Per-oral endoscopic myotomy (POEM): Its complications and beyond

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Abstract

Since the concept of natural orifice transluminal endoscopic surgery (NOTES) was introduced, per oral endoscopic myotomy (POEM) has been one of the most successful and widely-accepted procedures. Evidence from many studies suggests that POEM can achieve the same improvement in symptoms as laparoscopic Heller myotomy, but in a less invasive fashion. To date, no mortality has been reported, and the incidence of complications has been minimal. Most complications can be easily managed by non-surgical treatment, and many can be avoided by technical improvement of the operators. In this review, we describe the indications, technique, efficacy and complications of the POEM procedure. POEM for non-achalasia spastic disorders is also discussed.

Keywords: Achalasia, diffuse esophageal spasm, nutcracker esophagus, Jackhammer esophagus, hypertensive lower esophageal sphincter, per-oral endoscopic myotomy

การผ่าตัดหูรูดหลอดอาหารโดยการส่องกล้อง: ภาวะแทรกซ้อนและอื่น ๆ

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บทคัดย่อ

หลังจากมีการพัฒนาด้านการผ่าตัดโดยการส่องกล้องผ่านช่องทวาร (natural orifice transluminal endoscopic surgery) การผ่าตัดหูรูดหลอดอาหารโดยการส่องกล้อง (per-oral endoscopic myotomy) เป็นอีกหัตถการที่ได้รับการยอมรับมากขึ้นอย่างต่อเนื่องในการรักษาภาวะหูรูดหลอดอาหารไม่คลายตัว (achalasia) ซึ่งจากการศึกษาต่าง ๆ พบว่าได้ผลการรักษาที่ดีในขณะที่มีการบาดเจ็บต่อเนื้อเยื่อน้อยกว่าการผ่าตัดตามมาตรฐานและไม่มีบาดแผลภายนอก บทความนี้มีจุดมุ่งหมายที่จะรวบรวมถึงเทคนิคในการทำหัตถการดังกล่าว ภาวะแทรกซ้อนที่อาจจะเกิดขึ้น รวมถึงการนำหัตถการนี้ไปประยุกต์ใช้ในโรคอื่น ๆ ของหลอดอาหาร

Background

Achalasia is a rare esophageal disorder that results in impaired motility of the esophageal body and non-relaxation of the lower esophageal sphincter (LES). The etiology is still unclear, and treatment, which may be medical or surgical, focuses on palliation of dysphagia. In the era of minimally invasive surgery, laparoscopic Heller myotomy (LHM) has been a standard treatment of achalasia for decades. After Inoue H, et al reported the first case series of per-oral endoscopic myotomy (POEM) in 2010[1], it was accepted worldwide as a less invasive procedure that can achieve outcomes that are comparable to LHM[2-4].

Indications

POEM is a minimally invasive technique, so any achalasia patient could be a candidate for the procedure. It is safe to perform POEM even in patients who exhibit sigmoid dilation of the esophagus as well as those who have undergone previous treatment, including endoscopic balloon dilation, LHM, or prior POEM. If the patients have previously undergone LHM or POEM, the second myotomy is performed in a different location from the first. Other motility disorders such as diffuse esophageal spasm (DES), nutcracker esophagus, Jack-hammer esophagus, and hypertensive lower esophageal sphincter can also be treated by POEM. The main technical limitation to the performance of the procedure is severe submucosal fibrosis of the distal esophagus; this may occur in cases in which the patient has had severe esophagitis or previously received repeated endoscopic treatments such as multiple Botulinum toxin injections or balloon dilations.

POEM technique

All patients are fasted overnight. Before induction of general anesthesia, upper endoscopy is performed to clear all residual contents and reduce the risk of aspiration.

The procedure can be divided into two main steps: 1) creation of a submucosal tunnel, and 2) endoscopic myotomy. Entry into the submucosal space is achieved with submucosal injection of saline followed by a mucosotomy. To avoid mucosal injury, the submucosal tunnel is dissected as close to the muscular bundles as possible using a triangle-tip knife (TT knife, Olympus, Japan). During the procedure, a mixture of saline and indigo carmine is injected into the submucosal space to enhance visualization of the anatomical plane between the mucosa and the muscle fibers. The tunnel is extended beyond the esophagogastric junction (EGJ) onto stomach for 3 cm. Many landmarks can be used as indicators of the EGJ (table 1). The myotomy is then performed with the TT knife, targeting the circular muscle layer. At the conclusion of the procedure, the mucosal incision is closed with hemostatic clips.

