J Gastroenterol (2017) 52:401–406
DOI 10.1007/s00535-017-1314-5

The Japanese Society of Gastroenterology

REVIEW

Current status of achalasia management: a review on diagnosis and treatment

Joshua Tuason[1] · **Haruhiro Inoue**[1]

Received: 7 December 2016 / Accepted: 26 January 2017 / Published online: 10 February 2017

Abstract
Background Achalasia is a rare esophageal motility disorder that is characterized by loss of peristalsis and failure of relaxation of the lower esophageal sphincter (LES), particularly during swallowing. This review focuses on the diagnosis of esophageal motility disorders as defined by the Chicago Classification ver 3.0, and presents management options with regard to per-oral endoscopic myotomy (POEM) as the treatment of choice.
Methods A concise review of literature was performed for articles related to the management of achalasia, and this was contrasted with our institution's current practice.
Results Achalasia is still incompletely understood, and management is focused on establishing a proper diagnosis, and relieving the obstructive symptoms.
Conclusions Achalasia should be considered when dysphagia is present, and not otherwise caused by an obstruction or inflammation, and when criteria is met as per the Chicago Classification ver 3.0. Lowering LES tone and disruption of LES can be accomplished by various methods, most notably pneumatic balloon dilatation and surgical myotomy. POEM has been gaining momentum as a first line therapy for achalasia symptoms, and can be considered an important tool for motility disorders of the esophagus.

Keywords Achalasia · Peroral endoscopic myotomy · Esophageal motility disorders · Dysphagia

✉ Joshua Tuason
jetuason@yahoo.com

[1] Digestive Disease Center, Showa University Koto-Toyosu Hospital, 5-1-38 Toyosu, Koto-Ku, Tokyo 135-8577, Japan

Introduction

Achalasia is a neurodegenerative motility disorder of the esophagus that results in deranged peristalsis and loss of lower esophageal sphincter function, especially during swallowing [1–4]. The incidence is still rare, approximately 1.6 per 100,000 [5, 6]. It occurs equally in males and females, without racial predilection, and across all ages, with a peak incidence between the ages of 30 and 60 [7].

The disease manifests as symptoms of dysphagia, regurgitation of food and retrosternal chest pain [8]. Even with advancements in diagnostic tools and accurate screening methods, the etiology remains unclear. The general consensus of the literature suggests that achalasia represents a family of disorders rather than a single disease with a fixed pathophysiologic profile [9, 10]. The current understanding suggests that three factors determine the clinical phenotype including genetic predisposition, environmental triggers, and autoimmune myenteric plexitis [11–14]. The exact pathophysiology of the disease is not completely understood, and is beyond the scope of this review.

First-line treatment options have varied in the past, and well-established modalities such as pneumatic balloon dilation and surgical myotomy have been the mainstays over the past decade. Newer treatment options such as the peroral endoscopic myotomy (POEM) procedure have been practiced with increasing frequency in Asia and other parts of the world [15], but has yet to gain universal acceptance, though the data appears promising. POEM has the potential to be the preferred modality for achalasia and related esophageal motility disorders when personnel and logistics allow [16].

This review focuses on the diagnosis of achalasia based on the Chicago Classification ver. 3.0. A concise review of literature was conducted, focusing on the diagnosis and management of achalasia, and included papers discussing newer treatment modalities. We review the treatment options for achalasia and other motility disorders of the esophagus, and we draw special attention towards the POEM procedure as the primary management, and include our experience with its implementation.

Diagnosis

When approaching a patient with dysphagia as the chief complaint, a high index of suspicion for achalasia must be maintained. Evaluation must rule out common disorders, such as gastroesophageal reflux disease, mechanical obstruction, or malignancy [17]. Once such disorders are ruled out, work-up should then focus on motility disorders of the esophagus. A few technological advances have enhanced the diagnostic work-up for achalasia [18], but the modalities utilized most frequently include endoscopy, radiographic studies, and manometry. Esophagogastroduodenoscopy (EGD) is performed to rule out erosive gastroesophageal reflux disease, esophageal cancer, and structural lesions, such as strictures, webs, or rings. A normal EGD should not dissuade a clinician from making the diagnosis because up to 40% of patients with achalasia will have normal endoscopy [19]. Barium esophagogram may reveal a classic "bird's beak" appearance, esophageal dilation, or a corkscrew appearance with aperistalsis. In our institution, esophagogastroduodenoscopy, high-resolution manometry, barium esophagogram, as well as CT scan imaging have become the routine for patients presenting with dysphagia and a clinical history suggestive of an esophageal motility disorder.

