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Curriculum for training in peroral endoscopic myotomy (POEM) in Europe (Part I): European Society of Gastrointestinal Endoscopy (ESGE) Position Statement

Authors

Enrique Rodríguez de Santiago[1,2,3,‡], David J. Tate[4,‡], João Santos-Antunes[5], Sandra Nagl[6], Zuzana Vacková[7], Marcel Tantau[8], Isis K. Araujo[9], Eduardo Guimarães Hourneaux de Moura[10], Pietro Familiari[11], Helmut Messmann[6], Alanna Ebigbo[6], Paul Fockens[12,13], Raf Bisschops[14,15], Henriette Heinrich[16], Eduardo Albéniz[17], Amrita Sethi[18], Oleksandr Kiosov[19], Jan Martinek[20], Roy Soetikno[21], Ian M. Gralnek[22,23,*], Tony C. Tham[24,*]

Institutions

1 Department of Gastroenterology and Hepatology, Hospital Universitario Ramón y Cajal, Madrid, Spain
2 Instituto Ramón y Cajal de Investigación Sanitaria (IRYCIS), Madrid, Spain
3 Centro de Investigación Biomédica en Red en el Área temática de Enfermedades Hepáticas y Digestivas (CIBEREHD), Madrid, Spain
4 Department of Gastroenterology and Hepatology, University Hospital of Ghent, Ghent, Belgium
5 Gastroenterology Department, Centro Hospitalar S. João, Porto, Portugal
6 Department of Gastroenterology, University Hospital Augsburg, Augsburg, Germany
7 Department of Gastrointestinal Endoscopy, Military University Hospital Prague, Prague, Czech Republic
8 University of Medicine and Pharmacy "Iuliu Hatieganu", Cluj-Napoca, Romania
9 Endoscopy and Motility Unit, Gastroenterology Department, Hospital Clinic de Barcelona, Barcelona, Spain
10 Gastrointestinal Endoscopy Unit, Hospital das Clínicas of the University of São Paulo Medical School, São Paulo, Brazil
11 Digestive Endoscopy Unit, Fondazione Policlinico Universitario A. Gemelli IRCCS, Università Cattolica del Sacro Cuore, Rome, Italy
12 Department of Gastroenterology and Hepatology, Amsterdam UMC, Amsterdam, The Netherlands
13 Waikato Hospital, Hamilton, New Zealand
14 Department of Gastroenterology and Hepatology, UZ Leuven, Leuven, Belgium
15 Department of Translational Research in Gastrointestinal Diseases (TARGID), KU Leuven, Leuven, Belgium
16 Clarunis, Universitäres Bauchzentrum, Basel, Switzerland
17 Gastroenterology Department, Hospital Universitario de Navarra, Navarrabiomed, UPNA, IdiSNA, Pamplona, Spain
18 Pancreatobiliary Endoscopy Services, Division of Digestive and Liver Disease, Columbia University Irving Medical Center, New York, New York, USA
19 University Clinic, Zaporizhzhia State Medical and Pharmaceutical University, Zaporizhzhia, Ukraine
20 Department of Gastroenterology and Hepatology, St. Anne University Hospital, Brno, Czech Republic
21 Clinical Medicine, University of California San Francisco, California, USA
22 Ellen and Pinchas Mamber Institute of Gastroenterology and Hepatology, Emek Medical Center, Afula, Israel
23 Rappaport Faculty of Medicine, Technion Israel Institute of Technology, Haifa, Israel
24 Division of Gastroenterology, Ulster Hospital, Belfast, Northern Ireland

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‡ Joint first co-authorship.
* Joint senior authors.

Corresponding author
Enrique Rodríguez de Santiago, MD PhD, Servicio de Gastroenterología y Hepatología, Hospital Universitario Ramón y Cajal, Carretera de Colmenar Viejo, km 9.1, 28034 Madrid, Spain
enrodesan@gmail.com

MAIN RECOMMENDATIONS

Peroral endoscopic myotomy (POEM) is an advanced endoscopic procedure that has become a first-line treatment for esophageal achalasia and other esophageal spastic disorders. Structured training is essential to optimize the outcomes of this technique. The European Society of Gastrointestinal Endoscopy (ESGE) has recognized the need to formalize and enhance training in POEM. This Position Statement presents the results of a systematic review of the literature and a formal Delphi process, providing recommendations for an optimal training program in POEM that aims to produce endoscopists competent in this procedure. In a separate document (POEM curriculum Part II), we provide technical guidance on how to perform the POEM procedure based on the best available evidence.

1 POEM trainees should acquire a comprehensive theoretical knowledge of achalasia and other esophageal motility disorders that encompasses pathophysiology, diagnostic tool proficiency, clinical outcome assessment, potential adverse events, and periprocedural management.

2 Experience in advanced endoscopic procedures (endoscopic mucosal resection and/or endoscopic submucosal dissection [ESD]) is encouraged as a beneficial prerequisite for POEM training.

3 ESGE suggests that POEM trainees without ESD experience should perform an indicative minimum number of 20 cases on ex vivo or animal models before advancing to human POEM cases with an experienced trainer.

4 ESGE recommends that the trainee should observe an indicative minimum number of 20 live cases at expert centers before starting to perform POEM in humans.

