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REVIEW ARTICLE

Long-term outcomes of treatment for achalasia: Laparoscopic Heller myotomy versus POEM

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Abstract

Achalasia is a rare esophageal motility disorder characterized by nonrelaxation of the lower esophageal sphincter. Laparoscopic Heller myotomy (LHM) is the gold standard treatment for achalasia. Peroral endoscopic myotomy (POEM), a less invasive treatment, is performed extensively, and the selection of the intervention method remains debatable to date. In addition to the availability of extensive studies on short-term outcomes, recent studies on the long-term outcomes of LHM and POEM have shown similar clinical success after 5 y of follow-up. However, gastroesophageal reflux disease (GERD) was more common in patients who had undergone POEM than in those who had undergone LHM. Moreover, existing studies have compared treatment outcomes in various disease states. Some studies have suggested that POEM is superior to LHM for patients with type III achalasia because POEM allows for a longer myotomy. Research on treatment for sigmoid types is currently in progress. However, the long-term results comparing LHD and POEM are insufficient, and the best treatment remains controversial. Further research is needed, and treatment options should be discussed with patients and tailored to their individual needs and pathologies.

KEYWORDS
achalasia, gastroesophageal reflux disease, laparoscopic Heller myotomy, peroral endoscopic myotomy

1 | INTRODUCTION

Achalasia is a rare esophageal motility disorder characterized by an increased lower esophageal sphincter (LES) and loss of esophageal peristalsis, with an incidence of approximately 1 in 100000 people per year in adults.[1] Major symptoms include dysphagia, vomiting, chest pain, weight loss, heartburn, and respiratory complications due to regurgitation.[1] The goal of treatment is relegated to symptomatic relief via disruption of the LES, and laparoscopic Heller myotomy (LHM) with partial fundoplication has been recommended as the gold standard treatment for achalasia.[2] Peroral endoscopic myotomy (POEM) was first reported in 2010[3] and has been performed extensively worldwide. To date, the clear indications for LHM and POEM remain unknown; therefore, the appropriate application of LHM and POEM remains controversial. Although several studies have demonstrated a high clinical success and safety of POEM, most studies have shown only short- and mid-term outcomes. However, recent studies have analyzed the long-term outcomes over 5 y. In this review, we draw on previous reports to discuss the long-term outcomes and future status of LHM and POEM for achalasia.

2 | EFFICACY

2.1 | Long-term outcomes of LHM

Esophageal myotomy via left thoracotomy was first proposed by Heller in 1913, and the transabdominal approach was performed in the 1940s.[4,5] Gastroesophageal anatomic and functional antireflux barriers were missing, resulting in gastroesophageal reflux, and fundoplication was performed to prevent reflux esophagitis. Nissen[6] proposed the full wrap in 1958, Dor[6] developed the anterior wrap in 1962, and Toupet[6] popularized the posterior wrap in 1963.[6] LHM was first performed by Shimi et al in 1991, and is the most widely used laparoscopic esophageal myotomy to date.[7] Although several studies have analyzed the treatment outcomes, studies on long-term results are limited. Table 1 summarizes the long-term results over 5 y (how we conducted the literature review is described below).[8-27] According to the previous reports, clinical response was based on the Eckardt score or the rate of dysphagia improvement. The Eckardt score is the sum of symptom scores for dysphagia, regurgitation, chest pain, and the degree of weight loss proposed by Eckardt et al in 1992.[28] In recent years, many reports have described an Eckardt score of 3 or less as a clinical response. The rate of dysphagia improvement was defined as the clinical response in those reports that did not include an Eckardt score. The efficacy of LHM ranged from 49.8% to 98.1% after a median of over 5 y of follow-up. Data on the efficacy of LHM vary between reports; these differences may be attributable to different definitions of clinical response and the subjectivity of evaluation. To date, only three studies have reported long-term results (>10 y). In 2008, Rebecchi et al reported a 91% success rate in 138 patients with a median follow-up of 125 mo.[13] In 2021, our institution demonstrated 79% clinical success using data from 78 patients with a median follow-up of 143 mo.[24] Moreover, Csendes et al showed that 79% of patients reported symptomatic relief with a similar probability after a median follow-up of 204 mo.[26]

2.2 | Long-term outcomes of POEM

The technique of POEM combines the notion of natural orifice transluminal endoscopic surgery (NOTES) at Johns Hopkins Hospital and "third-space" endoscopy (endoscopy within a submucosal tunnel) at the Mayo Clinic and was first reported by Inoue et al in Japan.[3,29,30] POEM is a relatively new technique, and long-term follow-up studies are still in progress. Table 2 summarizes the outcomes of studies over 5 y (how we conducted the literature review is described below).[31-39] The efficacy of POEM ranges from 66.7% to 93.3%. This wide range of reported incidences may mirror the different definitions of clinical response and the subjectivity of evaluation, similar to the report on LHM. Recent meta-analyses showed that POEM was associated with a long-term clinical success of 83% after 5 y of follow-up.[40] A study by Onimaru et al, the only available study that analyzed the long-term results for ≥10 y, demonstrated clinical response in 14 of 15 patients (93%) who had undergone POEM.[33] However, the sample size was relatively small, and these patients underwent the procedure before POEM was standardized, which may contribute to several biases.

