A prospective analysis of GERD after POEM on anterior myotomy

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Abstract

Background Peroral endoscopic myotomy (POEM) is an emerging, minimally invasive procedure capable of overcoming limitations of achalasia treatments, but gastroesophageal reflux disease (GERD) after POEM is of concern and its risk factors have not been evaluated. This prospective study examined GERD and the association of POEM with reflux esophagitis.

Methods Achalasia patients were recruited from a single center. The pre- and postoperative assessments included Eckardt scores, manometry, endoscopy, and pH monitoring.

Results Between September 2011 and November 2014, 105 patients underwent POEM; 70 patients were followed up 3 months after POEM. Postoperatively, significant reductions were observed in lower esophageal sphincter (LES) pressure [from 40.0 ± 22.8 to 20.7 ± 14.0 mmHg (P < 0.05)], LES residual pressure [from 22.1 ± 13.3 to 11.4 ± 6.6 mmHg (P < 0.05)], and Eckardt scores [from 5.7 ± 2.5 to 0.7 ± 0.8 (P < 0.05)]. Symptomatic GERD and moderate reflux esophagitis developed in 5 and 11 patients (grade B, n = 8; grade C, n = 3), respectively, and were well controlled with proton pump inhibitors. Univariate logistic regression analysis revealed integrated relaxation pressure was a predictor of ≥grade B reflux esophagitis. No POEM factors were found to be associated with reflux esophagitis.

Conclusion POEM is effective and safe in treating achalasia, with no occurrence of clinically significant refractory GERD. Myotomy during POEM, especially of the gastric side, was not associated with ≥grade B (requiring medical intervention) reflux esophagitis. Extended gastric myotomy (2–3 cm) during POEM is recommended to improve outcomes.

Keywords Achalasia · GERD · POEM

Achalasia, a rare functional motility disorder of the esophagus, is characterized by incomplete lower esophageal sphincter (LES) relaxation, increased LES tone, and aperistalsis of the esophagus [1].

Clinical symptoms of achalasia include dysphagia, regurgitation, and chest pain. Decreasing the pressure at the LES is the only valid therapeutic approach to eliminate or reduce these symptoms, and endoscopic procedures (balloon dilations and botulinum toxin injection therapy) and surgery were the available treatments until peroral endoscopic myotomy (POEM) [2–15].

Balloon dilations and botulinum toxin injections are less invasive than surgery, but do not reliably produce consistent effects. However, surgery is superior to other therapeutic methods in that it has a curative effect with consistent outcomes, and the Heller myotomy with Dor fundoplication is the most popular technique [7, 16, 17].

Initially, fundoplication was not performed when Heller reported this procedure in early 1900 [18]. Achalasia patients were freed from the symptoms on treatment with Heller myotomy, but the high incidence of gastroesophageal reflux (GER) became evident over time [7].

Notes

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Therefore, Heller myotomy with fundoplication became popular. POEM is a revolutionary therapy for achalasia that was reported in 2008 by Inoue et al. [19]. POEM uses peroral endoscopy to incise the LES and its inner circular muscle; therefore, it is referred to as a “Heller myotomy that does not cut the body surface.” Because POEM is an esophageal myotomy, similar to the Heller myotomy, gastroesophageal reflux disease (GERD) after POEM is a major outcome that should be examined in the clinical setting.

There exist several papers reporting that GERD after POEM is not a problem clinically [19–23]. However, risk factors for GERD after POEM have not been reported or studied. This study aimed to examine GERD after POEM and to investigate whether POEM (especially myotomy of the gastric side) is associated with reflux esophagitis (>grade B, LA classification) that requires medical treatment clinically.

Methods

Patients

The data for our single-center POEM procedures were collected prospectively. The use of the POEM procedure was approved by the Institutional Review Board (IRB) of Fukuoka University Hospital, and written informed consent was obtained from all patients prior to enrollment in the study. The inclusion criterion was a confirmed diagnosis of achalasia.