5 The trainee should undertake an indicative minimum number of 10 cases under expert supervision for the initial human POEM procedures, ensuring that trainees can complete all POEM steps independently.

6 ESGE recommends avoiding complex POEM cases during the early training phase.

7 POEM competence should reflect the technical success rate, both the short- and long-term clinical success rates, and the rate of true adverse events.

8 A POEM center should maintain a prospective registry of all procedures performed, including patient work-up and outcomes, procedural techniques, and adverse events.

ABBREVIATIONS

AE	adverse event
EMR	endoscopic mucosal resection
ESD	endoscopic submucosal dissection
ESGE	European Society of Gastrointestinal Endoscopy
GERD	gastroesophageal reflux disease
GRADE	Grading of Recommendations Assessment, Development and Evaluation
PICO	population/problem, intervention, comparison, outcome
POEM	peroral endoscopic myotomy

SOURCE AND SCOPE

This manuscript represents the outcome of a formal Delphi process resulting in an official Position Statement of the ESGE and provides a framework to develop and maintain skills in POEM. This curriculum is set out in terms of the prerequisites for training, the theoretical knowledge and practical skills required for completion of training, and how competence should be defined and evidenced prior to independent practice.

1 Introduction

Achalasia is an esophageal motility disorder, characterized by the failure of the lower esophageal sphincter to relax properly, associated with loss of peristalsis, leading to impaired transit of food from the esophagus into the stomach [1]. The incidence of achalasia is approximately 1.6 cases per 100 000 and it usually presents between the ages of 25 and 60, with men and women equally affected [2].

The treatment of achalasia is aimed at lowering the resting pressure of the lower esophageal sphincter [3]. Recent European guidelines suggest that peroral endoscopic myotomy (POEM) has comparable efficacy to graded pneumatic dilation and laparoscopic Heller's myotomy, and treatment decisions in achalasia should be made based on patient-specific characteristics, patient preferences, possible adverse events (AEs), and a center's expertise [4, 5].

Promoting quality in endoscopy is of great importance for the European Society of Gastrointestinal Endoscopy (ESGE) to ensure effective treatment and optimal patient outcomes. Achieving high quality endoscopic procedures requires a well-trained and competent endoscopist. Training programs should focus on both technical and cognitive skills, including an understanding of the indications, limitations, underlying pathophysiology, and alternatives, plus the recognition of AEs and

their management. At present, there are no such standards for training in POEM in Europe. This curriculum sets out recommendations for an optimal training program in POEM that should produce an endoscopist competent in this procedure [6].

2 Methods

The development of the POEM curricula aligns with the current ESGE Publications Policy and the methodology of the ESGE curricula development for postgraduate training in advanced endoscopic procedures [6, 7]. A Position Statement format was considered appropriate given the educational significance of the topic and the limited expected body of evidence. This document focused on POEM training, irrespective of the specific esophageal motility disorder being addressed because the technical and theoretical principles involved are highly similar.

In May 2023, an email invitation to participate in the curricula was sent to all individual ESGE members. Applicants were required to submit a motivation letter and an updated curriculum vitae. The selection of participants was carried out by the project leaders and the chair of the Curricula Working Group based on applicants' expertise in POEM, clinical and research background, experience in curricula development and educational activities, and diversity. The ESGE Executive Committee subsequently approved the final list of 23 panelists.

In June 2023, the project leaders (E.R.d.S. and D.T) proposed a preliminary list of questions and topics to all panelists, forming five taskforces (**Appendix 1 s**, see online-only Supplementary material). Questions were structured using a PICO (Population/Problem, Intervention, Comparison, Outcome) format. In cases where framing a PICO question was not feasible or appropriate, questions were addressed through expert-based reviews. A virtual online meeting was held on 3 July 2023, during which panelists provided feedback on the preliminary list of questions and the curricula's structure. A final list of questions was approved, leading to the following sections:

- pre-adoption
- training
- autonomous implementation and assessment of proficiency
- best practice technique – a "state-of-the-art" section was deemed suitable to facilitate the learning and implementation of the technique; this section is presented as a separate document (Part II).

To standardize the literature search and methodology, a structured template was developed. Taskforces conducted systematic literature searches in a minimum of two databases from inception to August 2023. **Appendix 2 s** details the PICO questions and search strategies used. Subsequently, taskforces evaluated the available literature (**Table 1 s**) using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system. The GRADE system was used to assess the quality of evidence by study outcome and overall certainty, as well as to grade the recommendations. The quality and risk of bias of individual studies were assessed using the ROB-2 scale for randomized controlled trials, the Newcastle–Ottawa Scale or Robins-I for observational studies, and the QUADAS-2 tool for diagnostic accuracy studies. In cases where evidence was lacking or insufficient to use GRADE, taskforces were requested to formulate Good Practice Statements to represent ESGE's position [8]. Where applicable, statements were updated from previous ESGE guidelines on endoscopic treatment for gastrointestinal motility disorders to address our PICO questions [5, 9].

Taskforces initially drafted a list of statements and the evidence-based text supporting the recommendations. These documents were shared with the entire group, and a second online meeting was convened. Taskforces were asked to consider all comments but not to modify statements during the meeting, to prevent the authority, personality, or reputation of some participants from interfering in the Delphi process. In February 2024, panelists voted on and provided feedback in a free-text box for each statement. Prior to voting, all members were instructed to consider the clinical benefits and harms for patients and healthcare systems, the costs, evidence quality, and the environmental impact of the statements.

