. The mean frequency of the EGG at 1 hour postprandially with Child B was significantly increased compared to that with Child C ($p<0.05$). The 2 hour values wave had no significant differences among the grading of the Child classification **(Table 3)**. The rate of normogastria of the fasting and nocturnal EGG waves had no significant differences among the grading of the Child classification. The EGG wave rate at 1 hour and 2 hours postprandially had no significant differences among the grading of the Child classification **(Table 3)**.

In relationship with DM, the mean frequency of the fasting and nocturnal EGG waves had no significant differences between with and without DM. The EGG wave rate at 1 hour and 2 hours postprandially had no significant differences between with and without DM (**Table 4**). The rate of normogastria of the fasting and nocturnal EGG waves while fasting had no significant differences between with and without DM. The normogastria EGG wave rate at 1 hour and 2 hours postprandially had no significant differences between with and without DM (**Table 4**).

Gastric emptying (GE) study

The half time of GE with LC was indicated 191.1±48.1 minutes and control was 111.4±17.0 minutes. The half time of GE with LC was significantly increased compared to that with controls ($p<0.05$). The half time of GE with mild gastropathy and severe gastropathy was significantly increased compared to that with controls ($p<0.05$) (**Figure 1**). There were no significant differences between with mild and severe gastropathy. The half time of GE with Child A, B and C was significantly increased compared to that with controls ($p<0.05$) (**Figure 2**). There was no significant differences between Child A, B and C. The half time of GE with or without DM was significantly increased compared to that with controls ($p<0.05$) (**Figure 3**). There were no significant differences between with and without DM.

DISCUSSION

Gastric peristalses are associated with myoelectric phenomena termed slow waves and spike activity. Slow waves originate on the greater curvature near the orad, one third of the corpus where spontaneous depolarizations occur at a frequency of 3cpm in humans. EGG reflect gastric myoelectrical activity as it is recorded from the abdominal surface with electrodes placed on the skin (23,24). Increases in EGG frequency in that gastrointestinal tract following meals have been previously reported (25-27) and are known to be mediated *via* vagal mechanisms (28). For measuring gastric emptying, the nonradioactive breath test using the stable isotope ^{13}C octanoic acid has been reported (22).

A previous study demonstrated alterations in gastric emptying in alcoholic cirrhosis (6); we performed gastric motility and emptying in 76.6 % of HCV cirrhosis and only 16.6% of alcoholic cirrhosis was enrolled. Then, dysrhythmic EGG wave forms were observed in LC patients with severe PHG both in the fasting and postprandial state. The degree of PHG in LC would be influenced gastric motility. We also showed delay in gastric emptying in LC with liver cirrhosis both in mild and severe PHG. These are consistent with findings on abnormal gastric motility in LC (4,5). However, there was no relationship between the grade of PHG and gastric emptying. Gastric motility is mainly regulated by neural and hormonal factors; a high prevalence of autonomic nervous system dysfunction has been reported in LC (29). Serum secretin was elevated in LC and the higher the serum secretin, the more dysrhythmic were the EGG waveforms. However, secretin influencing gastric motility in LC has not been understood (7). Abnormalities of gastric motility with LC would be due to gastrointestinal peptides such as glucagons (30), cholecystokinin (31) or motilin (32). The reason is that metabolic abnormalities of these peptides have been reported in patients with LC (33,34). Postprandial hyperglycemia, hyperinsulinemia and hypoghrelinemia might be linked to delayed gut transit in LC (35).

PHG in patients with LC is recognized by mucosal or submucosal vascular dilatation without inflammation (3,36,37). The changes of gastric wall compliance or antral distensibility would be affected gastric motility and GE in portal hypertension (38). Autonomic neuropathy also occurs in LC patients which would be related to the alterations in vagal function as a result of gastric functions (39). Then, a prolongation of mouth-to-cecum transit of a solid meal in cirrhotic patients was shown (40,41). More experience is necessary to determine the correlation between the grade of PHG and gastric motility and emptying.

CONCLUSIONS

Here we have evaluated differences in gastric motility and emptying in patients with LC. Postprandial EGG and GE in LC patients would be affected by PHG. To elucidate the pathogenesis of gastric dysfunction in the grade of PHG further large number studies must be performed to measure gastric motility and emptying in LC patients.

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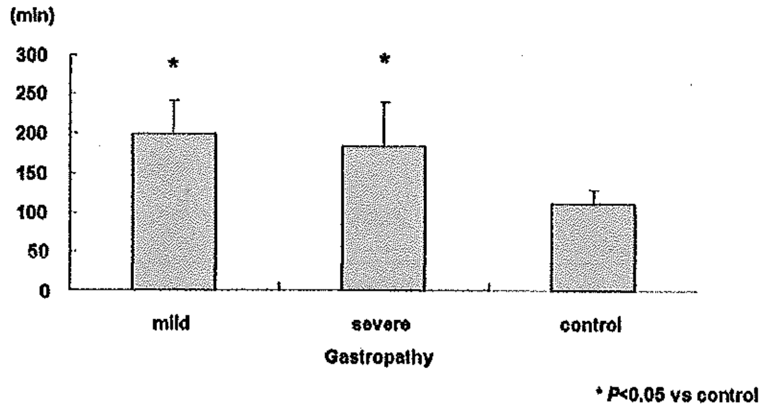

Figure 1

FIGURE 1. Gastric emptying with gastropathy. The half time of gastric emptying with mild gastropathy and severe gastropathy was significantly increased compared to that with controls ($p<0.05$).

