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ORIGINAL ARTICLE

Peroral Endoscopic Myotomy (POEM): Feasible as Reoperation Following Heller Myotomy

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Abstract
Purpose The purpose of this study was to demonstrate the feasibility of performing peroral endoscopic myotomy (POEM) in the management of recurrent achalasia after failed myotomy.
Methods Eight patients presented to our institution between October 2010 and June 2013 with recurrent/persistent symptoms after prior laparoscopic Heller myotomy. Three patients underwent redo laparoscopic Heller myotomy, and five patients consented to redo myotomy with POEM.
Results Demographics were similar between the groups with exception of age (POEM 69.5 vs. laparoscopic Heller myotomy (LHM) 34.5, $p=0.003$). Preoperative Eckardt scores, motility, and prior interventions were not significantly different. Three patients who underwent POEM and two who underwent laparoscopic Heller myotomy had prior fundoplication. There was one perforation identified after laparoscopic Heller myotomy and one patient with persistent subcutaneous emphysema after POEM. Both POEM and laparoscopic Heller myotomy demonstrated significant improvement in symptoms and Eckardt scores at average follow-up of approximately 5 months ($p<0.05$).
Conclusion POEM is a feasible option for patients after failed myotomy even in the presence of prior fundoplication. The procedure can be performed safely using a similar technique as for primary myotomy with the exception of creating the myotomy laterally along the right side of the esophagus and lesser curvature avoiding the previous anterior myotomy.

Keywords Achalasia · Dysphagia · POEM · Heller myotomy Recurrent achalasia · Reoperation · Failed Heller myotomy

Introduction

Peroral endoscopic myotomy (POEM) has recently gained popularity as a less invasive mode to treat esophageal achalasia. First described in 2009, this technique allows for an effective treatment using endoscopic tools to create a submucosal tunnel, myotomy of the circular muscle bundle, and closure of the mucosal entry point.[1] Short-term studies thus far have demonstrated 90–100 % success rate of eliminating dysphagia symptoms.[2] However, without performing an anti-reflux procedure, controversy exists as to the occurrence and long-term development of reflux in this population. Despite the disputed utility for POEM as the primary management of achalasia, we believe that there is a role for this technique in recurrent or persistent achalasia as it avoids reoperation at the distal esophagus and gastroesophageal junction.

Failure after primary surgical management of achalasia with laparoscopic Heller myotomy (LHM) occurs in 10 % of patients.[3,4] These patients with persistent or recurrent symptoms require further interventions and, in many cases, reoperation. First-line treatment for failed myotomy can include Botox injections or pneumatic dilation. However, after failure to relieve symptoms with these methods, reoperation often

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becomes necessary. Most commonly, primary myotomy failure is due to an inadequate myotomy or fibrosis and scarring at the site of myotomy,[5,6] and symptoms are relieved with revision of the myotomy. As centers are becoming more skilled with minimally invasive techniques, reoperation in these patients can be performed using laparoscopy to avoid a laparotomy. However, regardless if performed open or laparoscopic, reoperations can be difficult procedures requiring prolonged general anesthesia with associated blood loss and perioperative complications.

Due to our center's experience with POEM, we thought that revising a failed myotomy using this endoscopic technique as an alternative to reoperation could potentially avoid these problems with reoperation. In this short case series of appropriately chosen candidates, we were able to demonstrate that performing this redo myotomy endoscopically, in patients that would otherwise require reoperation, is a feasible and safe procedure when performed by an operator skilled with POEM.

Methods

Between October 2010 and June 2013, eight patients presented with recurrent dysphagia symptoms after failed Heller myotomy for achalasia to the NorthShore University HealthSystem. All patients were evaluated with a standard history and physical, were specifically evaluated for dysphagia and gastroesophageal reflux disease (GERD), and were staged with Eckardt scoring, a validated tool for evaluation of achalasia.[7] Patients additionally underwent preoperative esophagram, esophageal manometry, and esophagogastroduodenoscopy as part of their evaluation.

Three patients underwent the standard treatment, with a redo laparoscopic Heller myotomy and redo fundoplication. In 2011, one of the patients with recurrent dysphagia presented with a previous Heller myotomy but with no prior history of fundoplication. Due to our institution's experience with POEM and the absence of fundoplication, we felt that this patient was a good candidate for a redo myotomy with POEM. After explaining the associated risks and novel use of this technique, the patient consented to the procedure. Due to the ease of the procedure using the technique described below and a second success with another patient without prior fundoplication, the procedure was then offered to all patients presenting with failed myotomy regardless of the presence of fundoplication.