2.3 | Comparing the efficacy of LHM and POEM

To date, more than 25 studies comparing LHM and POEM have been reported, which demonstrated that the outcomes of POEM are comparable to those of LHM.[41] However, only reports showing short- or mid-term outcomes have been published, and comparative studies showing long-term results over 5 y (with 4 y being the longest) are lacking. In addition, most studies were retrospective, and randomized controlled trials (RCTs) are few. Podboy et al retrospectively analyzed the outcomes of LHM and POEM in 98 patients (LHM, 43; POEM, 55) with a mean follow-up of 5.44 and 3.94 y, respectively.[42] The results demonstrated that LHM and POEM had similar long-term efficacies (LHM, 65.1%; POEM, 72.7%, $P = 0.42$). Werner et al performed an RCT in 221 patients to compare the therapeutic effects of LHM and POEM.[43] Two years after the assigned intervention, clinical success was observed in 81.7% and 83.0% of patients in the LHM and POEM groups, respectively ($P < 0.01$), indicating that POEM was noninferior to LHM in symptomatic relief. Because achalasia is a persistent condition, all treatments tend to lose some efficacy over time; therefore, true long-term comparative studies of LHM versus POEM examining the effects for a minimum of 5–10 y postoperatively are expected.

2.4 | Meta-analysis of the efficacy of LHM and POEM

A systematic literature search of articles on LHM and POEM for the treatment of achalasia over 5 y was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines.[44] We searched MEDLINE (PubMed), Cochrane Central Register of Controlled Trials (Cochrane Library), and EMBASE (Dialog) until January 29, 2024. The search terms included "achalasia" and ("laparoscopy" and "heller myotomy" or "peroral endoscopic myotomy") (Appendix). The literature search was limited to the English articles. Abstracts, case reports, experimental studies in animal models, letters, and reviews were excluded. We also excluded studies with a follow-up period of less than 5 y. Two independent reviewers (N.F. and K.T.) independently performed the screening and data extraction procedures. Statistical heterogeneity was evaluated by visual inspection of the forest plots and by calculating the I^2 statistics (0%–40%, and may not be important; 30%–60%, may represent moderate heterogeneity; 50%–90%, may represent substantial heterogeneity; and 75%–100%, considerable heterogeneity) according to the Cochrane handbook. Moreover, pooled proportions with 95% confidence intervals (CIs) for clinical response, symptomatic GERD, reflux esophagitis, and abnormal acid exposure were assessed

TABLE 1 Results obtained with laparoscopic Heller Myotomy over 5 y.

Author	Year	Country	Study design	Patients	Age (year)	Male (%)	Follow up (M)	Clinical success (%)	GERD symptoms (%)	GERD EGD (%)	Severe GERD EGD (%)	GERD pH (%)	PPI	Additional treatment (%)	
Bonatti[8]	2005	USA	Retrospective	44	47[a]	45.3	63.6	84.1	11.4 (5/44)	15.4 (2/13)	0	NA	40.9	25	PD, surgery, botulinus
Rossetti[9]	2005	Italy	Prospective	182	45 (12–79)[b]	46.7	83.2	91.8	NA	NA	NA	0 (0/75)	NA	2.2	PD, surgery
Berch[10]	2005	USA	Retrospective	50	57.2[b]	54	74.4	64	NA	NA	NA	NA	NA	NA	NA
Jeansonne[11]	2007	USA	Retrospective	17	41.3[b]	NA	134.4	64.8	NA	NA	NA	NA	NA	29.5	PD, surgery, POEM
Cowgill[12]	2008	USA	Retrospective	47	52[b]	55	127.2	91.5	NA	NA	NA	NA	NA	12.8	PD, botulinus
Rebecchi[13]	2008	Italy	Randomizend	138	49 (11–80)[b]	54.3	125	91.3	2.9 (4/138)	0 (0/138)	0	1.4 (2/138)	1.4	8.1	PD
Kilic[14]	2009	USA	Retrospective	46	51 (22–90)[b]	57	76.8	80.4	NA	NA	NA	NA	NA	19.6	Surgery
Cuttitta[15]	2011	Italy	Retrospective	49	45[b]	42.8	75	93.9	NA	NA	NA	4.1 (2/29)	NA	NA	NA
Carter[16]	2011	USA	Retrospective	165	49 (14–93)[b]	44.8	62	78.2	12.1 (12/165)	NA	NA	NA	45	21.8	PD, surgery
Parise[17]	2011	Italy	Retrospective	137	47 (11–80)[b]	56	65	94.8	10.9 (15/137)	NA	NA	NA	NA	9.7	PD, surgery
Popoffv[18]	2012	USA	Retrospective	51	49[b]	43.1	71.2	62.7	27.4 (14/51)	NA	NA	NA	65	5.8	PD, surgery
Krishnamohan[19]	2014	USA	Retrospective	241	53[b]	56.8	77.5	49.8	NA	NA	NA	NA	NA	NA	NA
Persson[20]	2015	Sweden	Randomizend	25	43 (14–93)[b]	44	80.4	92	NA	NA	NA	NA	NA	8	PD
Moonen[21]	2016	Belgium	Randomizend	71	46[b]	53.3	79.2	84.4	NA	17.9 (7/39)	0	33.3 (11/33)	NA	NA	NA
Costantini[22]	2019	Italy	Retrospective	1001	46[a]	53.5	62	89.5	NA	NA	NA	NA	NA	10.5	PD, surgery
Costantino[23]	2020	USA	Retrospective	130	50[a]	55	79	78	NA	NA	NA	NA	NA	13.8	PD, surgery, botulinus
Fukushima[24]	2021	Japan	Retrospective	82	41[a]	50	142.5	78.7	NA	28 (23/82)	7.2 (6/82)	NA	15.9	4.8	PD, surgery, POEM
Haskins[25]	2022	USA	Retrospective	139	53[a]	51	67	91	16.2 (12/74)	NA	NA	NA	38	2	surgery
Csendes[26]	2022	Chile	Retrospective	80	47 (17–80)[b]	48.3	204	78.7	18.7 (15/80)	13.7 (11/80)	0	34.8 (15/43)	NA	10	PD, surgery
Tassi[27]	2023	Italy	Retrospective	155	51[a]	49	90.1	98.1	2.8 (6/155)	2.6 (4/155)	0	NA	NA	NA	NA