Table 1:

Useful landmarks to identify EGJ

Landmarks
Depth of the endoscope from incisor
Submucosal space become narrow contained high resistance
The palisade vessels are identified
The aberrant innermost longitudinal muscle bundles are identified
Increased vascularity in gastric cardia
Visualization of a blue hue on intraluminal endoscopic view at gastric cardia
Observed location of submucosal scope by another small caliber intraluminal scope

Variations in Technique

There are many centers performing POEM worldwide. A variety of modifications to the original technique have been described.

Location of myotomy

POEM can be performed at 2 o'clock (anterior-lesser curve) or 5 o'clock (posterior-lesser curve) positions. In some cases, previous procedures such as LHM, POEM, or ESD for an esophageal lesion had been performed, precluding safe submucosal dissection in the normal location; in these cases, a greater curve myotomy in the 7 o 'clock or 8 o'clock position is recommended. Most POEM centers recommended a myotomy location between 11 o'clock and 2 o'clock, but the posterior-lesser curve myotomy is favored in Shanghai (China) and Mineola (USA)[5].

Submucosal dissection

The submucosal tunnel can be created without difficulty with TT knife. However, using a T-type hybrid knife (ERBE, Germany), which can inject saline directly through the instrument, is another technique that may reduce operative times[6]. We do not recommend using blunt dissection with an endoscopic balloon because it may cause mucosal injury or bleeding.

Circular muscle myotomy vs. Full thickness myotomy

Circular muscle myotomy is normally performed in our institute. Nevertheless, some centers prefer a full thickness myotomy. Li QL, et al compared full thickness myotomy with circular muscle myotomy and found no difference in either efficacy or adverse events. Shorter operative times were observed with full thickness myotomy[7].

Efficacy

The first successful POEM in a human was completed on September 8, 2008, and a limited number of cases were performed in the first few years. Early results have been excellent; numerous articles show improvement of mean Eckardt score in the short-term follow up period, decreasing from 5.4 – 8.8 pre-operatively to 0.4 – 1.7 post-operatively[2-4, 8-15]. Significant improvements in LES pressure and barium column height have also been observed[1-4, 8-12, 16]. Success rates, defined by a post-POEM Eckardt score ≤3, are shown in Table 2. Unfortunately, no long-term follow-up has yet been published. In one recent study, complete relief of symptoms (Eckardt score for dysphagia = 0) was achieved in 97.8% of achalasia cases[17].

POEM is also an effective approach in patients who have failed LHM. Zhou PH, et al

Table 2:

Success rates after POEM

Study	Success rate (%)	Mean follow-up (mo.)
Costamagna 2012 (9)	100	3
Von Renteln 2012 (10)	94	3
Swanström 2012 (12)	100	11
Hungness 2013 (2)	89	6
Teitelbaum 2013 (3)	100	9
Von Renteln 2013 (8)	82.4	12
Lee 2013 (11)	100	7
Freidel 2013 (13)	95	3
Inoue 2013 (14)	100	12
Bhayani 2014 (4)	100	6

reported an improvement in mean Eckardt score from 9.2 to 1.3[18], whereas Onimaru M, et al reported mean pre- and post-operative scores as 6.5 and 1.1 respectively[19]. An impressive outcome in terms of Eckardt score improvement could also be expected after POEM in patients who have failed Botox injections or balloon dilation[20].

Complications

Overall, POEM is a safe procedure. Many centers have reported only minor complications, and there have been no mortalities to date[8, 9, 11-13, 16, 21-24]. From the international POEM survey (IPOEMS) database, severe adverse events occurred in only 3.2% of cases[5].

Insufflation-related complications

Insufflation during the procedure can lead to a variety of sequelae including pneumomediastinum, subcutaneous emphysema, pneumoperitoneum, and pneumothorax. When detected with CT scan, these were found in up to 48% of patients, but in most cases no intervention was required[25]. Because of the low incidence of serious complications, routine post-operative CT has not been advised.

In one study from Shanghai, pneumothorax was reported in 25.2% of cases, but treatment with thoracic drainage was performed only when high lung volume compression occurred (11.8%; 14/119). They also reported a 48.7% (58/119) incidence of hydrothorax after POEM, but drainage was needed in only 3.4% (2/58) of these cases[26]. Using CO_2 instead of air for insufflation may reduce the incidence of insufflation-related complications because CO_2 can be rapidly absorbed.