The consensus on statements was determined through an anonymous and iterative Delphi process. All individuals who applied for the taskforce but were not selected for the core group were invited to vote and provide written comments. A maximum of three voting rounds was established to reach consensus. Statements were graded using a 5-point Likert scale (1, Strongly disagree; 2, Disagree; 3, Neither agree nor disagree; 4, Agree; 5, Strongly agree) via a web-based platform. Consensus was defined as ≥ 80 % agreement (the sum of Agree and Strongly agree) on each statement. Prior to the second voting round, statements were reviewed and revised based on suggestions. The second and third voting rounds occurred between March and September 2024 (**Appendix 3 s**). Subsequently, the project leaders prepared a preliminary manuscript, which was shared with all members for feedback. At this stage, no modifications were allowed in the content of statements that achieved consensus during the anonymous voting (▶ **Table 1**).

The peer review process for ESGE policy documents was followed. The ESGE board, the core members of the Curricula Working Group, and external experts reviewed the manuscript. The document was circulated to all national society members and individual ESGE members for feedback. The final ESGE curricula for POEM was approved by all authors and was submitted to the journal *Endoscopy* for publication.

3 Pre-adoption

3.1 What is the theoretical knowledge needed before starting POEM training?

1 RECOMMENDATION

POEM trainees should acquire a comprehensive theoretical knowledge of achalasia and other esophageal motility disorders that encompasses pathophysiology, diagnostic tool proficiency, clinical outcome assessment, potential adverse events, and periprocedural management.

Good practice statement.

Level of agreement 100 %.

▶ **Table 1** List of agreed statements.

Statement number	Statement
Pre-adoption	
1	POEM trainees should acquire a comprehensive theoretical knowledge of achalasia and other esophageal motility disorders that encompasses pathophysiology, diagnostic tool proficiency, clinical outcome assessment, potential adverse events, and peri-procedural management. Good practice statement
2	POEM trainees should attend conferences and courses related to POEM before starting POEM procedures. Good practice statement
3	POEM trainees should develop and integrate endoscopic nontechnical skills, including communication and teamwork, situational awareness, leadership, judgment, and decision-making. Good practice statement
4	POEM trainees should have completed general upper gastrointestinal endoscopy training and be proficient in management of endoscopic adverse events prior to initiating POEM training. Good practice statement
5	Experience in advanced endoscopic procedures (EMR and/or ESD) is encouraged as a beneficial prerequisite for POEM training. Good practice statement
Training	
6	POEM trainees without previous experience in submucosal endoscopy may benefit from training on either simulation models for POEM or ESD to familiarize themselves with the complexity and the essential steps of submucosal endoscopy. Good practice statement
7	ESGE suggests that POEM trainees without ESD experience should perform an indicative minimum number of 20 cases on ex vivo or animal models before advancing to human POEM cases with an experienced trainer. The last five cases should be completed without perforating the gastric mucosa at the gastroesophageal junction and achieve complete mucosal closure. Good practice statement
8	ESGE recommends that the trainee should observe an indicative minimum number of 20 live cases at expert centers before starting to perform POEM in humans. Good practice statement
9	ESGE suggests that both stepwise progress and performing all POEM steps from the beginning are acceptable during the learning phase of the procedure. Good practice statement
10	ESGE recommends that the trainee should undertake an indicative minimum number of 10 cases under expert supervision for the initial human POEM procedures, ensuring that trainees can complete all POEM steps independently. Good practice statement
11	ESGE recommends avoiding complex POEM cases during the early training phase. Good practice statement
12	A POEM trainer should have expertise in managing adverse events of complex resection techniques such as bleeding and perforation. The trainer should have performed at least 100 unsupervised cases including difficult POEM cases (i. e. sigmoid esophagus, prior Heller's myotomy). Good practice statement
13	A POEM training center should maintain a sufficient case load to initiate a training program. Additionally, the center should possess adequate infrastructure for diagnosing esophageal motility disorders and facilitating the endoscopic, radiological, and surgical management of adverse events associated with POEM. Good practice statement
14	A POEM training program should range between an indicative 6 and 18 months in a high- or medium-volume POEM Western endoscopy unit. Good practice statement
15	POEM trainees should actively participate in patient selection processes for POEM at multidisciplinary team meetings. Good practice statement
Autonomous implementation and assessment of proficiency	
16	POEM competence should reflect the technical success rate, both the short- and long-term clinical success rates, and the rate of true adverse events
17	A minimum of 15 POEM procedures per endoscopist annually is advisable to maintain proficiency. Good practice statement
18	A minimum of 25 POEM procedures per center annually is advisable to maintain proficiency. Good practice statement
19	A POEM center should maintain a prospective registry of all procedures performed, including patient work-up and outcomes, procedural techniques, and adverse events. Good practice statement
20	The absolute number of procedures performed is not an accurate marker for competency in POEM. It should be combined with thresholds of procedural outcomes, including the technical and clinical success, and adverse event rates

EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; ESGE, European Society of Gastrointestinal Endoscopy; POEM, peroral endoscopic myotomy.