The gold standard for achalasia diagnosis is esophageal manometry, with findings of aperistalsis and failure of relaxation of the lower esophageal sphincter (LES) [20, 21]. With the incorporation of color pressure topography plots, we are provided with more information regarding the dynamics of the esophagus [22]. The Chicago Classification v3.0 categorizes esophageal motility disorders with high-resolution manometry (HRM), and presents a hierarchical approach to the interpretation. Motility disorders are divided into categories of esophagogastric junction outflow obstruction, major disorders of peristalsis, and minor disorders of peristalsis, as seen in Table 1 [23].

Another diagnostic modality that can determine the dynamic profile of the esophagus is the functional lumen imaging probe (FLIP), used mostly at the esophagogastric junction [24]. This device consists of a distensible bag surrounding a catheter with impedance electrodes that measures cross-sectional area and impedance patterns [25]. The advantage is that the results can be observed in real time, and therapy can be tailored appropriately to the findings [26]. Information regarding FLIP is still limited, and it is unknown whether its application will be valuable as an alternative or an adjunct to manometry.

Treatment

The pathophysiology of the disease is not fully understood, therefore treatment modalities can neither reverse nor prevent the neurodegeneration of the myenteric plexus [8]. The primary goal of management should focus on early diagnosis and prevention of late complications, in order to preserve esophageal structure and function [17]. Available treatments aim to relieve esophageal outflow obstruction by lowering LES tone, or disrupting the LES, to facilitate passage of food across the LES. Available methods have used pharmacologic or interventional means. O'Neill et al. mentioned that patient preference, patient symptoms, and local expertise should guide the choice as to which modality to utilize [5].

Medical management has been used to relax smooth muscles, reduce LES pressure, and provide symptom relief, however the effects are limited clinically, and produce side effects. These therapies are now reserved for short-term treatment in patients who cannot tolerate invasive methods, or as a bridge to more definitive treatment [27]. Endoscopic botulinum toxin injection is still an accepted method for symptom relief, however the effects are often short lived [28, 29]. As with oral pharmacologic agents, Botox injection should be reserved for patients who cannot tolerate more invasive methods.

The mainstay of recent achalasia management focuses on the disruption of the LES by interventional means. Endoscopic pneumatic balloon dilatation (PD) positions a balloon across the LES and inflates it, effectively rupturing the muscle of the affected segment. Graded PD is performed by an initial dilation of 3.0 cm, progressing slowly at 0.5-cm intervals to reach a target of 4.0 cm. This is performed periodically with 4–6 weeks between each dilation. This modality is stated to have fewer major complications and deaths as compared to surgical myotomy [30]. Surgical LES myotomy also disrupts the LES fibers with a longitudinal incision. The preferred method has been the laparoscopic approach, or laparoscopic Heller myotomy (LHM), due to decreased morbidity and faster recovery [31, 32]. Though this method effectively relieves the obstruction, it also increases the risk of gastroesophageal reflux, and most surgeons incorporate an anti-reflux procedure by way of a partial fundoplication [33, 34]. Studies initially showed superiority of surgical myotomy in terms of efficiency and

Table 1 Interpretation of HRM studies

Motility disorders of the esophagus based on Chicago Classification v3.0 [23]	
Disorders with EGJOO	Achalasia type I: classic achalasia
	Achalasia type II: with pan-pressurization
	Achalasia type III: spastic achalasia
	EGJOO
Major disorders of peristalsis	Absent contractility
	Distal esophageal spasm
	Jackhammer esophagus
Minor disorders of peristalsis	Ineffective esophageal motility
	Fragmented peristalsis

EGJOO esophagogastric junction outlet obstruction

durability compared to single balloon dilatation [35, 36]. Further comparison of these two modalities has shown similar outcomes in treatment success rates after 2-year follow-up when a graded approach to PD has been used [32, 37, 38]. Pneumatic balloon dilatation and surgical myotomy therefore remain the universally accepted treatments for achalasia presently, and patients should be followed up long term [39].