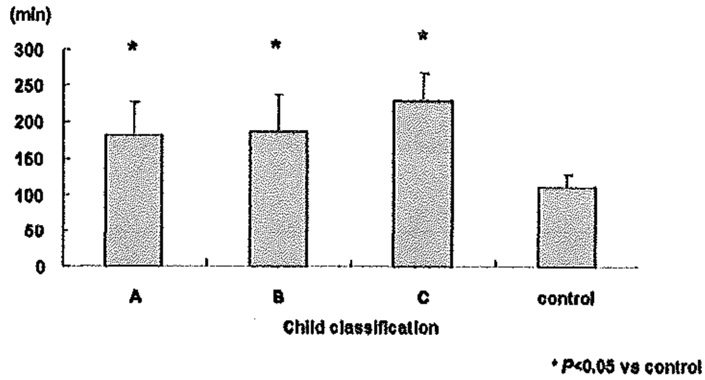

Figure 2

FIGURE 2. Gastric emptying with Child classified. The half time of gastric emptying with Child A, B and C was significantly increased compared to that with controls ($p<0.05$).

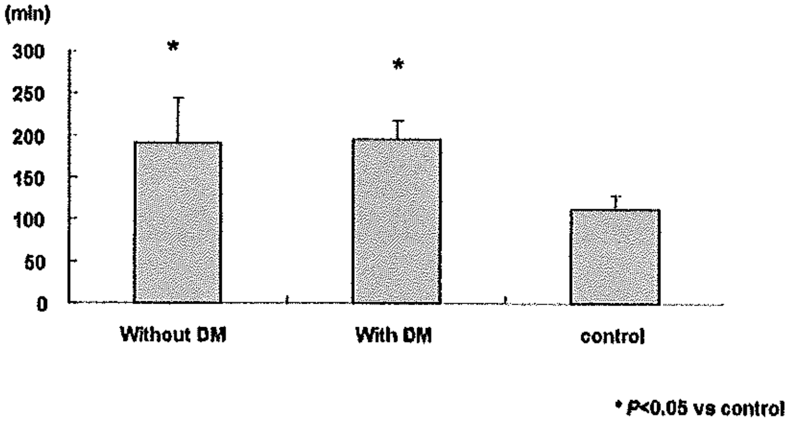

Figure 3

FIGURE 3. Gastric emptying with or without DM. The half time of gastric emptying with or without DM was significantly increased compared to that with controls ($p<0.05$).

TABLE 1. Clinical and laboratory characteristics of 30 patients with liver cirrhosis.

Male/Female (n)	16 / 14
Age (mean±SD) (years)	65.8±8.6
Etiology (n (%))	
HBV	0 (0)
HCV	23 (76.7)
Alcohol	5 (16.7)
Autoimmune	1 (3.3)
Cryptogenic	1 (3.3)
History of esophageal varices bleeding (n (%))	5 (16.7)
Form of esophageal varices (n (%))	
F1	20 (66.7)
F2	9 (30.0)
F3	1 (3.3)
Gastric varices (n (%))	3 (10.0)
Ascites (n (%))	18 (60.0)
History of hepatic encephalopathy (n (%))	6 (20)
Complication of diabetes mellitus (n (%))	12 (40.0)
Child-Pugh classification (n (%))	
A	14 (46.6)
B	11 (36.7)
C	5 (16.7)

TABLE 2. Frequency of the EGG and rate of normogastria with the grade of gastropathy.

EGG waves (cpm)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
Mild gastropathy	2.52±0.37	2.52±0.46	2.49±0.45	2.53±0.39
Severe gastropathy	2.87±0.37*	2.76±0.48	3.02±0.33*	2.91±0.39
Control	2.69±0.22	2.65±0.17	2.72±0.31	2.69±0.25

Rate of normogastria (%)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
Mild gastropathy	62.3±17.3	70.0±19.7	49.8±18.9	53.4±20.0
Severe gastropathy	69.7±16.0	72.6±13.9	69.9±14.9	69.3±16.2
Control	70.7±15.5	72.4±9.2	68.7±18.0	70.5±16.3

*$p<0.05$ *vs.* mild gastropathy

TABLE 3. Frequency of the EGG and rate of normogastria with Child classification.

EGG waves (cpm)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
Child A	2.61±0.35	2.71±0.46	2.64±0.41	2.61±0.41
Child B	2.59±0.43	2.46±0.52	2.56±0.51	2.63±0.49
Child C	2.94±0.42	2.70±0.43	3.19±0.29*	2.99±0.19
Control	2.69±0.22	2.65±0.17	2.72±0.31	2.69±0.25

Rate of normogastria (%)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
Child A	62.7±14.0	73.2±16.9	62.8±22.6	60.9±21.1
Child B	64.9±20.4	68.6±19.9	49.4±28.7	54.6±26.3
Child C	73.8±16.9	70.4±22.7	62.8±35.8	68.0±29.3
Control	70.7±15.5	72.4±9.2	68.7±18.0	70.5±16.3

*p<0.05 *vs.* Child B.

TABLE 4. Frequency of the EGG and rate of normogastria with or without DM.

EGG waves (cpm)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
LC without DM	2.67±0.39	2.52±0.50	2.76±0.43	2.67±0.43
LC with DM	2.62±0.45	2.84±0.31	2.57±0.58	2.70±0.43
Control	2.69±0.22	2.65±0.17	2.72±0.31	2.69±0.25

Rate of normogastria (%)	Fasting phase	Nocturnal phase	1-hr postprandial	2-hr postprandial
LC without DM	64.7±18.9	68.5±20.1	59.4±25.6	57.4±24.1
LC with DM	66.9±11.7	76.9±13.0	54.3±31.5	65.2±24.6
Control	70.7±15.5	72.4±9.2	68.7±18.0	70.5±16.3

n.s.