[a]Median.

[b]Mean (range).

TABLE 2 Results obtained with peroral endoscopic myotomy over 5 y.

Author	Year	Country	Study design	Patients	Age (year)	Male (%)	Follow up (M)	Clinical success (%)	GERD symptoms (%)	GERD EGD (%)	Severe GERD EGD (%)	GERD pH (%)	PPI	Additional treatment (%)	
Teitelbaum[31]	2018	USA	Retrospective	36	54.5[a]	44.4	65	83	21 (6/29)	13 (2/16)	0	NA	26	2.8	Surgery
Zhang[32]	2020	China	Retrospective	32	39 (19–58)[b]	50	88	88	28 (9/32)	25 (8/32)	0	NA	38	NA	NA
Onimaru[33]	2021	Japan	Retrospective	15	51[a]	46.7	Over 120	93.3	6.7 (1/15)	NA	NA	NA	26.7	26.7	PD
MaKay[34]	2021	USA	Retrospective	100	57[a]	52	72	79	9 (9/100)	NA	NA	NA	9	12	PD, surgery, POEM
AbiMansour[35]	2021	USA	Retrospective	73	49.7[b]	37	79.5	89	31.5 (23/73)	NA	NA	NA	31.5	NA	NA
Kuipers[36]	2022	Netherlands	Randomized	62	47[b]	52	60	81	49 (24/50)	33 (14/42)	5 (2/42)	NA	46	NA	NA
Nabi[37]	2022	India	Retrospective	319	40.5[b]	57.1	73	92.6	28.9 (78/270)	35.3 (42/119)	2.5 (3/11)	NA	29.4	3.1	PD, surgery, POEM
Shiwaku[38]	2022	Japan	Retrospective	100	NA	NA	60	NA	9 (9/100)	56 (56/100)	2 (2/100)	NA	48	NA	NA
Peng[39]	2023	China	Retrospective	39	70.8[b]	46.2	84.2	66.7	27.8 (10/36)	40 (2/5)	0	42.9 (3/7)	13.9	NA	NA

[a]Median.
[b]Mean (range).

using a random-effects model with the DerSimonian–Laird estimator to consider the variance between and among the studies according to the Cochrane handbook.[45] We used STATA SE16 (v. 16.1, Stata, College Station, TX, USA). Following the removal of duplicate records, a total of 3428 unique records were identified. After the screening process, a total of 29 studies were included (Figure 1). Twenty articles reported date on LHM, and nine articles examined POEM (Tables 1 and 2). Clinical response was reported by 83% (95% CI, 78–87) of the patients who underwent LHM and 85% (95% CI, 79–91) of patients after POEM, with no significant difference ($P = 0.53$) (Figure 2).

3 | GASTROESOPHAGEAL REFLUX DISEASE (GERD)

Because antireflux procedure is not performed in POEM, the higher incidence of GERD is a potential concern[46,47]. The diagnosis of GERD after LHM or POEM is not standardized; symptom assessment, endoscopy, and pH monitoring are used to evaluate GERD. The GerdQ questionnaire is a self-administered questionnaire including six items. Symptomatic reflux was evaluated using the GerdQ, in which a score of >7 is considered indicative of symptomatic GERD.[48] In articles with no GerdQ score listed, heartburn was defined as symptomatic GERD according to the previous reports.[16,18,19] The severity of reflux esophagitis was assessed using the Los Angeles classification. Los Angeles grade A or higher was defined as endoscopic esophagitis, and grade C or more was defined as severe endoscopic esophagitis.[49] Scholottmann et al analyzed the data of 5832 who underwent LHM and 1958 patients who underwent POEM from 53 and 21 articles, respectively, and showed that patients who underwent POEM had a higher incidence of symptomatic GERD (odds ratio [OR] 1.69, $P < 0.01$), endoscopic diagnosis of reflux esophagitis (OR 9.31, $P < 0.01$), and abnormal acid exposure on pH monitoring (OR 4.30, $P < 0.01$).[46] Repici et al reported similar outcomes in their meta-analysis. The rates of symptomatic GERD, reflux esophagitis, and GERD evidenced by pH monitoring were 8.6%, 14.9%, and 8.3% after LHM, and 18.1%, 39.3%, and 30.7% after POEM, respectively.[47] In a multicenter randomized trial of 221 patients, reflux esophagitis on endoscopy at 2 y after the intervention was observed in 20% and 57% of patients in the LHM and POEM groups, respectively. However, the percentage of patients with abnormal reflux on pH monitoring was similar for LHM and POEM (30% vs 30%).[43] Although that study was an RCT, only half of the patients agreed to undergo pH monitoring test at 2 y, thus bias may have been present.