Exclusion criteria for redo myotomy with POEM were similar to those for primary POEM which included esophageal varices, coagulopathy, active esophagitis, pregnancy, known gastroesophageal malignancy, or age less than 18 years. All patients consented to the procedure and were followed up according to the approved institutional review board protocol.

Surgical Technique

The POEM procedure was performed as described previously[8] by a surgeon experienced in POEM (Fig. 1). Under general anesthesia, patients were placed supine. Initially, air had been inadvertently used for insufflation with a complication as described later. However, after this error in equipment use was corrected, carbon dioxide was routinely used for insufflation and a high-definition standard upper endoscope was inserted into the esophagus and stomach. Once the gastroesophageal junction (GEJ) was identified, an overtube was placed over the endoscope and dissecting cap placed on the endoscope. Approximately 10 cm proximal to the GEJ, the mucosa was injected

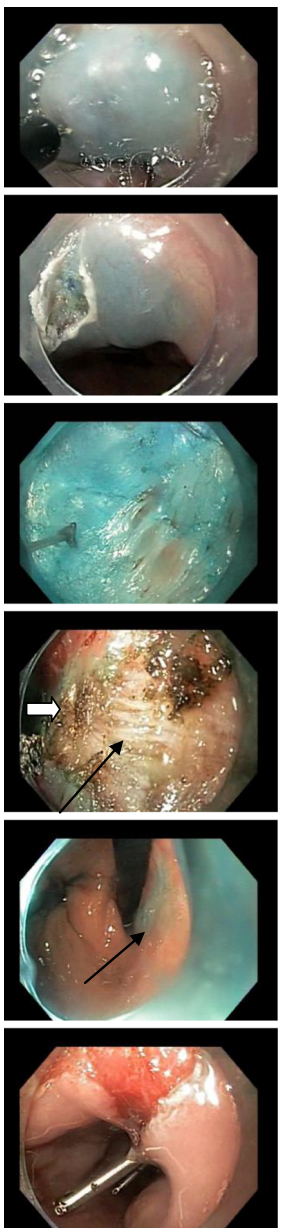

Fig. 1 Redo myotomy using a peroral endoscopic technique (POEM) in a patient who underwent previous failed laparoscopic Heller myotomy

with a mixture of methylene blue, saline, and epinephrine, on the right lateral aspect of the esophagus. Fluid injected into the lumen that settled on the posterior wall of the esophagus allowed for easy identification of the right lateral position. This lateral positioning was intentional in order to avoid creating a myotomy near the previous anterior myotomy, and the use of methylene blue allowed us to ensure this lateral positioning as we proceeded. The mucosotomy was made with a triangle tip knife (Olympus Inc., Center Valley, PA) and the submucosa entered. The submucosal tunnel was then created from the mucosotomy along the lesser curvature to 2–3 cm distal to the GEJ where blanching was identified on the stomach side. The myotomy of the circular fibers was then performed from 2 to 3 cm distal to the mucosotomy to the end of the tunnel at 2–3 cm distal to the GEJ. Using endoscopic clips, the mucosotomy was closed. After completion of the procedure, the scope easily traversed the GEJ, the scope was removed, and the patient was extubated and recovered.

The redo LHM was performed with five ports. Any postoperative adhesions preventing adequate exposure were removed. The previous fundoplication was carefully taken down, and a 10-cm myotomy was performed laterally along the right side of the esophagus avoiding the previous anterior myotomy and extended 3 cm onto the stomach. The antireflux procedure was then performed with either a Dor or Toupet fundoplication. An intraoperative upper endoscopy was performed to confirm the absence of perforation and the relaxation of the GEJ.

Postoperatively, all patients were admitted and remained *nil per os* (NPO) the first night. The following morning, if radiographic oral contrast testing was normal, the patient was started on our postoperative esophageal diet plan, which included liquids the first day and pureed food for 2 weeks. The registered nurses on the floor documented pain scores and analgesic use in our electronic medical record.

All patients were scheduled to return for follow-up at 3 weeks, 9 weeks, and 6 months. The POEM group was also followed prospectively in clinic at 1 and 2 years. Eckardt scores and dysphagia scores were collected at those time points and prospectively logged in a database.

Results

Preoperative

Three patients underwent LHM for redo myotomy, and five patients agreed to POEM for redo myotomy. Patient demographics for the two groups described in Table 1 showed similar BMI and gender but significantly older POEM group (mean age of 69.6 vs. 34.5). All patients in each group had had previous laparoscopic Heller myotomy. Three of the five patients in the POEM group and two of the three patients in the LHM group had undergone a fundoplication at that time as well, as specifically described in Table 1. There was no significant difference in the number of prior interventions, preoperative Eckardt scores, or preoperative anesthesia assessments as detailed in Table 1. All patients underwent preoperative workup with upper endoscopy, esophagram or computed tomography, and manometry. Preoperative resting and residual lower esophageal sphincter (LES) pressures were not significantly different between the groups.