2 RECOMMENDATION
POEM trainees should attend conferences and courses related to POEM before starting POEM procedures.
Good practice statement.
Level of agreement 86 %.

Some studies have emphasized the importance of cognitive skills (indication and diagnostic assessment) for the POEM procedure, but none have directly assessed the influence of theoretical knowledge or educational programs on POEM trainees or POEM outcomes [10–18]. To address this gap, ESGE has established and summarized good practice recommendations for the requisite theoretical knowledge prior to commencing POEM training. These recommendations fall into four categories: (i) clinical understanding and procedural context, (ii) diagnostic assessment, (iii) outcome assessment, and (iv) preprocedural and procedural requirements and settings (▶ **Table 2**).

Prior to commencing POEM procedures, experts suggest that trainees participate in POEM-related congresses, attend didactic training courses, and engage in self-directed online learning. Trainees should grasp the pathophysiology of motility disorders, distinguish between various types of achalasia, and comprehend the indications and contraindications for performing POEM, as well as esophageal disorders that can mimic achalasia. They should also be aware of the indications and challenges associated with POEM in advanced cases (e. g. sigmoid achalasia) or previously treated motility disorders. Furthermore, they must possess knowledge of the potential AEs during and after the POEM procedure.

The ability to devise an endoscopic plan for POEM based on anticipated clinical outcomes, prior surgical and/or endoscopic treatments, and patient expectations is crucial [10, 14–18]. Trainees should also possess a comparative understanding of POEM versus alternative treatment modalities, such as pneumatic balloon dilation, botulinum toxin injection, and laparoscopic Heller's myotomy.

Competence in the interpretation of high resolution manometry, radiological esophagograms, and esophagogastroduodenoscopy is essential. Trainees should also understand the principles of the endoluminal functional lumen imaging probe (EndoFLIP), although its clinical relevance remains unknown.

Trainees should be knowledgeable about the incidence of gastroesophageal reflux disease (GERD) following POEM and the significance of clinical reflux symptoms, endoscopy, and 24-hour pH/impedance studies for assessment and their interpretation. Understanding expected clinical outcomes for different motility disorders and the ability to assess these outcomes using the Eckardt score is imperative. Additionally, a comprehension of the relative role of high resolution manometry, EndoFLIP, and the esophagogram in evaluating treatment outcomes is necessary.

Trainees should be proficient in obtaining detailed medical histories and understand periprocedural antithrombotic management. Familiarity with POEM equipment is crucial. Trainees should also be well versed in the electrosurgical generator settings used during the various POEM steps and understand the advantages and disadvantages of different types of endoscopic knives.

A solid understanding of third-space endoscopy principles, including mediastinal anatomy and recognition of anatomical landmarks, such as the anterior and posterior esophageal walls and gastroesophageal junction landmarks, is indispensable. Recognition of the spine, aortic arch, and left main bronchus is also advisable. Trainees should consistently recognize mucosa, muscle layer orientation, and spindle veins within the submucosal tunnel. Additionally, POEM trainees should promptly identify and understand the management of AEs.

3.2 What are the nontechnical skills needed for POEM training?

3 RECOMMENDATION
POEM trainees should develop and integrate endoscopic nontechnical skills, including communication and teamwork, situational awareness, leadership, judgment, and decision-making.
Good practice statement.
Level of agreement 93 %.

Technical and patient outcomes after any endoscopic procedure are affected by the endoscopic nontechnical skills (ENTS) of the performing team. ENTS involve all nontheoretical knowledge regarding good communication and the decision-making abilities of the endoscopist [19–27]. There are four recognized skills that should be assessed, and it has been suggested that each skill should be graded as either poor, marginal, acceptable, or good [28]. Performance measures for the team are also related to better outcomes, and quality principles as per the SACRED team-centered approach [29] are recommended. ESGE has adapted these methodological frameworks for POEM training (▶ **Table 3**). As part of the nontechnical skills, the POEM practitioner should be able to discuss in detail the patient's informed consent form, the advantages of the procedure related to other interventions, and possible AEs and morbidity associated with the technique and anesthesia [30–32].

3.3 What are the technical skills required before starting POEM training?

4 RECOMMENDATION
POEM trainees should have completed general upper gastrointestinal endoscopy training and be proficient in management of endoscopic adverse events prior to initiating POEM training.
Good practice statement.
Level of agreement 95 %.

▶ **Table 2** Theoretical knowledge needed prior to commencing peroral endoscopic myotomy (POEM) procedures.