Patients with previous history of fundoplication and those on proton pump inhibitors (PPI) due to anticoagulant therapy were excluded, as were patients who had undergone posterior myotomy.

Investigations before and after POEM

Pre- and postoperative symptoms were quantified with Eckardt scores [24]. Patients were weighed, and tests (manometry, endoscopy, barium swallow, and computed tomography [CT]) were performed preoperatively. Three months after POEM, manometry and endoscopy were performed to evaluate the effectiveness of POEM and determine the presence and extent of postsurgical reflux esophagitis. In addition, gastroesophageal reflux was also evaluated 3 months postoperatively by 24-h pH monitoring using the ZepHe® Impedance/pH Reflux Monitoring System (Sandhill Scientific, USA).

Preparation before POEM

Patients were hospitalized 1 day before the POEM procedure so that esophagogastroduodenoscopy (EGD) could be performed to ensure all food remnants were removed from the esophagus prior to surgery.

Equipment used for POEM

A forward-viewing endoscope with an outer diameter of 9.8 mm (GIF-H260, Olympus Medical Systems, Japan), which is routinely employed for upper gastrointestinal (GI) examinations, was used with a short ST hood (DH-28GR, Fujifilm, Japan). A triangle-tip knife (KD-640L, Olympus) was used to create the submucosal tunnel as well as to divide circular muscle bundles. Coagulating forceps (FD-411QR Coagrasper, Olympus) were used to close larger vessels prior to dissection and for hemostasis. Carbon dioxide gas was used for insufflation during the procedure with a CO2 insufflator (UCR, Olympus). For electrosurgery, the VIO 300D electrogenerator (ERBE, Tübingen, Germany) was used. Finally, hemostatic clips (HX-610-90L EZ Clip and HX-610-90S EZ Clip Olympus) were applied for closure of the mucosal entry site.

The POEM procedure

The first case was performed by Haruhiro Inoue, who pioneered the POEM technique for clinical practice, and the next ten cases were operated upon under his supervision and as described by Inoue et al. [19]. After injection of approximately 10 mL of glycerol mixed with 0.3 % indigo carmine into the submucosal layer, a longitudinal mucosal incision was made in the mucosal surface to access the submucosal space. A submucosal tunnel was created in the one to two o’clock position on the ventral aspect of the esophagus to preserve the angle of His, and was then extended past the esophagogastric junction (EGJ) for 2–3 cm onto the gastric cardia. A proximal-to-distal circular myotomy was performed with care to preserve the longitudinal muscle layers of the esophagus and stomach. Preservation of the longitudinal muscle sheet potentially avoids unnecessary injury to the structures adjacent to the esophagus.

The secure incision of the LES was identified by the following points:

- length from incisor teeth to EGJ as a reference position for the scope
- narrowing of the esophageal lumen closer to the LES and then opening wide in the stomach when creating a submucosal tunnel
- change from palisade vessels (anatomically equivalent to the LES) to increased irregularity and augmentation of the vessels underlying the mucosa as viewed from the submucosal tunnel
- smooth endoscope passage through the LES inside the true esophageal lumen and mucosa of stomach is seen from the esophageal lumen after the myotomy
the branch of the left gastric artery and oblique muscle in the submucosal tunnel of the gastric side (sometimes, this cannot be confirmed)

After spraying an antibiotic (80 mg gentamycin) into the tunnel, the mucosal entry was closed using endoscopic clips.

Postprocedural management

Intravenous antibiotics were administered for 3 days after the procedure. On the first day after surgery, an endoscopy was performed to confirm mucosal integrity, as was barium swallow to confirm the smooth passage of contrast media into the stomach without leakage or stasis. A liquid diet was started on the day after surgery, followed by soft diet on day 2 post-POEM, with resumption of a normal diet on day 3 post-POEM. On discharge, patients were prescribed a PPI for 1 month and, thereafter, asked to discontinue the PPI until the postoperative examination.