Table 1 Preoperative patient demographics

	POEM (n=5)	Laparoscopic (n=3)	p value
Age	69.6	34.5	0.003
Sex			0.72
Female	1 (20 %)	1 (33.3 %)	
Male	4 (80 %)	2 (66.7 %)	
BMI	29.5	27.9	0.53
Previous intervention			ns
Botox	2/5	1/3	
Dilation	4/5	2/3	
Fundoplication	3/5[a]	2/3[b]	
ASA class			
I	0	1	
II	2	2	
III	3	0	
Mean resting LES pressure	7.5	8.5	0.90
Mean residual LES pressure	5.0	6.0	0.81

ns not significant

[a] One patient had previous Nissen, one had previous Dor, and one had previous Toupet fundoplications

[b] One patient had previous Nissen and one patient had previous Dor fundoplications

Intraoperative

There were no complications or adverse events intraoperatively for either POEM or LHM. Operative time was not significantly different for POEM compared to LHM (139.0±29.6 vs. 174.7±15.1 min, p=0.42). Estimated blood loss (EBL) was negligible in POEM and has an average of 35 mL in LHM. Myotomy lengths were comparable, and details of the POEM group are outlined in Table 2.

Postoperative

Postoperatively, there was one major complication, an esophageal leak and mediastinal abscess after LHM. This patient went on to have an esophageal stent, continued leak, and eventual thoracoscopy and washout with prolonged hospitalization (20 days). Thus, there was a longer average length

Table 2 Intraoperative data

	POEM	Laparoscopic	*p* value
Operative time (min)	139.0±29.6	174.7±15.0	0.42
EBL (mL)	N/A	35	–
Submucosal tunnel (cm)	12.8	N/A	–
Myotomy length (cm)	9.0	10	0.40

N/A not applicable

of stay for LHM compared to POEM although not significant (11 vs. 1.6 days, $p=0.167$). The average length of stay when excluding this patient is included in Table 3.

With similar follow-up at approximately 5 months ($p=0.957$), patients in the POEM and LHM groups both demonstrated significant improvement in Eckardt scores after the procedures. Both preoperative and postoperative Eckardt scores were not significantly different between the groups (Table 3).

Discussion

Achalasia is a rare disease altering the mechanics of the esophagus affecting one person in 100,000 per year. Treatment of this disease is aimed to palliate symptoms, due to our inability to reverse the underlying pathology. Initially treated with pharmacologic agents, these patients will all often need more definitive treatments.[7,9] The most effective treatments for these patients include surgery or dilation. While dilation is the most effective nonsurgical treatment for dysphagia relief, this treatment is associated with the highest risks of complications and is often a second choice to surgery for the primary treatment of this disease.[10] Although surgery is often preferred for definitive treatment of symptoms, when treated surgically, there still is a 10 % failure rate. This group of failed myotomy patients is a difficult group to treat. These patients are approached with different modalities including pneumatic dilation, Botox, and even reoperation.

Pneumatic dilation, often a nonsurgical treatment for primary disease, is a method of forceful dilation with a balloon to dilate and disrupt the LES. With this procedure, success may be user dependent and can be associated with many risks including reflux and, of most concern, perforation especially in the setting of previous myotomy. Although pneumatic dilation in the setting of previous myotomy has been shown to have similar rates of complications as when performed in the naïve esophagus,[11] when performed after failed laparoscopic Heller myotomy, it has been quoted with anywhere from a 12 %[12] to 80 % success rate.[5] This is not unlike the varying success rates reported for primary treatment.

As previously discussed, a failed Heller myotomy is most commonly due to incomplete myotomy or scarring and fibrosis of the myotomy site, and thus, surgical treatment is usually the most successful treatment. As in any patient with prior abdominal surgery, reoperation in these patients can be a challenge to the surgeon. However, the morbidity and mortality for redo Heller myotomy have been studied by many groups, and redo Heller myotomy has been an acceptable treatment for quite some time. In fact, recent studies have demonstrated that performing this procedure laparoscopically is comparable to open procedures.[13–15] A recent review investigated the feasibility of laparoscopic redo myotomy, showing 4 of 54 conversions to open, an average length of operation from 2 to 7.5 h, and perforation in 7 of 45 patients, all identified and repaired intraoperatively.[16]

Though the current gold standard for failed Heller myotomy is reoperation, we have found a novel treatment for failed myotomy which may be less invasive with similar outcomes. Unlike an intra-abdominal operation, POEM allows for the operator to revise the myotomy site without encountering the challenges due to postoperative changes and scarring. From our experience with endoscopic redo myotomy, we have found that a patient with a previous myotomy with or without fundoplication does not largely change the procedure from when performing a primary POEM.

