Previous esophageal dilatation as a risk factor for mucosal injury during laparoscopic Heller myotomy for achalasia

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Background
Esophageal achalasia is an esophageal-motility disorder of unknown etiology that results in impaired relaxation of the lower esophageal sphincter and loss of esophageal peristalsis. Achalasia can be primary (idiopathic) or secondary. In secondary achalasia, the cause for the degeneration of esophageal nerve fibers is known. Pathophysiologically, achalasia is caused by loss of inhibitory ganglion cells in the myenteric plexus. Several studies have attempted to explore initiating agents that may cause the disease such as viral infection, other environmental factors, autoimmunity, and genetic factors. However, the exact pathogenesis of primary achalasia is still not known.
Aim
The aim of the study is to assess esophageal dilatation before surgery as a risk factor for esophageal mucosal injuries during laparoscopic Heller's cardiomyotomy.
Patients and methods
This prospective study was performed on a total of 20 patients who diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy and willing to participate in the study at Tertiary Care Hospital at Ain Shams University Hospitals from July 2019 to June 2021 with inclusion and exclusion criteria.
Results
There was no statistically significant difference among the studied groups regarding type of achalasia and preoperative lower esophageal sphincter pressure. There was significant higher operative time among previous-dilatation group than the no-previous-dilatation group with no statistically significant difference among the studied groups regarding postoperative wound infection, intraoperative bleeding, and postoperative hospital stay. There was no statistically significant difference among the studied groups regarding postoperative-reflux esophagitis and perforation. Our results revealed a highly significant difference between the preoperative and postoperative Eckardt scores among the same group with *P* value of 0.007 in the no-previous-dilatation group and *P* value of 0.003 in the previous-dilatation group, while there was no statistically significant difference found between the studied groups regarding preoperative and postoperative Eckardt scores.
Conclusion
As evident from the study, previous esophageal dilatation is not a risk factor for mucosal injury during laparoscopic Heller myotomy for achalasia.
Laparoscopic Heller's cardiomyotomy achieved symptomatic improvement in all patients, regardless of prior pneumatic balloon dilation, and preoperative pneumatic balloon dilation did not affect the incidence of residual symptoms, necessity of additional postoperative treatments, occurrence of symptomatic gastroesophageal reflux disease, or intraoperative mucosal perforation.

Keywords:
achalasia, esophageal dilatation, laparoscopic Heller myotomy

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Introduction

Esophageal achalasia is an esophageal-motility disorder of unknown etiology that results in impaired relaxation of the lower esophageal sphincter (LES) and loss of esophageal peristalsis [1].

Achalasia can be primary (idiopathic) or secondary. In secondary achalasia, the cause for the degeneration of esophageal nerve fibers is known. Pathophysiologically, achalasia is caused by loss of inhibitory ganglion cells in the myenteric plexus. Several studies have attempted

to explore initiating agents that may cause the disease, such as viral infection, other environmental factors, autoimmunity, and genetic factors. However, the exact pathogenesis of primary achalasia is still not known [2].

The diagnosis of achalasia usually starts with a barium esophagram followed by esophageal manometry, the latter being considered the 'gold standard' for the diagnosis. On conventional manometry, absence of peristalsis sometimes with increased intraesophageal pressure owing to stasis of food and saliva and incomplete relaxation of the LES on swallowing (residual pressure >8–10 mmHg) are the hallmarks of achalasia [3].

However, traditional manometry had limitations: (a) 20–25% of suspected achalasia patients had normal LES relaxation, despite all the other features of achalasia, (b) 'vigorous' achalasia was a nebulous term overlapping with diffuse esophageal spasm, and (c) despite its key role in diagnosis, manometric features did not help predict the response to medical or surgical treatment. The new system of high-resolution manometry records intraluminal pressures circumferentially at 1-cm intervals over a 36-cm recording segment. This permits comprehensive description of esophageal motor events that are providing new insights into normal and disordered esophageal motor function [4].