Estimation of GERD

GERD was evaluated on the basis of symptoms and endoscopic findings, together with 24-h pH monitoring 3 months after POEM [25–28].

Because reflux esophagitis (>grade B, LA classification) requires medical treatment, it was analyzed statistically. A PPI was prescribed for patients diagnosed with symptomatic GERD or reflux esophagitis (>grade B, LA classification); these patients were re-evaluated another 3 months later by elicitation of symptoms during examination and an upper GI endoscopy.

Statistical analysis

Pre- versus postoperative assessment of Eckardt score, LES pressure, and LES residual pressure was analyzed using Student’s t test for paired samples. P value <0.05 was considered statistically significant. Continuous data are reported as the mean ± standard deviation (SD) if they are normally distributed, and as the medians and interquartile ranges (IQRs) if their distribution was not normal. Categorical data are presented as numbers (n) and percentages (%). A logistic regression analysis was used to assess independent contributions of the variables to reflux esophagitis, and the results are presented as odds ratios (ORs) and 95 % CIs. A P value <0.05 was considered to be statistically significant.

All statistical analyses were performed using the SPSS v 21.0 software program for Windows (SPSS, Chicago, Illinois, USA).

Results

Patient background

POEM was carried out in 105 patients between September 2011 and November 2014. A questionnaire assessment, endoscopy of the upper GI tract, and 24-h pH monitoring were done for 70 cases at 3 months or later after the POEM (Table 1). Based on the endoscopic findings, reflux esophagitis (LA classification) grades A, B, and C occurred in 31, 8, and 3 patients, respectively. No grade D severe reflux esophagitis was reported (Fig. 1). Patient demographics, stratified by the presence or absence of reflux esophagitis (grade B, LA classification), are described in Table 2.

Of the 70 patients, including 29 men and 41 women, with achalasia, the average age was 48.8 ± 18.8 (range 17–86) years. Fourteen patients had undergone balloon dilation prior to inclusion in this study. No severe complications were reported.

No > grade III adverse events (as per the Clavien–Dindo classification) were reported during this study [29]. Mucosal injury occurred in four cases, all of which were treated by conservative therapy.

The mean preoperative and postoperative LES pressures were 40.0 ± 22.8 and 20.7 ± 14.0 mmHg, respectively, indicating a statistically significant decrease after POEM. The mean preoperative and postoperative LES residual pressures were 22.1 ± 13.3 and 11.4 ± 6.6 mmHg. Furthermore, the Eckardt score significantly decreased from 5.7 ± 2.5 preoperatively to 0.7 ± 0.8 postoperatively (Fig. 2).

Incidence of reflux esophagitis after POEM

Postoperative endoscopic findings led to the classification of 44 % (31/70), 12 % (8/70), and 4 % (3/70) of patients as having grades A, B, and C reflux esophagitis, respectively, as per the LA classification (Fig. 1). Data for these patients are incomplete because three patients refused to undergo 24-h pH monitoring; however, analysis of data from patients who underwent 24-h pH monitoring revealed a positive correlation (correlation coefficient = 0.489; Fig. 3) between pH and endoscopy parameters. Five
patients were diagnosed with symptomatic GERD (4 with a grade A and 1 with a grade B LA classification). Treatment with PPI in patients with reflux esophagitis and symptomatic GERD resulted in an improvement.

Analysis of the factors predicting the development of reflux esophagitis

A univariate logistic regression analysis was performed on the factors shown in Table 3 to identify the factors that could predict the development of reflux esophagitis of greater than grade B severity (LA classification). We found that IRP was significantly affected the development of reflux esophagitis of grade B or higher severity.

POEM-related variables, such as the length of the myotomy, did not show a significant correlation with postoperative reflux esophagitis of grade B or higher severity.