The advent of the peroral endoscopic myotomy (POEM) procedure by Inoue et al. in 2008 provided another means of treatment that has been presented worldwide [40]. Initially described by Pasricha et al. [41], this form of natural orifice transluminal endoscopic surgery (NOTES) has provided adequate symptom relief, shown similar short-term results, and is less invasive as compared to laparoscopic Heller myotomy [42]. Short-term results have proven that POEM is a safe and effective approach for esophageal achalasia [43–45]. The patient is placed in a supine position under general anesthesia [46]. An endoscopic submucosal injection of dyed saline is followed by a mucosal incision, and subsequent creation of a submucosal tunnel to expose the circular muscle fibers at a length 2–3 cm beyond the LES. Selective circular muscle myotomy is then carried out under direct visualization, and the mucosa is closed with clips [47]. Advancements in technology as well as refinements in technique have led to safer procedures, as well as decreased operative time. The water-jet assisted triangle knife (Olympus, Tokyo, Japan) used in the creation of the submucosal plane, as well as the selective myotomy, provides a reduction of procedure time [48]. The use of the double-scope POEM technique provides a safe and reliable method for ensuring adequate gastric myotomy length during POEM, and may help to ensure proper outcomes [49]. These advancements along with the increase in operator expertise are what drive the use of POEM to be more widespread.

POEM has been used for all types of esophageal motility disorders, including, but not restricted to, advanced sigmoid achalasia and spastic motility disorders of the esophagus [50, 51]. POEM has even been performed successfully on refractory cases of achalasia following previous balloon dilation or laparoscopic Heller myotomy [52–55]. These cases should only be treated by highly experienced operators [47]. The advantage of POEM over surgical myotomy is that the length of the myotomy from the esophageal to gastric side can be adjusted freely to suit the individual case. This may make POEM a more appropriate, safe, and effective option for patients with sigmoid esophagus or history of surgical myotomy [56]. POEM has proven to be similar to LHM in terms of Eckardt score reduction, complications, operative time, and length of hospital stay [57–59]. POEM has also proven to be equally effective to pneumatic dilatation [60]. It is important to note, however, that data regarding the long-term effects of POEM are still limited, and randomized controlled trials comparing POEM with other treatment modalities are needed. This has been the barrier to the worldwide acceptance of the procedure, and its use has been confined to high-volume centers, though it is still believed that POEM represents a paradigm shift in the treatment of achalasia [61]. Post-procedure complications still arise, as with the other treatment modalities. On objective testing, the rate of gastroesophageal reflux disease (GERD) after POEM is 20–46%, which may not be significantly different from that observed after LHM with Dor fundoplication [62, 63].

At our institution, we have performed over 1200 cases of POEM since the innovation of the procedure, and this has become our treatment modality of choice for all motility disorders of the esophagus. Opinions have differed with regard to the length of the myotomy. Inoue et al. previously used a questionnaire regarding patients' dysphagia symptoms to determine the length of the myotomy [56]. The current practice in our institution has evolved over the years. We determine the length of the myotomy based on the patient symptoms, the results of the diagnostic evaluation, and the endoscopic findings. From a decision-making standpoint, we present our treatment algorithm with POEM as the first-line therapy seen in Fig. 1.