Treatments for esophageal achalasia are aimed at long-term symptomatic relief by decompression of the LES pressure. Various treatments are currently available, including pharmacological therapy (such as nitrates and short-acting calcium antagonists), endoscopic injection of botulinum toxin, endoscopic pneumatic balloon dilation (PBD), and laparoscopic or open esophagocardiomyotomy with antireflux procedure [5].

Surgical cardiomyotomy (Heller myotomy) is now 100-years old, the first report being dated in 1914. In the 90s, it has been revived through a minimal invasive approach [laparoscopic Heller myotomy (LHM)], and since then, it has become the golden standard to measure the efficacy of treatments for achalasia and the preferred treatment (especially in young patients), achieving good long-term results in about 90% of cases in most published series. It is a simple, elegant, one-shot therapy that has virtually no mortality and very little morbidity [6].

Apart from its efficacy in resolving dysphagia, LHM is a remarkably safe operation with minimal complication rate, and in most cases, it is performed with a postoperative hospital stay of 1–2 days [7].

Heller's myotomy requires delicate manipulation by preserving only the mucous membrane. To achieve complete disappearance of preoperative symptoms, myotomy needs to cover the gastric side as well as the esophageal side sufficiently. For this reason, mucosal injury of the esophagus and stomach can occur as the intraoperative complication during this procedure [8].

Intraoperative perforation of the esophageal mucosa is one of the most common complications associated with the procedure while performing the myotomy, which may occur in as many as 10% of cases [6].

Perforations are usually evident during the operation and repaired immediately, without any need to convert to open surgery. They are occasionally discovered afterward, on a performed contrast-swallow study before resuming oral intake, in which case they are generally managed conservatively. Reoperation is seldom necessary [6].

The intraoperative management of mucosal injury by suturing the perforated area with interrupted 3–0 Maxon sutures under laparoscopic guidance and performing Dor fundoplication to cover the perforated area [8].

Aim

The aim of the study is to assess esophageal dilatation before surgery as a risk factor for esophageal mucosal injuries during laparoscopic Heller's cardiomyotomy.

Patients and methods

After ethical committee approval and informed consents from the patients, this prospective study was performed on a total of 20 patients who diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy and willing to participate in the study at Tertiary Care Hospital at Ain Shams University Hospitals from July 2019 to June 2021.

Study population: patients diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy with the following inclusion criteria:

Inclusion criteria: group A, including patients' age between 18 and 60 years old, patients did not have previous dilatation, patients symptomatized more than 1 year, and patients from both sexes, and group B, including patients' age between 18 and 60 years old, patients who had failed previous dilatations one time or more, patients symptomatized more than 1 year, and patients from both sexes.

Exclusion criteria: patients underwent previous upper-abdominal surgeries, recurrent cases after previous Heller's cardiomyotomy, patients unfit for anesthesia, patients with sigmoid esophagus, and patients with symptomatic reflux and diffuse esophageal spasm.

Study procedures: all participants were submitted to the following.

Preoperative assessment

Full clinical history: dysphagia for solids and liquids, regurgitation of undigested food, respiratory complications (nocturnal cough and aspiration), chest pain, heartburn, and weight loss.

Full clinical examination: general and local abdominal examination.

Investigations including:

(1) Routine preoperative laboratory investigations: complete blood count, liver-function tests, kidney-function tests, coagulation profile, serum electrolytes, and viral markers.
(2) Routine preoperative radiological investigations: ECG, echocardiography, and plain chest radiograph.

Specific investigations: esophageal manometry evaluating esophageal peristalsis and LES pressure, upper gastrointestinal tract endoscopy commenting on esophageal peristalsis, and barium swallow showing smooth tapering of the lower esophagus, leading to a 'bird's beak' appearance.

Study operation: Heller's cardiomyotomy was done to all patients.

Sample size: 20 patients, these patients were divided into two groups:

Group A included patients undergoing Heller's cardiomyotomy without previous balloon dilatation.

Group B included patients undergoing Heller's cardiomyotomy with previous once or multiple failed sessions of balloon dilatation.

Sampling method: nonrandomized convenient sample.

Outcome measures

Primary outcome: the association between esophageal dilatation before surgery and esophageal mucosal injuries during laparoscopic Heller's cardiomyotomy.