Discussion

In recent years, POEM has been increasingly performed for the treatment of achalasia and related disorders [30–33]. POEM is less invasive and has a higher curative rate compared with conventional therapeutic methods; therefore, POEM is expected to become the standard treatment, worldwide, for esophageal motor dysfunction, including achalasia, in the near future. However, there are limited studies comparing POEM with conventional therapeutic methods, and one of the factors that needs evaluation is GERD after POEM.

During Heller myotomy (laparotomy), the adjacent structures surrounding the distal esophagus (e.g., the phrenoesophageal ligament) are inevitably dissected circumferentially, and the esophagus is pulled to the side of the abdominal cavity to perform a myotomy on the esophagus. This procedure is linked to an impairment of the natural antireflux mechanisms and causes postoperative refractory reflux esophagitis. Therefore, the Heller myotomy requires fundoplication to prevent reflux.

### Table 1 Patient demographics and perioperative characteristics

| Age [years, mean ± SD (range)] | 48.8 ± 18.8 (17–86) |
|-------------------------------|---------------------|
| Sex                           |                     |
| Men                           | 41                  |
| Women                         | 29                  |
| Type of achalasia             |                     |
| Straight type                 | 64                  |
| Sigmoid type                  | 6                   |
| Chicago classification        |                     |
| Type I                        | 6                   |
| Type II                       | 55                  |
| Type III                      | 9                   |
| Primary procedure, n          | 14                  |
| Balloon dilatation            | 14                  |
| Length of procedure (range), minutes | 148.6 ± 45.9 (75–345) |
| Myotomy length, mean (range), cm |                     |
| Total                         | 12.6 ± 4.3 (5–26)   |
| Esophageal                    | 10.0 ± 4.0 (3–23)   |
| Gastric                       | 2.6 ± 1.0 (1–5)     |
| Postoperative stay, mean ± SD (range), days | 7.3 ± 2.5 (3–21) |

SD standard deviation
Table 2 Patient demographics stratified by the presence or absence of reflux esophagitis ≥ grade B

