

Stimulating peristalsis improves esophagogastric junction observation during sedated esophagogastroduodenoscopy in children and adolescents

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Abstract

Background and study aims: Sedation impairs full visualization of the esophagogastric junction (EGJ) and Z line (the squamocolumnar junction) during esophagogastroduodenoscopy (EGD). The aim of this study was to determine whether induction of esophageal peristalsis could improve the ability to evaluate the Z line in children and adolescents.

Patients and methods: Study 1: Consecutive patients (10-15 years) undergoing EGD with propofol or midazolam sedation were enrolled. The proportion of Z line observed was compared between the two groups. Study 2: The effect of an air infusion near the EGJ following deflation of the stomach to induce esophageal peristalsis was investigated in the patients (15-18 years), undergoing EGD with propofol sedation. The proportion of Z line observed was compared between the stimulated group and control group.

Results: Study 1: 149 patients were evaluated; 87 received propofol (43 boys; average age 13.2 years (range, 10-15)) and 62 received midazolam (30 boys; average age 12.8 years (range, 10-15)). The proportion of the Z line visualized was low but was greater with propofol vs. midazolam sedation (36.8% vs 16.1%, $P=0.0059$). Study 2: 102 patients were evaluated; 62 had induction of peristalsis (34 boys; average age 16.2 years (range, 15-18)) and 40 controls (20 boys; average age 16.8 years (range, 15-18)). Complete visualization of the Z line achieved in 95% (59 of 62) following induction of peristalsis vs. 37.5% (15 of 40) of controls ($P<0.001$).

Conclusions: Induction of esophageal peristalsis greatly improved visualization of the Z line during sedated EGD in children and adolescents. (*Acta gastroenterol. belg.*, 2022, 85, 15-19).

Keywords: esophagogastroduodenoscopy, esophagogastric junction, Z line, sedation, peristalsis, children and adolescents.

Abbreviations: EGJ, esophagogastric junction, EGD, esophagogastroduodenoscopy.

Introduction

The prevalence and severity of gastroesophageal reflux disease (GERD) has increased significantly over the last 15 years even in Japanese children and adolescents (1) as well as in Japanese adults (2). As the incidence of Barrett's esophagus and esophageal adenocarcinoma has increased in Japan, thorough inspection of the esophagogastric junction (EGJ) has been increasingly emphasized (2). In addition, an irregular Z line which is characterized by < 1 cm columnar tongues that extend proximal to the EGJ has been paid much attention recently (3). This finding has been reported in approximately 10-15% of the population undergoing esophagogastroduodenoscopy (EGD). In those with an irregular Z line, there is up to a 44% prevalence of intestinal metaplasia (4). Although the increased awareness of GERD made adequate evaluation

of the EGJ and Z line (the squamocolumnar junction) at the time of EGD become more important, it is generally difficult to evaluate the EGJ and Z line especially in children and adolescents.

The importance of deep inspiration is emphasized in order to clearly observe the EGJ and Z line. However, sedation has a negative impact on evaluation of the EGJ because patient cooperation is impaired or lost (5,6). We recently developed a technique to induce peristalsis of the distal esophagus during sedation with propofol which allows improved observation of the EGJ and Z line during EGD. When administered to children by trained non-anesthesiologists, propofol sedation provides an excellent level of procedural success and fast recovery and maximal patient comfort without an increase in adverse events (7). However, midazolam is still widely used. The aim of this study was to retrospectively assess the effectiveness of the new technique to improve the EGJ and Z line observation during sedated EGD in children and adolescents.

Patients and Methods

Study design

This was a retrospective study. Both study 1 and study 2 were cross-sectional analyses of endoscopy results from a single center (Showa Inan General Hospital in Komagane, Japan). The Institutional Review Board of the hospital approved the retrospective chart review study protocol (No. 2019-08) on January 15, 2020. All subjects or their guardians had given written informed consent for the original procedures. The study was conducted in accordance with the Declaration of Helsinki. All authors had access to the study data, reviewed and approved the final manuscript.