Few studies showed that GERD was reported following LHM with fundoplication and POEM after more than 5 y. We performed meta-analysis (the method is described in the Efficacy section). Symptomatic GERD, reflux esophagitis, and abnormal acid exposure was observed in 11% (95% CI, 7–16), 15% (95% CI, 4–26), and 18% (95% CI, 2–33) of patients who underwent LHM with fundoplication, and 23% (95% CI, 14–31), 34% (95% CI, 21–47), and 43% (95% CI,

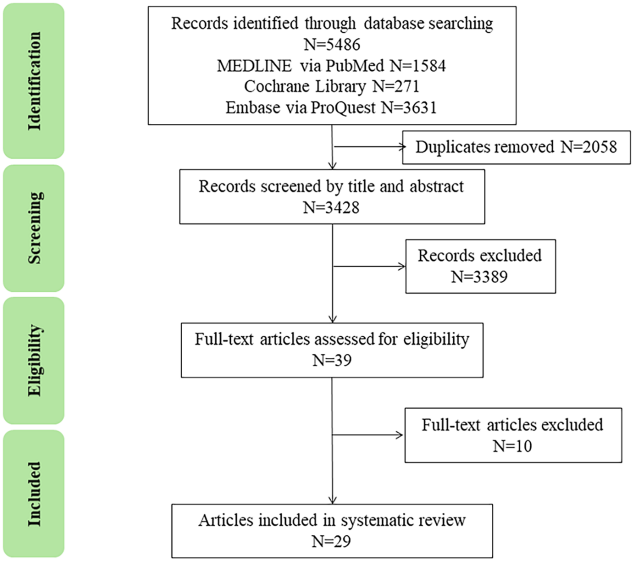

FIGURE 1 Literature search results.

5–36) of patients who underwent POEM. Symptomatic GERD and reflux esophagitis were observed more after POEM than LHM with fundoplication ($P = 0.030$, $P = 0.026$, respectively) (Figures 3 and 4). The pH monitoring data for >5 y after POEM was reported in only one study[39] and there were no significant differences between LHM with fundoplication and POEM ($P = 0.215$) (Figure 5). GERD is more common in POEM, even in long-term outcomes; however, comparative studies on the long-term outcomes between GERD after LHM with fundoplication and POEM are lacking, which warrants future investigation.

Antacid therapy is the first-line treatment for GERD, and most patients respond to proton pump inhibitors (PPIs). According to a meta-analysis reported by Repici et al, the rate of PPI use ranged from 2.6% to 27.8% after POEM, and 7% to 27% after LHM.[47] However, the criteria for prescribing PPIs to patients with GERD are lacking, and some cases received PPIs on demand, and the true rate of PPI requirement is unknown. The presence of severe esophagitis, long segment Barrett's esophagus (BE), or peptic strictures requires lifelong PPI therapy,[50] However, if only reflux symptoms are present, stasis or esophageal hypersensitivity may be the cause, rather than true acidic reflux, leading to uncertainty regarding the effectiveness of PPIs.[51] Additionally, the discrepancy between the symptoms and objective assessment of abnormal acid exposure on pH monitoring and endoscopy has been reported,[51] Repici et al reported a similar degree of dissociation between the occurrence of symptoms and higher rates of abnormal acid levels in LHM and POEM.[47] The clinical implications of increased acid exposure in the esophagus are currently unknown. However, abnormal regurgitation can cause serious conditions such as BE and adenocarcinoma.[52] Therefore, long-term acid suppression with PPI is recommended for patients with abnormal esophageal pH, regardless of their symptoms.[53] Postoperative BE after LHM and POEM was 2%–7% and 0%–3%, respectively, and a trend toward an increased prevalence of BE over time was observed.[31,42]

Determining whether the long-term complications of GERD, such as BE, are significantly different after LHM and POEM is imperative. In addition, the definition of GERD after intervention for achalasia, and indications for PPIs, needs to be standardized in the future.

4 | CANCER DEVELOPMENT

Achalasia is considered a risk factor for esophageal cancer, and the incidence of squamous cell carcinoma (SCC) is higher than that of adenocarcinoma. Some researchers have suggested that this risk is probably associated with chronic inflammation of the esophageal mucosa owing to food stasis and salivary and esophageal microbial dysbiosis, producing subsequent histologic changes of the mucosa and, finally, carcinoma.[54] According to a recent meta-analysis, the absolute risk of SCC is 0.308 per 100 person-years, and that of adenocarcinoma is 0.018,[55] and most studies have found an increased cancer risk of 7–33-fold in patients with achalasia compared to the general population.[56] However, there are few reports on the risk of esophageal cancer after interventions, ranging from 1.2% to 3.3% for LHM and 0.6% for POEM.[22,24,26,27] The incidence of esophageal cancer is expected to rise with continued follow-up. Additionally, there are no studies comparing the incidence of SCC after POEM and LHM, highlighting the need for further research in this area.