|                                | N  | GERD grade N/A | n  | GERD grade B/C |
|--------------------------------|----|----------------|----|----------------|
| **Before POEM**                |    |                |    |               |
| Sex (M/F)                      | 59 | (25/34)        | 11 | (4/7)          |
| Age (years)                    | 59 | 48.2 ± 19.1    | 11 | 51.7 ± 17.8    |
|                               |    | 43.0 (33.0, 62.0) |   | 51.0 (40.0, 66.0) |
| BMI (before POEM; kg/m²)       | 59 | 20.6 ± 3.27    | 11 | 21.1 ± 3.6     |
|                               |    | 19.9 (18.4, 22.9) |   | 20.8 (18.5, 22.5) |
| Degree of dilatation           |    |                |    |               |
| I                              | 33 |                | 6  |               |
| II                             | 24 |                | 5  |               |
| III                            | 2  |                | 0  |               |
| Type                           |    |                |    |               |
| Straight                       | 53 |                | 11 |               |
| Sigmoid                        | 6  |                | 0  |               |
| Chicago classification         |    |                |    |               |
| Type I                         | 4  |                | 2  |               |
| Type II                        | 48 |                | 7  |               |
| Type III                       | 7  |                | 2  |               |
| Primary procedure              |    |                |    |               |
| None                           | 48 |                | 8  |               |
| Balloon dilatation             | 11 |                | 3  |               |
| Hiatal hernia                  |    |                |    |               |
| None                           | 58 |                | 10 |               |
| Present                        | 1  |                | 1  |               |
| Eckardt score                  | 59 | 5.7 ± 2.4      | 11 | 5.6 ± 3.2     |
|                               |    | 6.0 (3.0, 7.0) |    | 5.0 (3.0, 9.0) |
| Mean LES pressure              | 53 | 40.7 ± 23.7    | 8  | 35.3 ± 15.8   |
|                               |    | 38.4 (22.8, 53.4) |   | 43.0 (20.7, 46.8) |
| LES residual pressure          | 47 | 22.6 ± 13.1    | 8  | 19.0 ± 14.9   |
|                               |    | 21.2 (12.7, 29.7) |   | 13.5 (6.9, 35.3) |
| IRP                            | 47 | 35.1 ± 14.7    | 8  | 32.5 ± 23.6   |
|                               |    | 34.0 (23.0, 45.0) |   | 21.00 (18.3, 52.3) |
| **Perioperative details**      |    |                |    |               |
| Length of procedure            | 59 | 148.7 ± 49.6   | 11 | 148.2 ± 17.4  |
|                               |    | 140.0 (120.0, 165.0) |   | 150.0 (130.0, 160.0) |
| Length of myotomy: total       | 59 | 12.3 ± 4.3     | 11 | 13.7 ± 4.1    |
|                               |    | 13.0 (9.0, 15.0) |    | 13.0 (10.0, 17.0) |
| Length of myotomy: esophageal  | 59 | 9.8 ± 4.0      | 11 | 11.2 ± 3.6    |
|                               |    | 10.0 (7.0, 12.0) |    | 12.0 (8.0, 14.0) |
| Length of myotomy: gastric     | 59 | 2.6 ± 1.1      | 11 | 2.5 ± 1.0     |
|                               |    | 3.0 (2.0, 3.0)  |    | 3.0 (2.0, 3.0)  |
| Postoperative stay, days       | 59 | 7.2 ± 2.5      | 11 | 7.9 ± 2.3     |
|                               |    | 7.0 (6.00, 7.00) |   | 7.0 (6.0, 9.0)  |
| Mucosal injury (yes/no)         | 4/55| 0/11           |    |               |
| **3 months after POEM**        |    |                |    |               |
| BMI (kg/m²)                    | 59 | 21.7 ± 3.2     | 11 | 21.9 ± 3.6    |
|                               |    | 21.4 (19.7, 23.5) |   | 20.6 (18.9, 25.4) |
| Eckardt score                  | 59 | 0.7 ± 0.86     | 11 | 0.7 ± 0.8     |
|                               |    | 0.00 (0.00, 1.00) |   | 1.00 (0.0, 1.0) |
However, POEM is known to have a curative effect, similar to the Heller myotomy. Additional fundoplication is not performed in POEM. Therefore, when POEM was first introduced, the development of GERD was also a concern. However, 6 years since the initial application of POEM, there have been no reports of the occurrence of GERD requiring surgical intervention with fundoplication.

Treatment of GERD focuses on controlling its symptoms and preventing the complications of reflux esophagitis. According to the frequency of reflux esophagitis in the postoperative endoscopic observations undertaken in this study, 84 % of the patients were classified as grade N or A, with 12 % in grade B, and 4 % in grade C; not only endoscopy, but also 24-h pH monitoring were performed to evaluate GER and there was a positive correlation between the observations from endoscopy and pH monitoring (correlation coefficient = 0.489). The total percent of time pH that was <4 was 13 % (9/70). These results indicate a slightly higher incidence of postoperative GER than that observed after Heller myotomy with fundoplication and a lower incidence than that after Heller myotomy without fundoplication [7].

Furthermore, both reflux esophagitis and symptomatic GERD were well controlled with PPIs for 3 months, clinically.

Despite the same myotomy as the Heller myotomy, why is it that GERD after POEM does not become a problem clinically? Preservation of the phrenoesophageal ligament is believed to hold the key to the development of postoperative GERD. Simić et al. [34] reported that preservation of the phrenoesophageal ligament during Heller myotomy can suppress the development of GERD, regardless of whether fundoplication is performed.