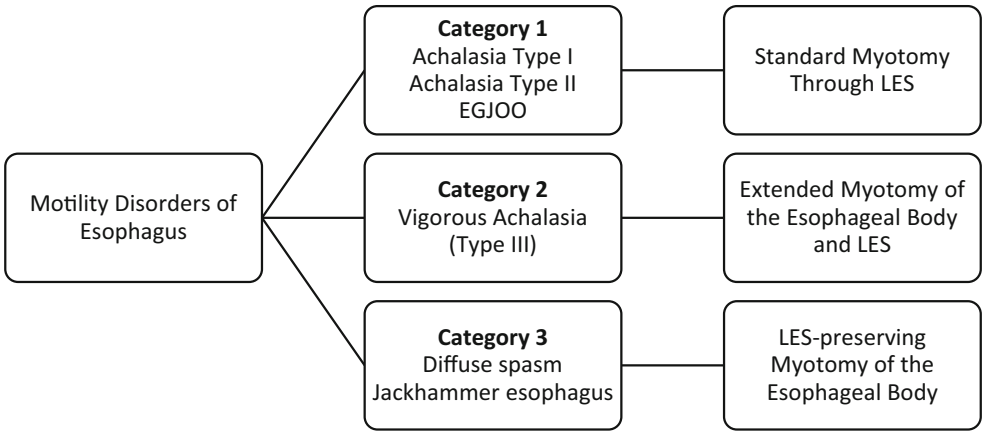

Fig. 1 Treatment algorithm for POEM. *EGJOO* Esophagogastric junction outlet obstruction, *LES* lower esophageal sphincter

The different motility disorders of the esophagus are based on manometric study, barium esophagogram, and endoscopic findings and are further subdivided into categories depending on the area of involvement of each disease entity. It then follows that a standard-length myotomy through the LES is adequate treatment for classic achalasia (type I), achalasia with pan pressurization (type II), and esophagogastric junction outlet obstruction. An extended myotomy of the esophageal body and the LES should be considered for vigorous achalasia (type III) with premature contractions. Diffuse spasm and jackhammer esophagus cases can be managed with a focused myotomy of the esophageal body, and the LES may be preserved. In some cases, the specific motility disorder may not be clearly identified at the time of the procedure. It is important to note the presence of spastic simultaneous contractions, or non-peristaltic contractions, as these intraoperative findings may also affect the length of the myotomy. Previous interventional procedures, as well as anatomy of the esophagus itself will also affect the decision on myotomy length as well as placement. Further long-term studies are needed to properly evaluate the outcomes of cases that follow this algorithm and more studies are needed in order to determine what constitutes an adequate myotomy, whether that be measurable by pressurization studies (EndoFLIP) or subjective symptom relief based on the Eckardt score. The purpose of this algorithm is not to create a guideline for clinical practice, but to assist the decision-making process, and clarify the primary focus of the intervention.

Conclusions

Achalasia remains a difficult to diagnose condition and a high index of suspicion must be maintained when patients present with dysphagia. Other causes of mechanical obstruction must be ruled out, and proper diagnostics must confirm a motility disorder of the esophagus. Treatment focused on disrupting the LES and lowering LES tone has been the mainstay of management, and has traditionally utilized pneumatic balloon dilatation and surgical myotomy. Peroral endoscopic myotomy is an effective treatment option for all types of motility disorders of the esophagus. With time and physician experience, POEM may become the ideal management for achalasia and its use may change the way we approach this rare disorder.

Compliance with ethical standards

Conflict of interest The authors declare there are no conflicts of interest.

References

1. Cohen S. Motor disorders of the esophagus. N Engl J Med. 1979;301:184–92.
2. Cohen S, Parkman HP. Treatment of achalasia–whalebone to botulinum toxin. N Engl J Med. 1995;332:815–6.
3. Vantrappen G, Hellemans J. Treatment of achalasia and related motor disorders. Gastroenterology. 1980;79:144–54.
4. Park W, Vaezi MF. Etiology and pathogenesis of achalasia: the current understanding. Am J Gastroenterol. 2005;100:1404–14.
5. O'Neill OM, Johnston BT, Coleman HG. Achalasia: a review of clinical diagnosis, epidemiology, treatment and outcomes. World J Gastroenterol. 2013;19(35):5806–12.
6. Sadowski DC, Ackah F, Jiang B, Svenson LW. Achalasia: incidence, prevalence and survival. A population-based study. Neurogastroenterol Motil. 2010;22:e256–61.
7. Francis DL, Katzka DA. Achalasia: an update on the disease and its treatment. Gastroenterology. 2010;139:369–74.
8. Winter H, Shukla R, Elshaer M, Riaz AA. Current management of achalasia—a review. Br J Med Pract. 2015;8(2):a810.
9. Pandolfino JE, Kwiatek MA, Nealis T, Bulsiewicz W, Post J, Kahrilas PJ. Achalasia: a new clinically relevant classification by high-resolution manometry. Gastroenterology. 2008;135:1526–33.
10. Sodikoff J, Lo A, Shetuni B, Kahrilas P, Yang G, Pandolfino JE. Histopathologic patterns across achalasia subtypes. Neurogastroenterol Motil. 2015;28:139–45.