Secondary outcome: operative time, intraoperative complications (perforation and bleeding), postoperative infection, reflux esophagitis, and postoperative stay.

Ethical considerations: the patient data were anonymous. Data presentation was not by the patient's name but by diagnosis and patient confidentiality was protected. An informed consent was taken from all participants, it was in Arabic language and confirmed by date and time. Confidentiality was preserved by assigning a number to patients' initials and only the investigator knew it.

Conflict of interest: the candidate declared that there is no conflict of interest and the cost of the study was paid by the candidate.

Statistical analysis

Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0 (Armonk, NY: IBM Corp.). Data to be presented in terms of range, mean, and SD (for numeric parametric variables); range, median, and interquartile range (for numeric nonparametric variables); or number and percentage (for categorical variables). The difference between two independent groups is to be analyzed using independent Student's *t* test as well as the mean difference and its 95% confidence interval (CI; for numeric parametric variables), or χ^2 test as well as the risk ratio and its 95% CI (for categorical variables). Binary logistic-regression analysis is to be performed for estimating the association between good/poor response, and the measured-variable receiver operating characteristic curves are to be constructed for estimating the validity of measured variables as predictors of good or poor response; validity is to be presented in terms of sensitivity, specificity, positive, and negative predictive values and their corresponding 95% CI significance level is set at 0.05.

Results

During this study, 28 patients were assessed for eligibility and 20 patients were included in the study. Of all eligible patients, six patients were excluded from the study based on the inclusion criteria and two patients refused to participate in the study.

Ultimately, the analysis was based on the data of 20 patients diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy divided into two groups.

Twenty patients underwent LHM+DF, of which nine (45%) were males and 11 (55%) were females. The mean age of patients was 40.60 ± 9.24 years. The mean

Table 1 Descriptive for demographics and characteristics of the studied patients

	N=20
Age (years)	
Mean±SD	40.60±9.24
Range	23–57
Sex [*n* (%)]	
Female	11 (55.0)
Male	9 (45.0)
BMI	
Mean±SD	20.50±3.24
Range	17–27
Duration of the disease	
Median (IQR)	3 (1.5–4)
Range	1–7

IQR, interquartile range.

Table 2 Descriptive for previous dilatations, type of achalasia, and pre-lower esophageal sphincter pressure of the studied patients

	N=20 [*n* (%)]
Previous dilatations	
No previous dilatations	9 (45.0)
Previous dilatations	11 (55.0)
Type of achalasia	
Grade I	6 (30.0)
Grade II	13 (65.0)
Grade III	1 (5.0)
Pre-LESP	
Mean±SD	42.20±9.81
Range	27–64

LESP, lower esophageal sphincter pressure.

preoperative LES pressure was 42.20±9.81 mmHg. Eleven (55%) patients underwent preoperative endoscopic PBDs. The mean operative time was 137.50±31.35. Intraoperative bleeding occurred in three patients (one of them from the non-PBD group and two from the PBD group) from short gastric vessels, which stopped after sealing of these vessels and using the harmonic blade. Mucosal perforation occurred in two patients from the PBD group, and it was repaired by simple interrupted vicryl 3–0 sutures. Wound infection occurred in three patients. The median hospital stay was 2 days. There was no mortality as shown in Tables 1–3.

Table 4 shows that there was no statistically significant difference between previous-dilatation group among age, sex, and BMI with *P* value of 0.964 and 0.460, respectively, while there was a statistically significant difference among duration of disease found higher in previous-dilatation groups with *P* value less than 0.001.

When patients were compared according to whether they underwent preoperative endoscopic PBD or not, there was no significant difference in terms of age, sex, BMI, preoperative LES pressure, hospitalization period, and complications. Operative time had a statistically significant difference between the two groups of patients as shown in Tables 5 and 6.