Antireflux mechanisms involve the inner circular muscles, oblique muscle, crus of diaphragm, and the phrenoesophageal ligament [35]. The role of the

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Table 2 continued

|                           | N  | GERD grade N/A | n  | GERD grade B/C |
|---------------------------|----|----------------|----|----------------|
| Mean LES pressure         | 49 | 20.8 ± 14.3    | 9  | 20.4 ± 13.1    |
|                           |    | 19.5 (13.7, 24.9) |   | 18.7 (7.3, 31.9) |
| LES residual pressure     | 38 | 12.0 ± 6.2     | 9  | 8.6 ± 8.1      |
|                           |    | 12.5 (7.8, 15.6) |   | 7.7 (0.8, 17.2) |
| IRP                       | 44 | 16.3 ± 7.4     | 8  | 9.5 ± 4.8      |
|                           |    | 15.0 (12.0, 19.8) |   | 8.0 (6.3, 11.0) |

BMI body mass index, GERD gastroesophageal reflux disease, IRP integrated relaxation pressure, LES lower esophageal sphincter, POEM peroral endoscopic myotomy, SD standard deviation

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**Fig. 2 A–C** The mean preoperative and postoperative LES pressures are 40.0 ± 22.8 and 20.7 ± 14.0 mmHg, respectively, indicating a statistically significant decrease after POEM. The mean preoperative and postoperative LES residual pressures are 22.1 ± 13.3 and 11.4 ± 6.6 mmHg. The Eckardt score significantly decreased from 5.7 ± 2.5 preoperatively to 0.7 ± 0.8 postoperatively.

**Fig. 3** Relationship between endoscopic findings of reflux esophagitis and result of 24-h pH monitoring. The correlation between the results of 24-h pH monitoring and endoscopy is nearly positive (correlation coefficient = 0.489).
phrenoesophageal ligament is to maintain them in the appropriate location anatomically. Therefore, myotomy with complete dissection of the phrenoesophageal ligament causes anatomic slippage and, as a result, postoperative GER is likely to occur.

In contrast, myotomy preserving the phrenoesophageal ligament obtains better reflux control. This theory is the same in POEM. POEM involves division of the inner circular muscles from the esophageal lumen, and the range of the procedure remains restricted to within the longitudinal muscles. Thus, POEM preserves the adjacent structures surrounding the distal esophagus, and the phrenoesophageal ligament remains intact.

In other words, in terms of preserving the antireflux mechanism, POEM is equally or more effective than Heller myotomy in that it preserves the phrenoesophageal ligament partially. Therefore, it is natural that the rate of GERD after POEM is low.

In addition, the fact that the angle of His was preserved in all cases in this study (POEM on anterior myotomy) is

### Table 3 Result of logistic regression analysis for erosive gastritis Los Angeles classification: grade B/C

|                          | Univariate analysis |                  |      |
|--------------------------|---------------------|------------------|------|
|                          | OR                  | 95 % CI          | P    |
| **Before POEM**          |                     |                  |      |
| Men (vs. women)          | 0.777               | 0.205–2.946      | 0.711|
| Age                     | 1.010               | 0.976–1.045      | 0.570|
| BMI                     | 1.046               | 0.865–1.266      | 0.640|
| Degree of dilatation     |                     |                  |      |
| I                       | 1.000               | Ref              |      |
| II                      | 1.146               | 0.313–4.196      | 0.837|
| III                     | n.c.                |                  |      |
| Sigmoid type (vs. straight type) | n.c.         |                  |      |
| Chicago classification   |                     |                  |      |
| Type I                  | 1.000               | Ref              |      |
| Type II                 | 0.292               | 0.045–1.899      | 0.197|
| Type III                | 0.571               | 0.057–5.775      | 0.635|
| Primary procedure (vs. no primary procedure) | 2.022 | 0.512–7.990 | 0.315|
| Primary procedure        |                     |                  |      |
| None                    | 1.000               | Ref              |      |
| Balloon dilatation       | 1.792               | 0.398–8.064      | 0.447|
| Hiatal hernia (vs. no hiatal hernia) | 5.800 | 0.335–100.459 | 0.227|
| Eckardt score            | 0.996               | 0.768–1.292      | 0.976|
| Mean LES pressure        | 0.988               | 0.952–1.026      | 0.534|
| LES residual pressure    | 0.978               | 0.920–1.040      | 0.478|
| IRP                     | 0.989               | 0.942–1.039      | 0.663|
| **POEM**                |                     |                  |      |
| Length of procedure      | 1.000               | 0.986–1.014      | 0.974|
| Length of myotomy: total | 1.079               | 0.928–1.254      | 0.323|
| Length of myotomy: esophageal | 1.092 | 0.930–1.282 | 0.283|
| Length of myotomy: gastric | 0.987         | 0.530–1.839      | 0.968|
| Postoperative stay, days | 1.102               | 0.889–1.366      | 0.374|
| Mucosal injury           | n.c.                |                  |      |
| **3 months after POEM**  |                     |                  |      |
| BMI                     | 1.017               | 0.834–1.240      | 0.869|
| Eckardt score            | 1.071               | 0.504–2.275      | 0.858|
| Mean LES pressure        | 0.998               | 0.947–1.052      | 0.938|
| LES residual pressure    | 0.918               | 0.812–1.039      | 0.175|
| IRP                     | 0.808               | 0.673–0.969      | 0.021|