5 | TREATMENT OPTIONS

5.1 | Pathology of achalasia

Based on the degree of esophageal motility, the pathology of achalasia is classified into three types (I–III). Moreover, treatment outcomes for LHM are based on the type of pathology, which revealed that type II had the highest success, followed by type I and type III.[57] In contrast, all manometric subtypes exhibited good clinical success after POEM.[58] A previous study compared the outcomes of LHM and POEM in patients with type III achalasia. Podboy et al analyzed 98 patients and demonstrated that the success rate for type III achalasia was higher for POEM than that for LHM (53.3% vs 44.4%, $P < 0.05$).[42] Kumbhari et al demonstrated that patients with type III achalasia showed a significantly more frequent clinical response for POEM than that for LHM (98.0% vs 80.8%, $P = 0.01$).[59] In addition, they demonstrated that myotomy length was longer in POEM than in LHM (16 vs 8 cm, $P < 0.01$).[59] Because spastic contractions are observed in the middle and distal esophagus in type III achalasia, reducing LES pressure alone does not control the symptoms, as the segment affected by spastic motility extends above the esophagogastric junction. Moreover, POEM allows myotomy of the LES and the body of the esophagus and can perform a longer myotomy than LHM, leading to a higher success rate; therefore, POEM is recommended for patients with type III achalasia.[59]

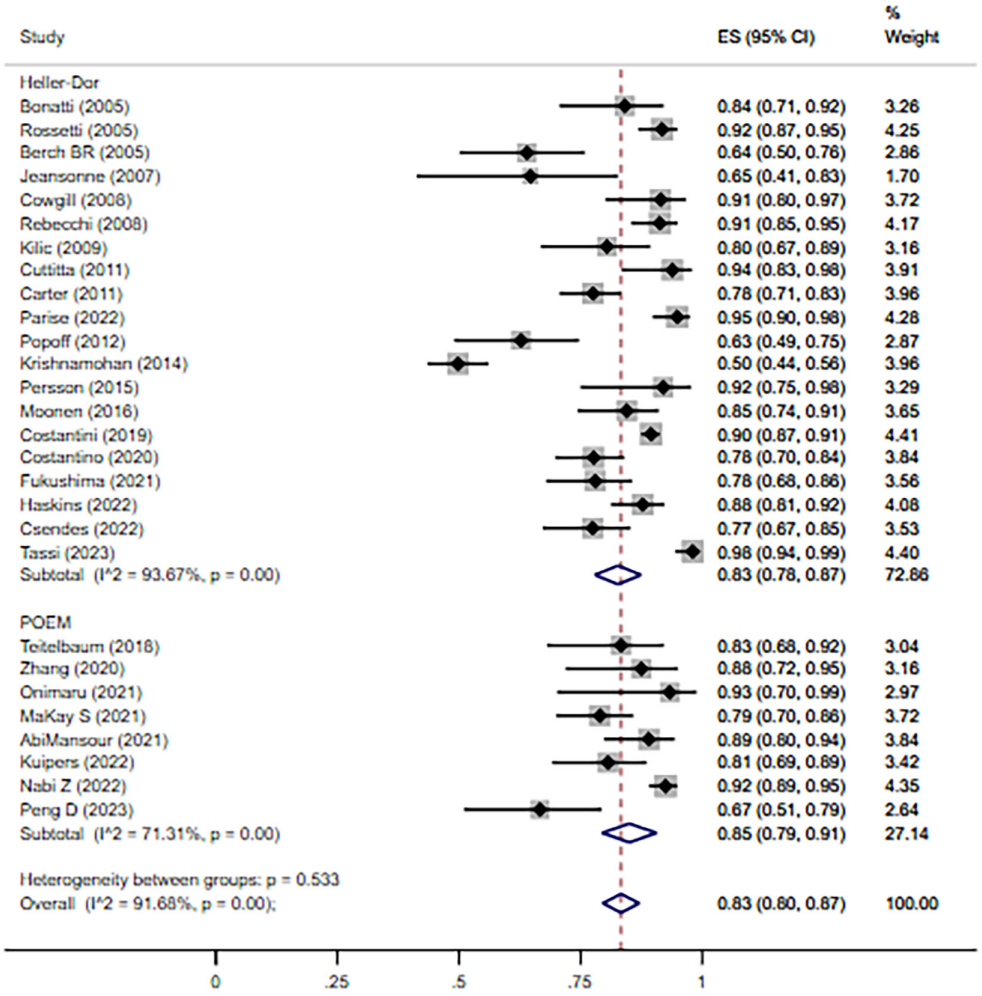

FIGURE 2 Forest plot of the proportion of clinical response after Laparoscopic Heller Myotomy (LHM) and Peroral Endoscopic Myotomy (POEM).