Table 3 Description of operative time and complications among study cases

	N=20
Operative time	
Mean±SD	137.50±31.35
Range	100–210
Postoperative wound infection [*n* (%)]	
No	17 (85.0)
Yes	3 (15.0)
Intraoperative bleeding [*n* (%)]	
No	17 (85.0)
Yes	3 (15.0)
Postoperative hospital stay	
Median (IQR)	2 (2–3)
Range	2–5
Postoperative-reflux esophagitis [*n* (%)]	
No	15 (75.0)
Yes	5 (25.0)
Perforation [*n* (%)]	
No	18 (90.0)
Yes	2 (10.0)
Pre-Eckardt score	
Median (IQR)	5 (4–7)
Range	2–9
Post-Eckardt score	
Median (IQR)	1 (0–1)
Range	0–3

IQR, interquartile range.

The median Eckardt score measured at 6 months postoperative was highly significantly lower than the preoperative Eckardt score [5 vs. 1 (*P*<0.001)]. In contrast, there was no significant difference in the preoperative and postoperative Eckardt scores between patients who underwent preoperative endoscopic PBD and those who did not, as shown in Tables 7 and 8.

Discussion

Esophageal achalasia is a rare esophageal functional disorder characterized by discoordinated or absent esophageal peristalsis and incomplete relaxation of the LES during swallowing due to the destruction and loss of inhibitory myenteric ganglion cells in the Auerbach's plexus of the esophagus [5].

Effective methods for treating achalasia include endoscopic injection of botulinum toxin, endoscopic balloon inflation, per-oral endoscopic myotomy, and LHM and fundoplication [9]. Of these, the Heller–Dor procedure is based on two major concepts: (a) relieving the disturbed passage through the LES by

Table 4 Comparison between previous dilatation groups among demographics and characteristics of the studied patients

	Previous dilatations		Test value	*P* value	Significance
	No previous dilatations	Previous dilatations			
	N=9	*N*=11			
Age (years)					
Mean±SD	38.11±9.57	42.64±8.88	–1.095•	0.288	NS
Range	23–55	25–57			
Sex [*n* (%)]					
Female	5 (55.6)	6 (54.5)	0.002*	0.964	NS
Male	4 (44.4)	5 (45.5)			
BMI					
Mean±SD	19.89±3.95	21.00±2.61	–0.755•	0.460	NS
Range	17–27	17–25			
Duration of the disease					
Median (IQR)	1 (1–2)	4 (3–5)	–3.492≠	0.000	HS
Range	1–3	2–7			

IQR, interquartile range. *χ^2 test. •Independent *t* test. ≠Mann–Whitney test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Table 5 Comparison between previous dilatation groups as regards type of achalasia

	Previous dilatations [*n* (%)]		Test value	*P* value	Significance
	No previous dilatations	Previous dilatations			
	N=9	*N*=11			
Type of achalasia					
Grade I	1 (11.1)	5 (45.5)	4.201*	0.122	NS
Grade II	8 (88.9)	5 (45.5)			
Grade III	0	1 (9.1)			
Pre-LESP					
Mean±SD	42.78±9.90	41.73±10.20	0.232•	0.819	NS
Range	29–56	27–64			

LESP, lower esophageal sphincter pressure. *χ^2 test. •Independent *t* test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Table 6 Comparison between previous dilatation groups as regards operative characteristics

	Previous dilatations		Test value	*P* value	Significance
	No previous dilatations	Previous dilatations			
	N=9	*N*=11			
Operative time					
Mean±SD	118.89±25.22	152.73±28.14	–2.801•	0.012	S
Range	100–180	125–210			
Postoperative wound infection [*n* (%)]					
No	7 (77.8)	10 (90.9)	0.669*	0.413	NS
Yes	2 (22.2)	1 (9.1)			
Intraoperative bleeding [*n* (%)]					
No	8 (88.9)	9 (81.8)	0.194*	0.660	NS
Yes	1 (11.1)	2 (18.2)			
Postoperative hospital stay					
Median (IQR)	2 (2–3)	2 (2–4)	–0.671≠	0.502	NS
Range	2–3	2–5			

IQR, interquartile range. *χ^2 test. •Independent *t* test. ≠Mann–Whitney test.

Heller myotomy and (b) fundoplication to prevent postoperative gastroesophageal reflux [8].