During the procedure, clinically significant pneumoperitoneum actually occurs more frequently than clinically significant pneumomediastinum. If the abdomen is not overly distended and there is no adverse physiologic effect, no intervention is needed; in cases that do require intervention, an 18 gauge angiocatheter (connected to a 10cc syringe of normal saline to visualize the vented gas) is sufficient treatment.

Bleeding

In the submucosal space, there are relatively few vascular structures. Most of the vessels can be controlled with a coagulating forceps (Coagrasper, Olympus, Japan). To avoid bleeding from the cut edge of the muscle, spray coagulation is advised while performing the myotomy. When bleeding is encountered, using the dissection cap to compress the suspected area may slow any bleeding vessels, and irrigation with saline improves visualization. Perioperative hemostasis is universally successful. No cases of POEM have been converted to operative procedure to control bleeding. Small submucosal hematomas that develop post-operatively can be managed conservatively.

In one case series, 0.7% (3/428) patients experienced delayed bleeding in the submucosal tunnel that manifested as hematemesis; there were no predisposing factors or difficulties during the procedures. Bleeding was identified and controlled with coagulation in 2 patients. In the third patient, endoscopy did not reveal the bleeding point, and hemostasis was achieved with Sengstaken-Blakemore tube (SB tube) compression[27]; however, use of an SB tube to control bleeding cannot be recommended due to a lack of circular muscle continuity after the POEM procedure, which may lead to mucosal laceration and full-thickness perforation.

Mucosal injury and dehisced mucosal closure

Mucosal perforation is the most feared complication. The incidence varies among studies[1, 2, 8, 9, 12, 13, 16] but may be as high as 40%[21]. From the IPOEMS database, perforation was reported in 6.7% (56/841) of cases overall[5]. The most common site of perforation is at the EGJ where the lumen is narrowest. Almost all perforations can be managed with hemostatic clips; endoscopic suture (OverStitch, Apollo Endosurgery, Texas) repair and fibrin sealant have been proposed as alternatives in difficult cases[28, 29]. Small mucosal defects, however, can simply be managed with IV antibiotics and a small increase in the duration of NPO status.

Both barium esophagram and upper endoscopy are performed in all patients on post-operative day 1. Unless there is a mucosal defect, the patients are allowed to drink liquids, and regular diet is started on post-operative day 2. In a small percentage of cases, a small area of mucosal necrosis over the submucosal tunnel is found at the time of endoscopy; however, fasting alone is usually sufficient treatment.

Dehisced mucosal closure seldom occurs. Various hemostatic clips can be applied to re-close the incision. Closure with endoloops and hemosatic clips can be performed if mucosal edema prevents closure in the standard fashion[30]. The use of OverStitch (Apollo Endosurgery, Texas) has been described for closure of perforations[28], but could also be applied to difficult mucosotomy closures at the time of the POEM procedure.

Gastroesophageal reflux (GER)

During POEM, the myotomy is performed without fundoplication; therefore, the concern for development of post-operative GER is very high. Although the reported incidence of GER was very low in some studies[1, 10, 14], esophagitis was detected in 33-43% of cases in which endoscopy was performed[2, 8, 15, 16, 23, 31]. When 24-hour pH studies are used in addition to endoscopy, the rate of detecting GER may be as high as 50%[12]. When compared to LHM, Teitelbaum EN, et al reported a lower incidence of symptomatic GER in the POEM group[3]; however, Bhayani NH, et al reported no significant difference in pH testing between POEM and LHM[4]. The reported incidence of GER is shown in Table 3. When GER does occur, however, patients are either asymptomatic or controlled with PPI alone; there have been no reported cases of fundoplication in POEM patients.

Richards WO, et al reported that Heller alone (without Dor) resulted in a 48% incidence of post-surgical GER, whereas Heller with Dor fundoplication reduced the incidence to 9%[32]. Based on these findings, an antireflux procedure is generally recommended at the time of myotomy. Nowadays, fundoplication is usually performed with a partial wrap, which may be anterior (Dor) or posterior (Toupet). Rawlings A, et al conducted a randomized control trial that demonstrated a

Table 2:

Incidence of GER after POEM

Study	Reflux rate (%)	Detection method
Inoue 2010 (1)	6	endoscopy
Von Renteln 2012 (10)	6	endoscopy
Swanström 2012 (12)	50	endoscopy+ pH testing
Hungness 2013 (2)	33	endoscopy
Teitelbaum 2013 (3)	17	symptom
Von Renteln 2013 (8)	42	endoscopy
Inoue 2013 (14)	5	symptom
Stavropoulos 2013 (23)	43	endoscopy
Chiu 2013 (31)	20	pH testing
Bhayani 2014 (4)	39	pH testing
Minami 2014 (16)	39	endoscopy
Sharata 2015 (17)	38	pH testing