11. Singh R, Ghoshal UC, Misra A, Mittal B. Achalasia is associated with eNOS4a4a, iNOS22GA, and nNOS29TT genotypes: a case-control study. J Neurogastroenterol Motil. 2015;21:380–9.
12. Shteyer E, Edvardson S, Wynia-Smith SL, Pierri CL, Zangen T, Hashavya S, Begin M, Yaacov B, et al. Truncating mutation in the nitric oxide synthase 1 gene is associated with infantile achalasia. Gastroenterology. 2015;148(533–6):e4.
13. Vigo AG, Martinez A, de la Concha EG, Urcelay E, de Ruiz Leon A. Suggested association of NOS2A polymorphism in idiopathic achalasia: no evidence in a large case-control study. Am J Gastroenterol. 2009;104:1326–7.
14. Goldblum JR, Rice TW, Richter JE. Histopathologic features in esophagomyotomy specimens from patients with achalasia. Gastroenterology. 1996;111:648–54.
15. Minami H, Inoue H, Haji A, et al. Per-oral endoscopic myotomy: emerging indications and evolving techniques. Dig Endosc. 2015;26:175–81.
16. Friedel D, Modayil R, Stavropoulos SN. Per-oral endoscopic myotomy: major advance in achalasia treatment and in endoscopic surgery. World J Gastroenterol. 2014;20:17746–55.
17. Pandolfino JE, Gawron AJ. Achalasia: a systematic review. JAMA. 2015;313(18):1841–52.
18. Bogte A, Bredenoord AJ, Oors J, Siersema PD, Smout AJPM. Reproducibility of esophageal high-resolution manometry. Neurogastroenterol Motil. 2011;23(7):e271–6.
19. Howard PJ, Maher L, Pryde A, et al. Five-year prospective study of the incidence, clinical features, and diagnosis of achalasia in Edinburgh. Gut. 1992;33:1011–5.
20. Kumar P, Clark M. Clinical medicine. 4th ed. Edinburgh: WB Saunders; 1998. p. 229–31.
21. Pohl D, Tutuian R. Achalasia: an overview of diagnosis and treatment. J Gastrointest Liver Dis. 2007;16(3):297–303.
22. Pandolfino JE, Ghosh SK, Rice J, Clarke JO, Kwiatek MA, Kahrilas PJ. Classifying esophageal motility by pressure topography characteristics: a study of 400 patients and 75 controls. Am J Gastroenterol. 2008;103(1):27–37.
23. Kahrilas PJ, Bredenoord AJ, Fox M, Gyawali CP, Roman S, Smout AJ, Pandolfino JE, IHRMWG. The Chicago Classification of esophageal motility disorders, v3.0. Neurogastroenterol Motil. 2015;27:160–74.
24. McMahon BP, Frøkjær JB, Kunwald P, Liao D, et al. The functional lumen imaging probe (FLIP) for evaluation of the esophagogastric junction. Am J Physiol Gastrointest Liver Physiol. 2007;292:G377–84.
25. Gyawali CP. Achalasia: new perspectives on an old disease. Neurogastroenterol Motil. 2016;28:4–11.
26. Kwiatek MA, Pandolfino JE, Hirano I, Kahrilas PJ. Esophagogastric junction distensibility assessed with an endoscopic functional luminal imaging probe (EndoFLIP). Gastrointest Endosc. 2010;72(2):272–8.
27. Vela MF. Management strategies for achalasia. Neurogastroenterol Motil. 2014;26:1215–21.
28. Vaezi MF, Pandolfino JE, Vela MF. ACG clinical guideline: diagnosis and management of achalasia. Am J Gastroenterol. 2013;108:1238–49.
29. Pasricha PJ, Rai R, Ravich WJ, Hendrix TR, Kalloo AN. Botulinum toxin for achalasia: long-term outcome and predictors of response. Gastroenterology. 1996;110(5):1410–5.
30. Lynch KL, Pandolfino JE, Howden CW, Kahrilas PJ. Major complications of pneumatic dilation and Heller myotomy for achalasia: single-center experience and systematic review of the literature. Am J Gastroenterol. 2012;107(12):1817–25.
31. Ali A, Pellegrini CA. Laparoscopic myotomy: technique and efficacy in treating achalasia. Gastrointest Endosc Clin N Am. 2001;11:347–58.
32. Campos GM, Vittinghoff E, Rabl C, et al. Endoscopic and surgical treatments for achalasia: a systematic review and meta-analysis. Ann Surg. 2009;249(1):45–57.