5.2 | Stages of achalasia

The sigmoid esophagus is characterized by marked dilatation and tortuosity of the esophageal body, which is an endstage achalasia, although its definition differs in the literature. The treatment for sigmoid esophagus is challenging, and the 2018 ISDE guidelines do not recommend a specific treatment for endstage achalasia.[60] Successful treatments of sigmoid-type achalasia with LHM have been demonstrated by previous studies. In a review, Herbella et al[61] noted that excellent and good outcomes were obtained in an average of 79% of the patients with endstage achalasia.[62] However, some studies have found that the clinical success of LHMs for sigmoid-type achalasia is inferior to that of the nonsigmoid type. In a recent report by Salvador et al, symptom control was 71.2% for patients with sigmoid type achalasia and 89% for patients with nonsigmoid type achalasia, which is inferior in the sigmoid type ($P < 0.01$).[62]

Although POEM was not initially indicated for patients with sigmoid type, POEM has been performed in recent years. In a meta-analysis of the 11 studies involving 428 patients conducted by Mandavdhare et al, the clinical success for the patients for sigmoid type was 89%.[63] Xu et al reported a similarly good outcome, with a clinical response rate of 90% in the patients with sigmoid type.[64] However, morphological changes in sigmoid achalasia make POEM more challenging than in nonsigmoid achalasia. Owing to inflammation and fibrosis in the submucosa and high tortuosity both distally and proximally, treating sigmoid achalasia requires more time and expertise. Some studies have reported that mucosal injury, perforation, and gas-related complications were more common than in nonsigmoid type achalasia, and POEM for the sigmoid type should be performed by an experienced operator.[64,65] Additionally, the effects of LHM tend to worsen over time, especially in patients with sigmoid-type achalasia, and it is not possible to determine whether POEM is recommended for patients with sigmoid achalasia based only on the short-term results of POEM.[66] Furthermore, there are no reports comparing LHM and POEM for patients with sigmoid-type achalasia. Therefore, the most effective treatment option for patients with a sigmoid esophagus remains controversial.

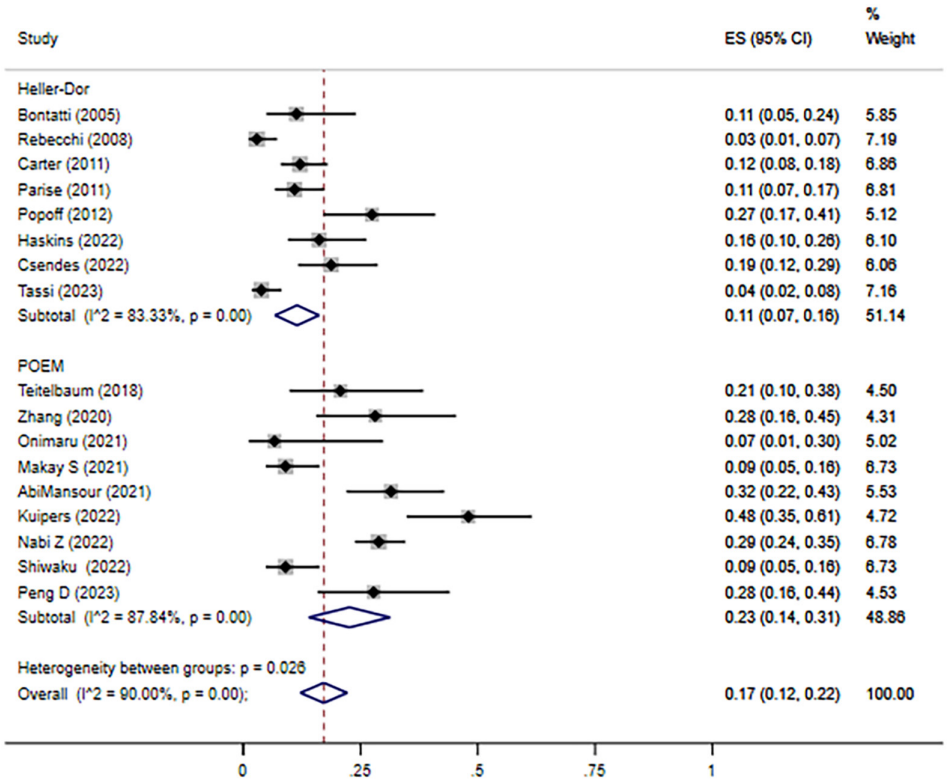

FIGURE 3 Forest plot of the proportion of symptomatic gastroesophageal reflux disease (GERD) after Laparoscopic Heller Myotomy (LHM) with fundoplication and Peroral Endoscopic Myotomy (POEM).