41.7% (10/24) incidence of acid reflux after Dor fundoplication compared to 21% (4/19) after Toupet[33]. Khajanchee YS, et al also reported a 33.3% incidence of acid reflux after Toupet[34]. From the IPOEMS database, a mean incidence of GER as evidenced by endoscopy was 17% (range 0-43%). When pH studies were performed, the incidence was up to 38%[5]. Compared to the studies mentioned above, it seems that the rate of GER after POEM is quite similar to the rate after LHM with Dor fundoplication. We believe that because POEM does not disrupt the phrenoesophageal ligament, which plays an important role in the pathogenesis of GER, the incidence of GER is comparable to LHM even though no fundoplication is performed during the POEM procedure. Many studies support the benefit of limited phrenoesophageal dissection. Simić AP, et al reported in their prospective study that limited dissection of the phrenoesophageal ligament significantly reduced the incident of GER from 23.5% with the standard Heller-Dor to 9.4% when Heller is performed with a limited hiatal dissection and no fundoplication (limited LHM)[35]. Robert M, et al also supports the effectiveness of limited hiatal dissection: without an anti-reflux procedure, postoperative GER occurred in 9.4% of patients at 2 months post-operatively and 11.3% in long-term follow-up[36]. Zurita Macías Valadez LC, et al, however, reported a 21.6% rate of symptomatic GER after limited hiatal dissection without fundoplication[37]. The wide range in reported rates of GER after limited LHM may be related to differences in the extent of dissection carried out in different centers; POEM, meanwhile, does not require any dissection of the hiatus, so post-POEM reflux rates are likely at the lower end of the spectrum.

POEM beyond Achalasia

Myotomy has a role in the treatment of not only achalasia but also other spastic disorders of the esophagus, especially diffuse esophageal spasm (DES). Dating back to 1960, Ellis FH, et al published the first series of esophagomyotomy in manometrically diagnosed DES patients, with success rates of 83%[38]. Because a longer myotomy is generally needed in spastic disorders of esophagus, most operations were done via thoracotomy or, with the advent of minimally invasive techniques, thoracoscopy. With a long myotomy, 70 – 88% and 80 – 100 % rates of improvement can be achieved for dysphagia and chest pain, respectively[39-43]. An obvious benefit of POEM over a traditional myotomy is that POEM allows for division of both the intra-thoracic and intra-abdominal muscle and can provide a very long myotomy without the morbidity of surgery. The efficacy of POEM in DES has been demonstrated in 2 patients from 2 case reports[44, 45].

While many studies have included multiple esophageal motility disorders in aggregate, individual analyses of Nutcracker esophagus and hypertensive LES (HTLES) are lacking; the benefit of myotomy in these disorders, however, appears to be weaker than in achalasia or DES. Some studies support the use of POEM in Nutcracker esophagus or HTLES[21, 46], and a myotomy could certainly be considered as a treatment option for patients who have failed medical management.

According to Chicago classification, Jackhammer esophagus is defined by at least 1 swallow with a distal contractile integral (DCI) greater than 8000 mmHg-s-cm detected by high-resolution esophageal pressure topography (EPT)[47]. Although recurrence of mild chest pain after POEM was observed in one case report of Jackhammer esophagus[48], another report of one patient demonstrated dramatic improvements in both symptom scores and manometry tracings[49].

From the IPOEMS database, which includes 841 patients, the POEM procedure was performed in 25 DES patients, 106 Nutcracker patients, and 58 HTLES patients. Compared to typical type 1 and 2 achalasia patients, POEM appeared to be equally effective in Nutcracker esophagus and HTLES patients; POEM was less effective for DES patients[5]. According to Sharata AM, et al, which included 12

Nutcracker esophagus, 5 DES, and 8 HTLES patients, complete dysphagia relief was achieved in 70.8% of non-achalasia cases, while chest pain was relieved in 91.5%[17].

Conclusions

To date, over 2000 POEM procedures have been performed worldwide. Many studies revealed an impressive efficacy with very low complication rates. Recent evidence also supports the use of this technique not only for achalasia but also for spastic disorders of esophagus. However, long-term outcomes and large comparative studies are still needed.

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