Area of knowledge	Requirement
Clinical understanding and procedural context	
Pathophysiology of motility disorders	Understanding of the pathophysiology of esophageal motility disorders
	Knowledge of different types of achalasia
Indications and contraindications	Knowledge of the indications and contraindications for performing POEM in different motility disorders
	Knowledge of the indications and challenges of POEM in advanced (such as sigmoid achalasia) or pre-treated motility disorders
	Ability to formulate an endoscopic plan for the POEM procedure based on prior surgical and/or endoscopic treatments
	Knowledge of potential adverse events during and after POEM procedure
Other treatment modalities	Knowledge of alternative treatment options
	Comparative understanding of POEM versus alternative treatment modalities
Diagnostic assessment	
Pretherapeutic examinations	Competence in interpretation of HRM and TBE to identify types of motility disorders amenable for POEM
	Understanding of the role of EGD to rule out early squamous lesions and other causes of dysphagia
Adjunctive diagnostic tool	Familiarity with impedance planimetry (the endoluminal functional lumen imaging probe [EndoFLIP])
Post-POEM diagnostics	Knowledge of the incidence of GERD following POEM and the role of clinical reflux symptoms, EGD, and 24-hour pH impedance studies in its assessment and interpretation
Outcome assessment	
Clinical outcome	Understanding of the expected clinical outcomes of POEM for different motility disorders
	Ability to assess clinical treatment outcomes using the Eckardt score and understand its limitations
Outcome assessment with different diagnostic modalities	Knowledge about the role of HRM and the esophagogram in the assessment of treatment outcomes
	Knowledge about EndoFLIP as a tool to assess treatment outcome after POEM in real time
Preprocedural and procedural requirements and settings	
Prerequisites	Understanding of periprocedural antiplatelet and anticoagulation management
Anesthesia	Understanding of the requirement for general anesthesia during the POEM procedure
Equipment and settings	Understanding of the importance of using a distal attachment cap
	Understanding of the importance of using low-flow CO_2
	Knowledge about the different types of endoscopic knives, coagulation graspers, electrosurgical generators, and appropriate electrosurgery settings for POEM
Procedure-related proficiency	Understanding of the principles of third-space endoscopy, including mediastinal, esophageal, and intratunnel anatomy
	Understanding of the prevention, management, and consequences of POEM-related adverse events
	Recognition of the anatomical landmarks to identify the anterior and posterior walls of the esophagus and landmarks at the gastroesophageal junction
	Identification of the orientation of mucosa and muscle layers in the submucosal tunnel

EGD, esophagogastroduodenoscopy; GERD, gastroesophageal reflux disease; HRM, high resolution manometry; TBE, timed barium esophagogram.

▶ **Table 3** Endoscopic nontechnical skills for peroral endoscopic myotomy (POEM) training.

Element	Descriptor
a The endoscopic nontechnical skills (NETS) system.	
Communication and teamwork	
Exchanging information	Gives clear and timely information and instructions (including an appropriate informed consent)
	Seeks previous information to aid the procedure (e. g. clinical history, manometry/esophagogram/endoscopy report)
	Listens and responds to team input
	Confirms team preparation including equipment availability
Maintaining a shared understanding	Clarifies and confirms shared information with team (e. g. type of procedure, length of myotomy)
	Talks about the progress of the procedure, including difficulties and concerns
	Calmly indicates when a situation requires urgency
Maintaining a patient-centered approach	Greets patient and introduces self and team
	Regularly checks patient comfort
	Explains findings to patient and/or relatives clearly
Situation awareness	
Preparation	Checks indications are appropriate, and the patient is fit for the procedure
	Checks if assistants are adequately trained
	Ensures equipment present and functioning correctly
	Optimizes environmental conditions before starting (e. g. equipment positioning)
	Does not perform any procedure beyond own level of skill (e. g. avoiding difficult POEM cases during the early training period)
Continuous assessment	Uses all available techniques to inform the decision-making process
	Monitors results from therapy (e. g. bleeding)
	Re-evaluates risk regularly depending on current status
Problem recognition	Identifies issues quickly and highlights them to the team
	Recognizes increased risk due to unexpected findings
Focus	Minimizes interruptions
	Stops distracting behavior by staff
	Keeps focus on the screen
Leadership	
Supporting others	Maintains a relaxed atmosphere
	Gives praise for tasks done well
	Does not rush staff when not necessary
Maintaining standards	Follows unit procedures and protocols
	Ensures privacy and patient dignity
	Adequately documents procedure
Dealing with problems	Emphasizes urgency if needed and gives clear directions
	Delegates tasks to achieve goals
	Remains calm under pressure and assumes responsibility
Judgement and decision-making	
Considering options	Generates options to resolve problems
	Seeks help or opinion of colleagues

▶ **Table 3** (Continuation)

Element	Descriptor
Making decisions	Reaches and clearly communicates decisions and implements plan effectively
Reviewing the situation	Re-evaluates outcomes
	Ensures appropriate follow-up and checks for complications
	Makes changes based on reflection to improve practice
b The SACRED team-centered approach to advanced gastrointestinal endoscopy.	
Principle	Descriptor
Selection	An MDT evaluates the case prior to the POEM procedure
Acceptance	Recognition of increased risk for AEs related to diagnostic procedures
Complications	Establishes pathways to deal with AEs and regular conferences to discuss cases with MDT
Reconnaissance	Establishes a communication system – verbal conscious competence may be relevant
Envelopment	The report should be available for the patient, along with instructions in case an AE occurs
Documentation	The outcome should be discussed with the MDT

AE, adverse event; MDT, multidisciplinary team.

5 RECOMMENDATION

Experience in advanced endoscopic procedures (endoscopic mucosal resection and/or endoscopic submucosal dissection) is encouraged as a beneficial prerequisite for POEM training.

Good practice statement.

Level of agreement 87 %.