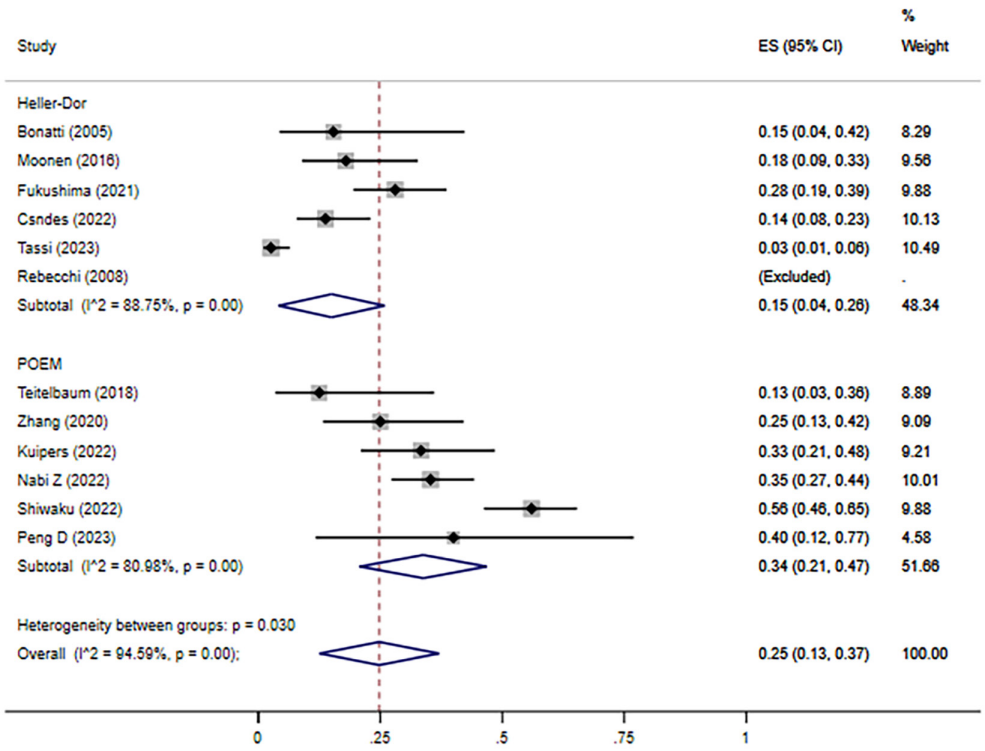

FIGURE 4 Forest plot of the proportion of reflux esophagitis after Laparoscopic Heller Myotomy (LHM) with fundoplication and Peroral Endoscopic Myotomy (POEM).

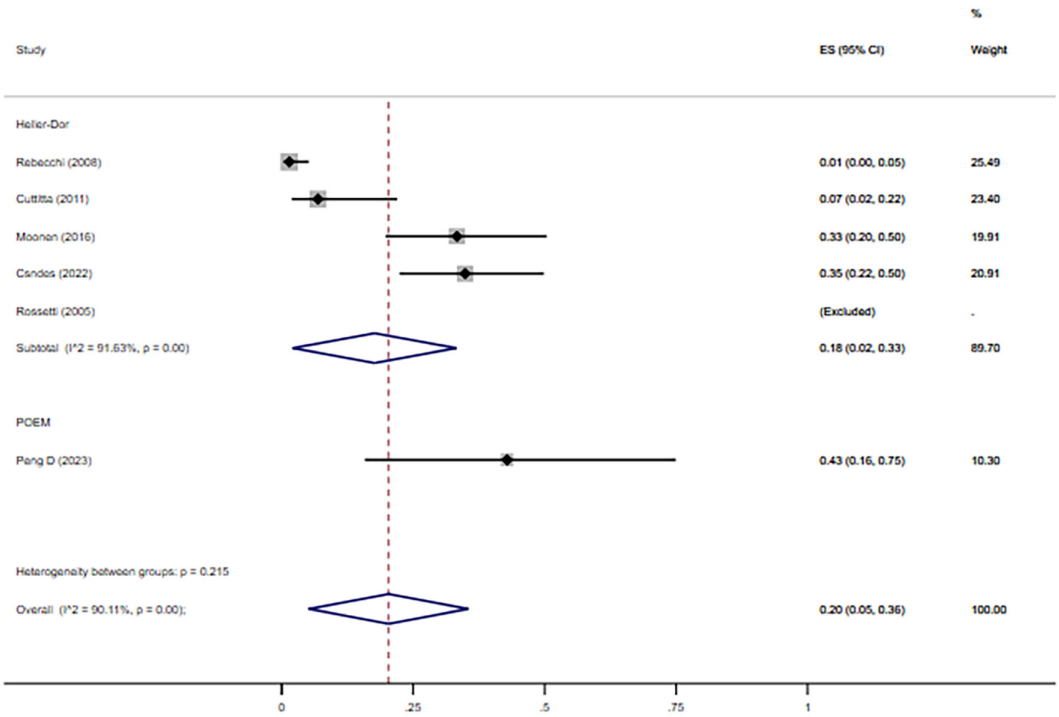

FIGURE 5 Forest plot of the proportion of abnormal acid exposure after Laparoscopic Heller Myotomy (LHM) with fundoplication and Peroral Endoscopic Myotomy (POEM).