*BMI* body mass index, *GERD* gastroesophageal reflux disease, *IRP* integrated relaxation pressure, *LES* lower esophageal sphincter, *POEM* peroral endoscopic myotomy, *SD* standard deviation, n.c. not calculated.
considered to be a contributory factor that helped maintain the function of the system, thus preventing GER. In this regard, further investigations of the differences in GERD between subtypes of POEM—antero myotomy without incision of the angle of His and posterior myotomy with incision of the angle of His—are needed.

The present study investigated whether POEM (especially myotomy of the gastric side) is associated with reflux esophagitis of grade B or higher severity. While examining the predictors of \( \geq \)grade B reflux esophagitis, we found that postoperative IRP significantly affected the development of \( \geq \)grade B reflux esophagitis. However, POEM-related variables, such as the length of the myotomy, did not show a significant correlation with postoperative reflux esophagitis of grade B or higher severity.

As described in the beginning, decreasing the pressure at the LES is the only valid therapeutic approach to eliminate or reduce these symptoms. However, there are no precise landmarks of the LES anatomically. Thus, an extended gastric myotomy (3 cm) is recommended to improve the results of therapy in conventional surgery [36]. In POEM, the LES is not detected precisely during surgery. Therefore, a gastric myotomy of sufficient length is needed to improve the results of this procedure. However, for example, if the length of gastric myotomy is related to the severity of esophagitis after POEM, the length of the myotomy should be kept minimal. In this study, the myotomy itself during POEM was not associated with the severity of postoperative reflux esophagitis of grade B or higher severity, statistically.

Considering these results, an extended gastric myotomy (approximately 2–3 cm) is also recommended in POEM. In the event moderate esophagitis occurs after POEM, it can be controlled by PPIs. However, caution should be exercised during the anterior myotomy on the gastric aspect as the branch of the left gastric artery exists on the gastric side. In this study, we found POEM to be safe and effective in providing symptomatic relief for patients with achalasia. No clinically problematic development of refractory GERD occurred; furthermore, the myotomy itself during POEM was not associated with the severity of reflux esophagitis. This study has certain limitations: POEM was conducted at a single center, the number of patients was limited, and long-term outcomes were not evaluated. Thus, additional multicenter studies with larger samples and long-term outcomes are warranted.

In conclusion, POEM is safe and effective in providing symptomatic relief for patients with achalasia. No clinically significant development of refractory GERD occurred; furthermore, the myotomy itself during POEM was not associated with reflux esophagitis of grade B or higher severity. Therefore, an extended gastric myotomy is recommended in the POEM procedure to improve the results of therapy as well as conventional surgery.

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Compliance with ethical standards

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