Table 3 Postoperative data

	POEM	Laparoscopic	*p* value
Length of stay (days)	1.6±0.2	2.5±0.5[a]	ns
Major complications	1/5 (subcutaneous emphysema)	1/3 (perforation/mediastinal abscess)	ns
Outcome			
Follow-up (days)	148.2	152.3	ns
Preop Eckardt scores	6.8 (5–10)	5.33 (4–6)	ns
Postop Eckardt scores	0.6[b]	1.0[c]	ns

ns not significant

[a] Excludes one patient with a 20-day admission secondary to perforation

[b] POEM preop vs. postop Eckardt scores, $p=0.0004$

[c] Laparoscopic preop vs. postop Eckardt scores, $p=0.008$

Surprisingly, compared to our experience with primary POEM (n=40), we did not observe any differences in difficulty in the procedure. Previous fundoplication did not appear to change the intraluminal anatomy when performing the procedure. Upon retroflexion within the stomach, the typical blanching of the mucosa was not obscured by the presence of the fundoplication and submucosal dissection onto the lesser curvature of the stomach for a few centimeters was still possible. Although postoperative changes were not evident, in order to avoid encountering the prior myotomy, the redo myotomy is best made laterally, avoiding the anterior esophagus. This is similar to performing a myotomy during a redo laparoscopic Heller myotomy. Just as in a primary POEM, we avoid a posterior myotomy due to the proximity of the aorta and potential for lethal vascular injury. We additionally avoid disrupting the angle of His by remaining lateral on the right esophagus and lesser curvature of the stomach as opposed to the greater curvature.

In this small case series, we demonstrate that redo myotomy with POEM may be comparable to a redo LHM at our institution. Preoperatively, all patients had previous operations and failed myotomy presenting with recurrent symptoms. Patients were initially chosen for POEM due to the absence of fundoplication; however, after the successful experience with the first two patients using POEM, POEM was subsequently used in the remaining patients with prior fundoplication without additional difficulty.

Despite the POEM cohort having older patients, age was not considered when patients were selected for the procedure and was incidental that there was this age discrepancy. Despite the difference in age between the cohorts, the length of stay was still shorter, though not significant, than the laparoscopic group. Due to inadvertent usage of air insufflation, one patient experienced subcutaneous emphysema after POEM. Although this patient remained stable with no difficulty ventilating or evidence of pneumothorax, as a precaution, the patient remained intubated in the ICU overnight for observation. The patient was extubated the following morning with no complications, had resolution of the subcutaneous emphysema, and was discharged home on postoperative day 2. This complication has not occurred again since the use of carbon dioxide rather than air for insufflation. The LHM group had one patient with an esophageal perforation identified on routine postoperative imaging. This patient ultimately required a return to the operating room for washout and prolonged hospitalization. He eventually recovered and continues to do well without recurrent dysphagia. Although our series was not large enough to capture the actual incidence of complications in these groups, one could postulate a higher incidence of major complications, such as perforation, after a redo laparoscopic procedure as compared to POEM due to the mediastinal dissection through scarred tissue and obscured tissue planes during a reoperation.

We demonstrate the feasibility of POEM for revision of failed myotomy in a small cohort. From our preliminary study, it appears that this technique may demonstrate a safer and less morbid treatment than reoperation. Additionally, we demonstrate in our small case series similar outcomes between POEM and LHM with significant improvement in symptoms at 5-month follow-up. These results should be viewed with caution, and long-term studies in a large population must be performed.

Conclusion

From our experience, it appears that any patient with failed myotomy, who would otherwise meet criteria for primary POEM for achalasia, may be a candidate for a redo myotomy with POEM regardless of prior fundoplication. This procedure should be performed at a center experienced in POEM, and we emphasize the importance of staying right lateral on the esophagus when performing the redo myotomy as described above. Additionally, due to the potential risks associated in patients with prior interventions and operations on the esophagus, the operator should be prepared to convert to a laparoscopic or open procedure. We feel that there may be an appropriate and beneficial use of POEM in these patients, and we plan to continue our practice, collecting more data to further study the role of POEM after failed myotomy.

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