6 | ADDITIONAL TREATMENT

Although both LHM and POEM show good clinical outcomes, few patients require reintervention. The rate of additional treatment for patients who underwent LHM is 2.0%–29.5% and POEM is 2.8%–26.7% (Tables 1 and 2) with long-term follow-up, and additional treatments such as pneumatic dilation (PD), surgery, and POEM were performed.[8,9,11,12,13,14,16,17,18,20,22,31,33,34,37] Reintervention is technically challenging and requires experienced surgeons owing to the presence of fibrosis, scars, and tissue adhesions. POEM is an endoscopic approach that can be used to perform myotomies in different orientations. Furthermore, POEM is less affected by tissue adhesion and scars from previous treatments than LHM.[67] Therefore, POEM has been performed as an additional treatment and has reported good clinical success in patients with failed LHM.[68] However, few studies have compared different treatments for failed LHM. We compared LHM and POEM in patients with recurrent symptoms after LHM and showed that rescue POEM was associated with better surgical outcomes than that of redo LHM.[69] An RCT by Saleh et al showed that POEM achieved a significantly higher success rate than did PD (62.2% vs 26.7%, $P < 0.01$) in patients with recurrent symptoms after LHM.[70] Studies comparing the results of LHM, PD, and POEM as additional treatments after the failure of LHM are lacking. Recently, POEM has also been performed on patients with recurrence after POEM. A multiple study by Ichkhanian et al demonstrated that the success rates of repeat POEM, PD, and LHM were 76%, 60%, and 29%, respectively, in patients with persistent or recurrent symptoms after POEM.[71] A meta-analysis by Tan et al revealed that POEM is a safe and effective treatment for patients who underwent any kind of previously failed intervention, with a clinical success rate of 90.8%.[67] POEM is effective for reintervention after LHM and POEM; however, only a limited number of patients with short-term results are available, and the choice of additional treatment, in terms of effectiveness, remains controversial.

7 | CONCLUSION

The efficacy of LHM and POEM is comparable, and the incidence of GERD is higher in patients with POEM than in those with LHM after 5 y of follow-up. However, existing studies on long-term outcomes are scarce, and it is not possible to conclude whether one technique is better than the other. Therefore, the treatment options and their advantages and disadvantages should be explained to patients with achalasia, and treatment should be tailored to their individual needs and pathologies.

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None.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest for this article.

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Approval of the research protocol: N/A.

Informed Consent: N/A.

Registry and the Registration No. of the study/trial: N/A.

Animal Studies: N/A.

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APPENDIX

Search strategy

MEDLINE

#1 "Esophageal Achalasia"[Mesh] OR achalasia*[tiab]

#2 "peroral endoscopic myoto*"[tiab] OR "endoscopic myotom*"[tiab] OR POEM[tiab]

#3 "Heller Myotomy"[Mesh] OR Helle*[tiab] AND (Myotom*[tiab] OR cardiomyotom*[tiab] OR operation*[tiab])

#4 "Laparoscopy"[Mesh] OR laparoscop*[tiab]

#5 #3 AND #4

#6 "laparoscopic myotom*"[tiab]

#7 #5 OR #6

#8 #1 AND (#2 OR #7)

#9 ("Review"[Publication Type] OR "Case Reports"[Publication Type] OR "case report*"[tiab])

#10 (child*[tiab] OR pediatric*[tiab])

#11 #8 NOT (#9 OR #10)

EMBASE

S1 EMB.EXACT.EXPLODE("esophagus achalasia") OR TI(achalasia*) OR AB(achalasia*)

S2 TI("peroral endoscopic myoto*") OR AB("peroral endoscopic myoto*") OR TI("endoscopic myotom*") OR AB("endoscopic myotom*") OR TI(POEM) OR AB(POEM)

S3 EMB.EXACT.EXPLODE("cardioesophagomyotomy") OR (TI(Helle*) AND (TI(Myotom*) OR TI(cardiomyotom*) OR TI(operation*))) OR (AB(Helle*) AND (AB(Myotom*) OR AB(cardiomyotom*) OR AB(operation*)))

S4 EMB.EXACT.EXPLODE("Laparoscopy") OR TI(laparoscop*) OR AB(laparoscop*)

S5 S3 AND S4

S6 TI("laparoscopic myotom*") OR AB("laparoscopic myotom*")

S7 S5 OR S6

S8 S1 AND (S2 OR S7)

S9 PT("Review") OR PT("Case Reports") OR TI("case report*") OR AB("case report*")

S10 TI(child*) OR AB(child*) OR TI(pediatric*) OR AB(pediatric*)

S11 S8 NOT (S9 OR S10)

CENTRAL

#1 ([mh "Esophageal Achalasia"]) OR (achalasia*:ti,ab)

#2 (("peroral endoscopic" NEXT myoto*):ti,ab) OR (("endoscopic" NEXT myotom*):ti,ab) OR (POEM:ti,ab)

#3 ([mh "Heller Myotomy"]) OR (Helle*:ti,ab AND (Myotom*:ti,ab OR cardiomyotom*:ti,ab OR operation*:ti,ab))

#4 ([mh Laparoscopy]) OR (laparoscop*:ti,ab)

#5 #3 AND #4

#6 (("laparoscopic" NEXT myotom*):ti,ab)

#5 #5 OR #6

#7 #1 AND (#2 OR #5)

#8 (Review:pt OR "Case Reports":pt OR ("case" NEXT report*):ti,ab)

#9 (child*:ti,ab OR (pediatric*:ti,ab))

#10 #7 NOT (#8 OR #9)