Based on the excellent short-term success rates, laparoscopic myotomy with antireflux procedures [i.e. laparoscopic Heller–Dor surgery (LHD)] has been proposed as the preferred initial treatment approach for achalasia [10].

In this procedure, Heller's myotomy requires delicate manipulation by preserving only the mucous membrane. To achieve complete disappearance of

Table 7 Comparison between previous dilatation groups as regards operative complications

	Previous dilatations [*n* (%)]		Test value	*P* value	Significance
	No previous dilatations	Previous dilatations			
	N=9	*N*=11			
Postoperative-reflux esophagitis					
No	6 (66.7)	9 (81.8)	0.606*	0.436	NS
Yes	3 (33.3)	2 (18.2)			
Perforation					
No	9 (100.0)	9 (81.8)	1.818*	0.178	NS
Yes	0	2 (18.2)			
Pre-Eckardt score					
Median (IQR)	5 (4–7)	5 (4–7)	–0.116≠	0.908	NS
Range	2–9	2–9			
Post-Eckardt score					
Median (IQR)	1 (0–1)	1 (0–1)	–0.207≠	0.836	NS
Range	0–2	0–3			

IQR, interquartile range. *χ^2 test. •Independent *t* test. ≠Mann–Whitney test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Table 8 Comparison between previous dilatation groups as regards Eckardt score

	Pre	Post	Test value	*P* value	Significance
No previous dilatations					
Eckardt score					
Median (IQR)	5 (4–7)	1 (0–1)	–2.677≠	0.007	HS
Range	2–9	0–2			
Previous dilatations					
Eckardt score					
Median (IQR)	5 (4–7)	1 (0–1)	–2.992≠	0.003	HS
Range	2–9	0–3			

IQR, interquartile range. ≠Wilcoxon signed-rank test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

preoperative symptoms, myotomy needs to cover the gastric side as well as the esophageal side sufficiently. For this reason, mucosal injury of the esophagus and stomach can occur as the intraoperative complication during this procedure [8].

Since mucosal injury during myotomy represents major conflict and often is the most frequent complication seen with the Heller–Dor procedure for achalasia, examination of risk factors for such mucosal injury and assessment of esophageal dilatation before surgery during laparoscopic Heller's cardiomyotomy for decreasing mucosal injury was highlighted as a main point of interest [8].

Controversy remains whether preoperative PBD influences the surgical outcome of laparoscopic esophagocardiomyotomy in patients with esophageal achalasia [5].

So, we aimed in this study to assess esophageal dilatation before surgery as a risk factor for esophageal mucosal injuries during laparoscopic Heller's cardiomyotomy.

This prospective study was conducted at Tertiary Care Hospital at Ain Shams University Hospitals from July 2019 to June 2021 and performed on a total of 20 patients who were diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy.

During this study, 28 patients were assessed for eligibility and 20 patients were included in the study. Of all eligible patients, six patients were excluded from the study based on the inclusion criteria and two patients refused to participate in the study.

Ultimately, the analysis was based on the data of 20 patients diagnosed with esophageal achalasia undergoing Heller's cardiomyotomy divided into two groups.

To the best of our knowledge, data regarding assessment of risk factors for esophageal mucosal injuries during LHM are limited and conflicting. Thus, the present study was conducted to evaluate the risk of esophageal dilatation before LHM for occurrence of esophageal mucosal injuries.

The current study revealed that there was no statistically significant difference between the previous-dilatation group among age, sex, and BMI, with *P* value of 0.288, 0.964, and 0.460, respectively, while there was a statistically significant difference among duration of disease found higher in the previous-dilatation group with *P* value less than 0.001.

Our study results revealed that there was no statistically significant difference among the studied groups regarding the type of achalasia and preoperative LES pressure (*P*=0.122, 0.819), respectively.

Our results revealed that there was significantly higher operative time among the previous-dilatation group than the no-previous-dilatation group (*P*<0.001) with no statistically significant difference among the studied groups regarding postoperative wound infection, intraoperative bleeding, and postoperative hospital stay (*P*=0.413, 0.660, and 0.502), respectively.