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Patients

Study 1: Children between ages 10 and 15 who had undergone diagnostic EGD with either propofol or midazolam sedation at the Digestive Disease Center, Showa Inan General Hospital between January 2005 and September 2020 were consecutively enrolled. The indications for endoscopy were upper gastrointestinal symptoms including recurrent abdominal pain, vomiting, nausea, regurgitation, and dyspepsia, follow-up of known findings, anemia, and screening of abnormal school examination or systemic disease. Patients underwent endoscopy with both propofol and midazolam sedation were excluded. Patients with therapeutic endoscopy including foreign body removal, hemostasis, and percutaneous endoscopic gastrostomy or endoscope-guided duodenal tube placement were also excluded. Repeat EGD on already-included subjects was included but counted separately (n=29). Data regarding age, gender, weight, height, indication for EGD, EGD findings, comorbidity, and type of sedation were obtained from electronic medical records. Weight and height were used to calculate body mass index percentiles. Missing data on height and weight were supplemented with Japanese standard weight or height for age.

Study 2: Consecutive patients between the age of 15 and 18 years who had undergone diagnostic EGD with propofol sedation at the Digestive Disease Center, Showa Inan General Hospital between January 2018 and September 2020 were enrolled and categorized as to whether they received peristalsis induction of the EGJ region or not (controls). The esophageal peristalsis induction technique was performed by two endoscopists (AM, AH).

Procedures

All EGD examinations in this study were carried out without tracheal intubation and were performed by experienced endoscopists. The sedatives and their doses were determined by the endoscopists' discretion. All medications given during the procedure were recorded. EGDs were performed using either a small caliber or standard upper endoscope (GIF-XP 240, XP260, or H290; Olympus Optical Co. Ltd, Tokyo, Japan) with an endoscopic video information system (CV 240, CV260, or CV290, Olympus, Tokyo, Japan). The outer diameter of the instruments used is 7.7 mm, 6.5 mm, or 8.9 mm and the size of biopsy channels are 2.2 mm, 2.0 mm or 2.8mm, respectively. The endoscopic images were recorded by both computer image and text reporting system. All patients had cardiovascular monitoring and continuous oximeter measurement. Respiratory or cardiovascular complications were recorded by the nurse at the time of the procedure. When oxygen desaturation (SpO₂ <90%) continued more than 20 seconds, supplemental oxygen was given.

Technique to stimulate esophageal peristalsis

After the esophagus was examined, the stomach was entered and the gastric fluid was aspirated and then the stomach was deflated. The endoscope was then withdrawn into the lower part of the esophagus and the distal esophagus was distended with air to stimulate peristalsis. Peristalsis, when stimulated, greatly improved the ability to observe the EGJ and Z line. After observation of the EGJ, the stomach and duodenum were examined.

Definitions

The EGJ was defined as the distal end of the lower esophageal palisade vessels, and if this site could not be determined, it was defined as the extreme proximal end of the gastric mucosal folds. The Z line is the squamocolumnar junction. When the circumference of the Z line was visible entirely, it was defined as entire observation (Figure 1 left). When the circumference of the Z line was not visible entirely, it was defined as partial or poor observation (Figure 1 right).

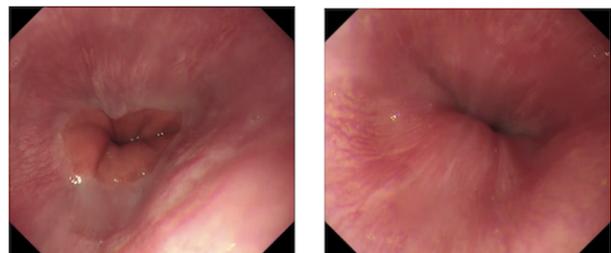


Figure 1. — Esophagogastric junction observed during sedated esophagogastroduodenoscopy. Left, when the circumference of the Z line was visible entirely, it was defined as entire observation. Right, when the circumference of the Z line was not visible entirely, it was defined as partial or poor observation.

Data collection and evaluation

The evaluation of the EGJ and Z line was retrospectively done using the endoscopic images by an investigator (IH) who did not perform EGD and were blinded to the categorized groups. The proportion of the Z line visualized was recorded because the investigator was able to recognize the Z line easier than EGJ in the endoscopic images.

Study 1: The proportion of the entire Z line was compared between patients who received propofol and midazolam sedation.

Study 2: The proportion of the entire Z line was compared between patients in which peristalsis was stimulated (stimulated group) and those not stimulated (control group).