POEM is a challenging advanced endoscopic procedure requiring extensive endoscopic expertise. Some authors and expert societies have addressed the need for prior adoption of specific technical skills, as well as experience in submucosal endoscopy [11, 13, 14, 18, 33, 34]. However, neither the definition nor the evaluation of these skills has been formalized, and the published assessment tools have focused on the actual training rather than previous endoscopic expertise [13, 35]. There is a lack of randomized evidence directly assessing technical skills requirements before entering dedicated POEM training and its impact on the POEM learning curve or treatment outcome. Therefore, we have produced good practice recommendations for mandatory and recommended endoscopic and nonendoscopic technical skills for future POEM trainees (▶ **Table 4**).

POEM trainees should have completed structured general endoscopic training in upper gastrointestinal endoscopy and achieved competence in specific skills including maintaining a stable scope position and tip control, and endoscopic hemostasis (injection, coagulation techniques, clipping, defect closure). Trainees should be familiar with the practical use of all necessary endoscopic instruments (various endoscopic knives, distal attachment cap, hemostatic tools, clips), setting of the electrosurgical unit and insufflation pump, and basic troubleshooting of these devices. Competence in colonoscopy and polypectomy is beneficial, but not an absolute prerequisite. Competency in endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic ultrasound (EUS) are not required.

Most of the studies on the POEM learning curve have involved endoscopists who have completed advanced fellowships, with a highly heterogeneous experience in submucosal endoscopy. Nevertheless, competence in endoscopic mucosal resection (EMR) and/or endoscopic submucosal dissection (ESD) could accelerate the learning curve for POEM, potentially increasing the safety and effectiveness of the procedure [36]. One retrospective study has assessed the influence of prior ESD experience in gaining proficiency in POEM, with endoscopists with greater experience in ESD acquiring proficiency in POEM faster, although there was no difference with regard to clinical outcomes or AEs [37].

It is required that trainees can recognize capnoperitoneum in a timely manner and adequately relieve it by puncture if needed. Although it should not be viewed as a requirement, it is advisable to be competent in alternative endoscopic treatment modalities for achalasia, such as botulinum toxin injections and pneumatic dilation.

▶ **Table 4** Technical skills required before peroral endoscopic myotomy (POEM) training.

	Skill
Endoscopic skills	
Mandatory	Proficiency in general upper gastrointestinal endoscopy
	Endoscopic management of adverse events (bleeding)
	Maintaining stable scope position and manipulating the scope (precise targeting, tip control, torque)
	Competence in different methods of hemostasis (adrenalin injection, coagulation techniques with electrosurgical knife or with coagulation forceps, hemoclip placement, and use of endoscope/cap for tamponade)
	Practical use of different endoscopic accessories that are required during a POEM procedure (different endoscopic knives, electrocoagulation forceps, injection needle)
Recommended	Competence in colonoscopy
	Competence in snare polypectomy
	Competence in endoscopic resection techniques (EMR, ESD) in the upper and/or lower gastrointestinal tract
	Competence in mucosal closure and perforation management
	Experience with OTS clips and endoscopic suture devices
	Esophageal stenting
	Endoscopic balloon dilation (in achalasia)
Not required	ERCP and/or EUS
Other technical skills	
Mandatory	Setting of the electrocautery unit
	Puncture of a capnoperitoneum
	Knowledge of other CO_2-related complications (in cooperation with other medical specialists)
Recommended	Use of endoscopic tools from the nurse's perspective including basic troubleshooting

EMR, endoscopic mucosal resection; ERCP, endoscopic retrograde cholangiopancreatography; ESD, endoscopic submucosal dissection; EUS, endoscopic ultrasound; OTS, over-the-scope.

4 Training

4.1 Steps to acquire competence

4.1.1 Is simulation and ex vivo/animal training recommended before starting POEM in humans?

6 RECOMMENDATION

POEM trainees without previous experience in submucosal endoscopy may benefit from training on either simulation models for POEM or ESD to familiarize themselves with the complexity and the essential steps of submucosal endoscopy.
Good practice statement.
Level of agreement 94 %.

7 RECOMMENDATION

ESGE suggests that POEM trainees without ESD experience should perform an indicative minimum number of 20 cases on ex vivo or animal models before advancing to human POEM cases with an experienced trainer. The last five cases should be completed without perforating the gastric mucosa at the gastroesophageal junction and achieve complete mucosal closure.
Good practice statement.
Level of agreement 84 %.

Evidence-based curricula and standardized training protocols do not exist for POEM. For POEM trainees without previous experience in submucosal endoscopy, ESGE recommends a step-up approach with initial hands-on training on ex vivo models and/or POEM/ESD simulators, after which trainees can advance to in vivo animal models and, in a final step, clinical cases supervised by an experienced trainer.

Mechanical simulators and virtual reality computer simulators are available for various endoscopic procedures and are frequently used during early training for novice endoscopists. Simulation training provides a risk-free solution that introduces trainees to new procedures and enables them to learn specific skills at an individual pace; however, the tactile feedback and visual reality are inferior to training on animal models or clinical cases [38–40]. Most studies evaluating simulation training have primarily focused on novice learners, revealing some advantages in terms of performance and procedure time; however, there is no high quality evidence to demonstrate a definitive contribution to competency acquisition [38, 41]. Some studies have even shown that simulation training without expert feedback does not enhance trainee skills, so an experienced trainer is always needed [42]. A novel simulation-based training model called EndoGel (Sunarrow Co. Ltd., Tokyo, Japan) replicates the characteristics of the gastrointestinal tract, serving as a realistic and feasible model for training in mucosal marking, submucosal injection, and dissection [43]. With respect to POEM, there is a lack of evidence demonstrating that simulation training improves outcomes.