33. Richards WO, Torquati A, Holzman MD, et al. Heller myotomy versus Heller myotomy with Dor fundoplication for achalasia: a prospective randomized double-blind clinical trial. Ann Surg. 2004;240(3):405–12.
34. Rawlings A, Soper NJ, Oelschlager B, et al. Laparoscopic Dor versus Toupet fundoplication following Heller myotomy for achalasia: results of a multicenter, prospective, randomized-controlled trial. Surg Endosc. 2012;26(1):18–26.
35. Persson J, Johnsson E, Kostic S, Lundell L, Smedh U. Treatment of achalasia with laparoscopic myotomy or pneumatic dilatation: long-term results of a prospective, randomized study. World J Surg. 2015;39(3):713–20.
36. Novais PA, Lemme EMO. 24-h pH monitoring patterns and clinical response after achalasia treatment with pneumatic dilation or laparoscopic Heller myotomy. Aliment Pharmacol Ther. 2010;32(10):1257–65.
37. Boeckxstaens GE, Annese V, des Varannes SB, Chaussade S, Costantini M, Cuttitta A, Elizalde JI, Fumagalli U, et al. Pneumatic dilation versus laparoscopic Hellers myotomy for idiopathic achalasia. N Engl J Med. 2011;36:1807–16.
38. Vela MF, Richter JE, Khandwala F, et al. The long-term efficacy of pneumatic dilatation and Heller myotomy for the treatment of achalasia. Clin Gastroenterol Hepatol. 2006;4:580–7.
39. Gerson LB. Pneumatic dilation or myotomy for achalasia? Gastroenterology. 2007;132(2):811–3.
40. Inoue H, Minami H, Kobayashi Y, et al. Peroral endoscopic myotomy (POEM) for esophageal achalasia. Endoscopy. 2010;42(4):265–71.
41. Pasricha PJ, Hawari R, Ahmed I, et al. Submucosal endoscopic esophageal myotomy: a novel experimental approach for the treatment of achalasia. Endoscopy. 2007;39:761–4.
42. Ujiki MB, Yetasook AK, Zapf M, Linn JG, Carbray JM, Denham W. Peroral endoscopic myotomy: a short-term comparison with the standard laparoscopic approach. Surgery. 2013;154(4):893–7.
43. Von Renteln D, Inoue H, Minami H. Peroral endoscopic myotomy for the treatment of achalasia: a prospective single center study. Am J Gastroenterol. 2012;107:411–7.
44. Von Renteln D, Fuchs KH, Fockens P. Peroral endoscopic myotomy for the treatment of achalasia: an international prospective multicenter study. Gastroenterology. 2013;145:309–11.
45. Patel K, Abbassi-Ghadi N, Markar S, Kumar S, Jethwa P, Zaninotto G. Peroral endoscopic myotomy for the treatment of esophageal achalasia: systematic review and pooled analysis. Dis Esophagus. 2016;29:807–19. doi:10.1111/dote.12387.
46. Inoue H, Tianle KM, Ikeda H, et al. Peroral endoscopic myotomy for esophageal achalasia: technique, indication, and outcomes. Thorac Surg Clin. 2011;21:519–25.
47. Bechara R, Onimaru M, Ikeda H, et al. Per-oral endoscopic myotomy, 1000 cases later: pearls, pitfalls, and practical considerations. Gastrointest Endosc. 2016;84(2):330–8.
48. Balassone V, Ikeda H, Kazuya S, et al. Peroral endoscopic myotomy: first human experience with a water-jet-assisted triangle knife. Gastrointest Endosc. **(Epub 2016 May 6)**.
49. Grimes KL, Inoue H, Onimaru M, et al. Double-scope per oral endoscopic myotomy (POEM): a prospective randomized controlled trial. Surg Endosc. 2016;30:1344–51.
50. Youn YH, Minami H, Chiu PW, Park H. Peroral endoscopic myotomy for treating achalasia and esophageal motility disorders. J Neurogastroenterol Motil. 2016;22:14–24.
51. Shiwaku H, Inoue H, Beppu R, et al. Successful treatment of diffuse esophageal spasm by peroral endoscopic myotomy. Gastrointest Endosc. 2013;77:149–50.