Statistical analyses

Differences in the categorical variables were analyzed using Chi-square tests or, when appropriate, Fisher's exact test. The continuous data were expressed as the means ±

SD and were compared using Student's *t*-test. *P* values <0.05 were considered to indicate statistical significance. Statistical analysis was performed using GraphPad Prism (ver. 8 for Windows, GraphPad Software Inc.).

Results

Study 1

A total of 149 patients were evaluated including 87 with propofol sedation (43 boys; average age, 13.2 year (range, 10-15)) and 62 with midazolam sedation (30 boys; average age, 12.8 years (range, 10-15)). Fifty % (31/62) of patients receiving midazolam sedation also received pentazocine while mono-propofol sedation was performed in the propofol sedation group. There were no significant differences in baseline characteristics and clinical features among the groups (Table 1). The

major indications for EGD were the presence of upper gastrointestinal symptoms and/or follow-up of known findings. The major endoscopic findings were chronic gastritis, peptic ulcer and reflux esophagitis. No patients had a hiatal hernia.

The ability to entirely observe the Z line was significantly greater among those receiving propofol sedation compared to those receiving midazolam sedation (36.8% vs. 16.1%, *P*=0.0059) (Table 2).

Study 2

A total of 102 patients were evaluated; 62 with esophageal peristalsis stimulation (34 boys; average age, 16.2 years (range, 15-18)) and 40 from control group (20 boys; average age, 16.8 years (range, 15-18)). There were no significant differences in baseline characteristics and clinical features between the two groups (Table 3).

Table 1. — **Baseline characteristics and clinical features of patients enrolled in study 1**

	Propofol (n=87)	Midazolam (n=62)	<i>P</i> value
Demographics			
Average age, year (range)	13.2 ± 1.4 (10-15)	12.8 ± 1.4 (10-15)	0.0563
Gender, boy	43 (49.4%)	30 (48.4%)	>0.9999
Average weight, kg (range)	48.0 ± 10.8 (25.8-80.2)	45.3 ± 11.5 (25.8-78.0)	0.1474
Average height, cm (range)	156.7 ± 9.0 (135.3-175.2)	154.1 ± 9.4 (136.2-175.6)	0.0935
Average BMI, kg/m ² (range)	19.4 ± 3.1 (13.7-27.8)	18.8 ± 3.3 (13.5-26.8)	0.3215
Indications, N (%)			0.3517
Upper GI symptoms	62 (71.3)	45 (72.6)	
Follow-up	21 (24.1)	11 (17.7)	
Anemia	1 (1.2)	6 (9.7)	
Screening	3 (3.4)	0 (0.0)	
Endoscopic findings, N (%)			
Chronic gastritis	16 (18.4)	18 (29.0)	0.1656
Peptic ulcer	13 (14.9)	3 (4.8)	0.0615
Reflux esophagitis	6 (6.9)	10 (16.1)	0.1058
Hiatal hernia	0 (0.0)	0 (0.0)	
Gastric polyp	3 (3.5)	0 (0.0)	0.2662
Comorbidity, N (%)			
<i>H. pylori</i> infection	10 (11.5)	14 (22.6)	0.0758
Eosinophilic gastrointestinal disorders	8 (9.2)	4 (6.5)	0.7616
Inflammatory bowel disease	0 (0.0)	2 (3.2)	0.1715

BMI, body mass index; GI, gastrointestinal

Table 2. — **Evaluation of Z line (the squamocolumnar junction) during sedated esophagogastroduodenoscopy in Study 1**

Z line evaluation	Propofol (n=87)	Midazolam (n=62)	<i>P</i> value
Entire observation	32 (36.8%)	10 (16.1%)	0.0059
Partial or poor observation	55 (63.2%)	52 (83.9%)	

All received propofol sedation. The major endoscopic findings were reflux esophagitis, chronic gastritis, and peptic ulcer. No patients had an esophageal hiatal hernia.

Entire observation of the Z line was achieved in 59 (95%) of 62 patients who received the esophageal

peristalsis stimulation versus 15 (37.5%) of 40 in the unstimulated group (*P*<0.001) (Table 4).

No sedation-related adverse events such as hypoxia, hypotension or arrhythmias occurred in either study.