Tsuboi *et al.* [11] conducted a propensity-score-matched study that involved 526 patients with achalasia who underwent LHD as an initial treatment and patients were roughly classified by the status of preoperative balloon dilation and matched with propensity scores for age, sex, BMI, morphologic type, and maximum esophageal-transverse diameter.

Consequently, 94 patients each were assigned to the BD group and to the non-BD group to evaluate the effect of preoperative balloon dilation on treatment outcomes of LHD for achalasia.

Tsuboi *et al.* [11] revealed that the median surgical time was 172.5 min in the BD group and 170 min in the non-BD group, without a significant difference (*P*=0.988). Almost all of the participants had minor intraoperative blood loss and no difference was found between the groups (*P*=0.189). Twelve (12.8%) patients in the BD group and 20 patients in the non-BD group suffered mucosal injury, an intraoperative complication, without a significant difference (*P*=0.121). No patient underwent laparotomy for intraoperative complications, including hemorrhage or mucosal injury.

Souma *et al.* [5] conducted a retrospective review on a prospectively compiled surgical database of 103 consecutive patients with esophageal achalasia who underwent LHD to evaluate whether preoperative PBD represents a risk factor for surgical complications and affects the symptomatic and/or functional outcomes of LHD, and the data were compared between the patients with preoperative PBD (PBD group, *n*=26) and without PBD (non-PBD group, *n*=77).

In contrast to our results, Souma *et al.* [5] revealed that the median operating time was 221 min in the PBD group, and 201 min in the non-PBD group; the difference between the two groups was not statistically significant (*P*=0.373), while intraoperative blood loss was negligible and did not exceed 100 ml in most patients of the two groups, which agreed with our results.

Previously, Tsuboi *et al.* [8] conducted a retrospective study of patients who underwent the LHD procedure for achalasia, which enrolled 435 patients to examine risk factors for such mucosal injury during this procedure and the patients were divided into 67 patients who sustained mucosal injury during surgery and 368 without mucosal injury.

Tsuboi *et al.* [8] revealed that the mucosal-injury group had significantly longer operative time, higher intraoperative blood loss, delayed resumption of oral food intake, and extended postoperative hospital stay (all, *P*<0.001).

Tsuboi *et al.* [8] concluded that advanced patient age (≥60 years), maximum transverse diameter of the esophagus (≥80 mm), and operative experience were identified as risk factors for mucosal injury during the LHD procedure.

Regarding complications, our results revealed that there was no statistically significant difference among the studied groups regarding postoperative-reflux esophagitis and perforation (*P*=0.436, 0.178), respectively.

Tsuboi *et al.* [11], revealed that the timing of the first meal and the length of the postoperative stay after surgery were also similar in the two groups with no significant difference. However, postsurgical-reflux esophagitis developed in seven (7.4%) patients in the BD group and in only one (1.1%) in the non-BD group, showing a significantly higher incidence in the BD group (*P*=0.03). The grade of reflux esophagitis was also worse in the BD group (*P*=0.03).

In contrast to our results, Souma *et al.* [5] reported that the incidence of intraoperative mucosal perforation was significantly higher in the PBD group (*n*=8: 30.7%) compared with the non-PBD group (*n*=6: 7.7%), which revealed significant associations between intraoperative mucosal perforation with preoperative PBD (*P*=0.005) and maximum transverse diameter of the esophagography (*P*=0.003).

Souma *et al,* [5] concluded that the maximum transverse diameter at preoperative esophagography

and preoperative PBD was a predictor of intraoperative mucosal perforation (P=0.005, 0.003), respectively.

The Eckardt symptom score is the grading system for achalasia most frequently used for the evaluation of symptoms (dysphagia, regurgitation, retrosternal pain, and weight loss), stages, and efficacy of achalasia treatment. A symptom score of 0–1 corresponds to clinical stage 0, a score of 2–3 to stage I, a score of 4–6 to stage II, and a score more than 6 to stage III. Stages 0 and I indicate remission of the disease. On the other hand, stages II and III represent failure of treatment [12].