Although prospective comparative studies are lacking, evidence suggests that preclinical training using ex vivo and live animal models can prepare trainees to perform POEM safely and effectively in human cases [39]. Ex vivo models are a cost-effective alternative to simulators and offer superior haptic and visual realism for advanced endoscopic procedures [40, 44]. Animal models provide the highest degree of realism and can simulate conditions such as intraprocedural bleeding, perforation, and pneumoperitoneum/pneumomediastinum; however, the associated costs and ethical concerns around animal research limit their utility in training [39, 45, 46]. Published studies provide little information on the number of animal procedures required for preclinical training, which varies widely (five to 12) and may also depend on prior endoscopy experience [47–51]. Studies on the learning curve in ex vivo or animal models have shown that approximately 26 POEM cases are needed before mastery is achieved in terms of AEs and speed [52]. Given the potential for serious AEs and the availability of alternative training options, initiating POEM training in humans is strongly discouraged. In expert centers with close supervision, initial training experience in humans may be considered for endoscopists with sufficient ESD experience; however, clinical evidence supporting this strategy is lacking.

In summary, the existing evidence supports the use of preclinical models and underscores the importance of specialized training programs, aligning with the recommendation for a step-up training approach within the POEM curriculum [53–57].

4.1.2 Is the observation of live cases at expert centers recommended before starting POEM in humans?

8 RECOMMENDATION
ESGE recommends that trainees should observe an indicative minimum number of 20 live cases at expert centers before starting to perform POEM in humans.
Good practice statement.
Level of agreement 96 %.

The available evidence suggests that observing cases before engaging in POEM procedures is crucial in acquiring proficiency. Although none of the studies directly compared the outcomes of those who observed cases with those who did not, a unanimous consensus exists among all the studies regarding the significance of this observational phase. The studies, which are all observational [13, 33, 34, 37, 49, 58–64], uniformly stress the importance of observing expert practitioners performing POEM to gain insights into the procedural workflow and grasp the technique's subtleties.

The number of cases recommended for observation varied, with some studies indicating the observation of as few as two cases [61], while others suggested up to 22 cases as an adequate learning experience [49]. Furthermore, these studies evaluated endoscopists actively engaged in endoscopy training programs. The results consistently revealed high rates of clinical success and a low incidence of AEs, underscoring the safety and efficacy of the procedure when performed by adequately trained individuals.

4.1.3 Is stepwise POEM training recommended?

9 RECOMMENDATION
ESGE suggests that both stepwise progress and performing all POEM steps from the beginning are acceptable during the learning phase of the procedure.
Good practice statement.
Level of agreement 83 %.

Stepwise POEM learning entails training in the procedure in a step-by-step manner, repeating each procedure step as many times as necessary to achieve competence, before performing a complete POEM procedure. A suggested order is proposed for the completion of each stage, determined by the difficulty level of each step rather than the sequence of procedures performed. It is suggested that the first step should be learning dissection/tunneling, followed by learning myotomy, and finally learning to create a submucosal tunnel orifice [13, 64, 65]. Training in mucosal closure and the management of perforation, including stent placement, are key parts of POEM training. Once proficient in each stage, the trainee would be ready to commence training in the next step.

No studies have directly compared different POEM training methodologies, complete procedure versus stepwise training. Both methods are cited as a safe and suitable approach for learning [13, 64, 65].

4.1.4 Is expert supervision needed during the first POEM cases?

10 RECOMMENDATION

ESGE recommends that the trainee should undertake an indicative minimum number of 10 cases under expert supervision for the initial human POEM procedures, ensuring that trainees can complete all POEM steps independently.

Good practice statement.

Level of agreement 94 %.

Several observational studies [33, 34, 37, 49, 60] have reported on the role of experienced endoscopists' supervision during the initial stages of performing the POEM technique. All identified studies advocate for the importance of supervision during the early stages of POEM, emphasizing its potential benefits [33, 34, 37, 49, 60]. It is worth noting that none of these studies directly compared the outcomes of supervised versus unsupervised procedures; however, it is common sense to be supervised during training in a new invasive procedure. Likewise, there is a lack of comparative analysis regarding the optimal number of procedures that should be conducted under supervision, and the recommendations provided in these articles vary considerably in this regard. The cutoff of 10 cases was agreed upon as reasonable by this expert panel.

4.1.5 Should complex POEM cases be avoided during the early training phase?

11 RECOMMENDATION

ESGE recommends avoiding complex POEM cases during the early training phase.

Good practice statement.

Level of agreement 93 %.

For the POEM training program in Japan, the initial 2 months of training are dedicated to laying a solid foundation [66]. During this period, trainees focus on studying the anatomical features of the disease and assisting experts in performing the procedure. In the subsequent months, trainees gradually transition to performing POEM on uncomplicated cases. As they develop the necessary skills, they progress to handling more complex cases, such as sigmoid-type achalasia, prior Heller's myotomy, elderly patients with co-morbidities, type III achalasia, and those with distal esophageal spasm or hypercontractile esophagus.