Discussion

Sedation during EGD is recognized to have a negative effect on evaluation of the EGJ (5,6). This study showed that the ability to evaluate the EGJ and Z line is in part related to the type of sedation used and is greater when sedation was achieved with propofol than with midazolam (36.8% vs 16.1%, *P*=0.0059) (Table 2).

Table 3. — Baseline characteristics and clinical features of 102 patients enrolled in study 2

	Peristalsis-inducing technique (+) (N=62)	Peristalsis-inducing technique (-) (N=40)	P value
Demographics			
Average age (range), year	16.2±3.0 (15-18)	16.8±2.8 (15-18)	0.53
Gender (male)	34 (55%)	20 (50%)	0.63
<i>H. pylori</i> -infected	4 (6.5%)	3 (7.5%)	0.84
Indications, N (%)			
Upper GI symptoms	62 (100)	40 (100)	
Endoscopic findings, N (%)			
Esophageal hiatal hernia	0	0	
Reflux esophagitis	8 (13)	4 (10)	0.66
Chronic gastritis	3 (48)	2 (5)	0.97
Gastric or duodenal ulcer	1 (1.6)	1 (2.5)	0.75

GI, gastrointestinal

Table 4. — Evaluation of Z line (the squamocolumnar junction) with or without peristalsis-inducing technique during esophagogastroduodenoscopy with propofol sedation in Study 2

Z line evaluation	Peristalsis-inducing technique (+) (N=62)	Peristalsis-inducing technique (-) (N=40)	P value
Entire observation	59 (95%)	15 (37.5%)	<0.001
Partial or poor observation	3 (5%)	25 (62.5%)	

Despite this improvement, the overall proportion with full visualization of the Z line was low. However, induction of peristalsis of the distal esophagus dramatically improved the ability to achieve complete observation of the Z line during EGD under propofol sedation (95% vs. 37.5% of controls, $P<0.001$) (Table 4). These data are consistent with data showing that propofol showed no depression on gastrointestinal motility for 15 minutes after administration in mice (8). In addition, propofol sedation inhibited gastric peristalsis less than dexmedetomidine in endoscopic submucosal dissection (9).

The effect of induction of peristalsis was only studied under propofol sedation and whether a similar benefit with midazolam sedation occurred was not examined. The mechanism of association between sedatives and EGJ exposure is unclear. Previous reports have discussed that the dominant extent of EGJ exposure in the resting state was determined by the pinchcock function of the diaphragmatic crura on the lower esophagus and the tone of the lower esophageal sphincter (5,6). We speculate the most important factor for the EGJ exposure is whether the patients can perform a deep inspiration. According to Berridge *et al.*, the cardia is not usually located in the same place as the esophageal hiatus, but slightly on the anal side. When the diaphragm moves down by deep inspiration, the abdominal esophagus becomes very short, such that the cardia and the esophageal hiatus are located on the same level (10). In this condition the EGJ and Z line can be entirely observed endoscopically (11,12). In this study the esophageal peristalsis stimulation substituted for inability to perform deep inspiration under sedation, allowing the entire observation of the EGJ and Z line during sedated EGD.

This study has some limitations. It was retrospective and it is not possible to eliminate the influence of the

patients' background or any confounding factors. During the period covered by this study, the technical abilities of the endoscopes have improved and it is not possible to correct for possible different inspection techniques or other pre-existing bias of the endoscopists. The underlying mechanism for the esophageal peristalsis stimulation using insufflation following deflation of the stomach was not clarified in this study. However, the evaluation method used in study 2 was simple because the proportion of the entire Z line visualized instead of the EGJ was compared between the stimulated group and control group. In addition, as the investigator (IH) was completely blinded to the clinical history of the patients and the method of Z line observation used in the two groups, the results of study 2 would be reliable.

In conclusion, during both propofol or midazolam sedation, the proportion in whom the entire EGJ and Z line could be examined was low during sedated EGD in children. However, using air inflation following deflation of the stomach to induce peristalsis of the EGJ region overcame the negative effect of sedation allowing a full evaluation of the Z line during sedated EGD in children and adolescents. Based on the results of this study 2, we routinely observe the entire Z line using the esophageal peristalsis stimulation procedure in EGD. Further prospective or randomized trials to support these findings are warranted.

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Conflicts of interest

The authors declare no conflicts of interest for this article.

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