52. Ling T, Guo H, Zou X. Effect of peroral endoscopic myotomy in achalasia patients with failure of prior pneumatic dilation: a prospective case-control study. J Gastroenterol Hepatol. 2014;29:1609–13.
53. Zhou PH, Li QL, Yao LQ, et al. Peroral endoscopic remyotomy for failed Heller myotomy: a prospective single-center study. Endoscopy. 2013;45:161–6.
54. Onimaru M, Inoue H, Ikeda H, et al. Peroral endoscopic myotomy is a viable option for failed surgical esophagocardiomyotomy instead of redo surgical Heller myotomy: a single center prospective study. J Am Coll Surg. 2013;217:598–605.
55. Vigneswaran Y, Yetasook AK, Zhao JC, Denham W, Linn JG, Ujiki MB. Peroral endoscopic myotomy (POEM): feasible as reoperation following Heller myotomy. J Gastrointest Surg. 2014;18:1071–6.
56. Inoue H, Sato H, Ikeda H, Onimaru M, et al. Per-oral endoscopic myotomy: a series of 500 patients. J Am Coll Surg. 2015;221:256–64.
57. Marano L, Pallabazzer G, Solito B, Santi S, Pigazzi A, De Luca R, Biondo FG, Spaziani A, Longaroni M, Di Martino N, et al. Surgery or peroral esophageal myotomy for achalasia: a systematic review and meta-analysis. Med (Baltimore). 2016;95:e3001.
58. Talukdar R, Inoue H, Reddy DN. Efficacy of peroral endoscopic myotomy (POEM) in the treatment of achalasia: a systematic review and meta-analysis. Surg Endosc. 2015;29(11):3030–46.
59. Chan SM, Wu JC, Teoh AY, et al. Comparison of early outcomes and quality of life after laparoscopic Heller's cardiomyotomy to peroral endoscopic myotomy for treatment of achalasia. Dig Endosc. 2016;28(1):27–32.
60. Sanaka MR, Hayat U, Thota PN, et al. Efficacy of peroral endoscopic myotomy vs other achalasia treatments in improving esophageal function. World J Gastroenterol. 2016;22(20):4918–25.
61. Stavropoulos SN, Modayil R, Friedel D, et al. The international per oral endoscopic myotomy survey (IPOEMS): a snapshot of the global POEM experience. Surg Endosc. 2013;27(9):3322–38.
62. Stavropoulos SN, Desilets DJ, Fuchs KH, et al. Per-oral endoscopic myotomy white paper summary. Gastrointest Endosc. 2014;80(1):1–15.
63. Swanstrom LL, Kurian A, Dunst CM, Sharata A, Bhayani N, Rieder E. Long-term outcomes of an endoscopic myotomy for achalasia: the POEM procedure. Ann Surg. 2012;256(4):659–67.