Our results revealed a highly significant difference between the preoperative and postoperative Eckardt scores among the same group with P value of 0.007 in the no-previous-dilatation group and P value of 0.003 in the previous-dilatation group, while there was no statistically significant difference found between the studied groups regarding preoperative and postoperative Eckardt scores (P=0.908, 0.836), respectively.

These results were in concordance with the data reported by Souma *et al.* [5], which revealed that preoperative dysphagia improved in all patients postoperatively with no statistically significant differences observed regarding postoperative chest pain, heartburn, or weight gain between the two groups.

Tsuboi *et al.* [11] revealed that there was no difference in postoperative symptoms based on the postoperative questionnaires completed 3 months after the surgery, with improved symptoms noted in both groups, and patient satisfaction was high in both groups, but that in the non-BD group was significantly higher (P<0.05) explained by significantly higher postoperative-reflux esophagitis in the BD group.

When balloon dilation is performed as the first treatment, fibrogenesis caused by muscle-layer laceration in the lower esophagus and inflammation-associated neovascularity around the esophagus are expected. Consequently, an increased incidence of mucosal injury and bleeding in esophageal myotomy is likely [11].

Consequently, Tsuboi *et al.* [11] concluded that preoperative balloon dilation had no effect on intraoperative complications, but did increase the incidence of postoperative-reflux esophagitis in patients undergoing LHD for achalasia.

According to Souma *et al.* [5], repetitive endoscopic PBDs may cause submucosal hemorrhage, resulting in fibrosis and adhesion formation over time, which makes surgical myotomy difficult and increases the risk of esophageal mucosal perforation.

Thus, this results in more difficulties intraoperative in our study that increased operative time in the PBD group in comparison with non-PBD group, which was non-PBD, 118.89 ± 25.22; PBD, 152.73 ± 28.14, with a P value of 0.012, which is statistically significant.

Also, these intraoperative adhesions result in more perforations (two cases) and intraoperative bleeding (two cases) in the PBD group than non-PBD patients (0 cases of perforations and one case of intraoperative bleeding), but this was not statistically significant.

Postoperatively, both groups expressed equally high satisfaction with surgery, the number of patients symptomatized with dysphagia, regurgitation, and heartburn was decreased (dysphagia: non-PBD, nine patients–0 patient; PBD, 10 patients–0 patients) (regurgitation: non-PBD, five patients–one patient; PBD, four patients–0 patients) (heartburn: non-PBD, six patients–two patients; PBD, seven patients–two patients).

The median postoperative Eckardt scores between the two groups revealed no differences (it was one in both groups) with a P value of 0.836, which is statistically nonsignificant.Postoperative hospital stay between the two groups is almost the same without any statistical significance.

To conclude, however, previous PBD sessions negatively impact the Heller cardiomyotomy in terms of operative time and difficulty of dissection due to increased adhesions and fibrosis, both groups expressed equally high satisfaction with surgery.

The strength points of this study

The strength points of this study are that it is a prospective study design and having no patients lost to follow-up during the study. Most studies that have investigated the effect of preoperative balloon dilation on surgical outcomes, including the incidence of intraoperative mucosal injury, were retrospective in design and with an insufficient data of patients, so there is still no consensus on their outcomes [11].

The limitations of the study

The limitations of the study are worthy of mention, including a relatively smaller sample size relative to the previous studies, not being a multicentric study, and this represents a significant risk of publication bias. Another limitation is that the number of preoperative PBD was

not mentioned since the risk of mucosal perforation is also considered to increase proportionally with the number of preoperative PBD as repeated PBD might increase the inflammatory response around the LES [5].

Therefore, further investigation with a larger number of patients is required to evaluate the impact of the repeated dilation on intraoperative mucosal perforation [10].

Conclusion

As evident from the study, previous esophageal dilatation is not a risk factor for mucosal injury during LHM for achalasia.

Laparoscopic Heller's cardiomyotomy achieved symptomatic improvement in all patients, regardless of prior PBD, and preoperative PBD did not affect the incidence of residual symptoms, necessity of additional postoperative treatments, occurrence of symptomatic gastroesophageal reflux disease, or intraoperative mucosal perforation.

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Conflicts of interest
No conflict of interest.

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