Regarding the selection of cases during the training curve, only Zein et al. found no statistically significant association between procedural time and pre-POEM patient factors (age and baseline Eckardt score) [61]; however, other studies reported that case selection was crucial in influencing endoscopic operative time and AEs, notably increasing the risk of mucosal perforation during the procedure [60, 63]. In this regard, defining a case as complex is essential, and there are some tools that can be used for case selection. Complex achalasia patients are usually defined as those with multiple prior treatments, prior myotomy, achalasia type III, and sigmoid-type achalasia [67]. Other models have found age, disease duration, antithrombotic use, severe esophageal dilatation, mucosal edema, submucosal fibrosis, and tunnel length to be predictors of difficult POEM [68, 69].

Considering these findings, it becomes evident that careful patient case selection is paramount during the initial stages of POEM training. This approach ensures trainees develop their POEM skills safely and progressively as they navigate the learning curve.

4.2 Requisites for training modules, trainers, and training centers

4.2.1 What are the requirements for a POEM trainer?

12 RECOMMENDATION

A POEM trainer should have expertise in managing adverse events of complex resection techniques such as bleeding and perforation. The trainer should have performed at least 100 unsupervised cases including difficult POEM cases (i. e. sigmoid esophagus, prior Heller's myotomy).

Good practice statement.

Level of agreement 86 %.

Our search did not find studies directly evaluating the skills and case load required to serve as a POEM trainer, mentor, or proctor. Previously, the case load defining an expert, mentor, or trainer has ranged from 50 to 300 cases [37, 59]. All studies mentioned that trainers were experienced in ESD and the management of AEs. The cutoff of 100 cases was agreed upon as reasonable by the expert panel.

4.2.2 What are the requirements for a POEM training center?

13 RECOMMENDATION
A POEM training center should maintain a sufficient case load to initiate a training program. Additionally, the center should possess adequate infrastructure for diagnosing esophageal motility disorders and facilitating the endoscopic, radiological, and surgical management of adverse events associated with POEM.
Good practice statement.
Level of agreement 80 %.

No studies have been published evaluating the necessary infrastructure, standards, and case load for POEM training. In addition, there are no accreditation procedures specifically for POEM training centers. Most studies reporting on training or on the establishment of a POEM service relate to large tertiary care centers with experience in interventional endoscopy and ESD, and access to emergency thoracic and abdominal surgery, interventional radiology, and an intensive care unit. In Japan, the Ministry of Health, Labor, and Welfare requires the following institutional criteria to perform POEM [70]:

1. designation as a specialized institution of gastroenterology, gastroenterological surgery, and anesthesiology
2. more than 10 cases of POEM to have been treated
3. at least one full-time doctor with over 5 years of clinical experience in gastroenterological surgery or gastroenterology and more than 20 cases of esophageal ESD; the surgeon should have treated over 15 cases of POEM as the primary surgeon or as an assistant
4. more than three full-time doctors, including at least one gastroenterological surgeon, on the POEM clinical team
5. a full-time designated specialist anesthesiologist
6. capability for urgent surgery.

4.2.3 How long should a POEM training program take?

14 RECOMMENDATION
A POEM training program should range between an indicative 6 and 18 months in a high- or medium-volume POEM Western endoscopy unit.
Good practice statement.
Level of agreement 83 %.

A POEM training program encompasses observing real cases, attending courses about POEM, theoretical self-learning, practicing on ex vivo or animal models, and performing procedures on human patients under supervision [11, 13, 18, 33, 34, 36, 37, 49, 50, 52, 58–63, 70–72]. Considering that several of these activities may or may not overlap, and that learning is conditioned by previous experience in therapeutic endoscopy and ESD [37], learning curves can be highly variable. Accordingly, a minimum training duration of 6 months is advised in high-volume Western endoscopy units, which typically handle 60–100 POEM cases annually. In contrast, for units with lower case volumes, an extended training period ranging from 1 to 1.5 years is recommended. Additionally, this timeframe may vary depending on whether the trainee is involved in a dedicated POEM program, if the program is combined with other ESD or third-space endoscopy techniques, or if the trainee intermittently attends the expert center.

4.2.4 Should POEM trainees be involved in the selection of patients for POEM?

15 RECOMMENDATION
POEM trainees should actively participate in patient selection processes for POEM at multidisciplinary team meetings.
Good practice statement.
Level of agreement 97 %.

A formalized multidisciplinary team (MDT) approach is recommended in advanced endoscopy [29]. The selection of patients for POEM is a complex procedure that involves an understanding of the various types of achalasia and their treatment options, while at the same time taking patient factors into account. At best, an MDT comprising an interventional endoscopist, a surgeon, a radiologist, and a (neuro-)gastroenterologist should be involved in the discussion of cases. Involving trainees within an MDT has the potential to improve their understanding of achalasia and POEM. POEM trainees will profit from the discussions around the process of case selection and gain deeper insights into the indications and contraindications for POEM.

4.2.5 What are the minimum requirements for a POEM endoscopy report?

A summary with the key elements that should be included in a POEM endoscopy report is provided in ▶ **Table 5**.

5 Autonomous implementation and assessment of proficiency

5.1 What is the definition of POEM competence? What volume of POEM procedures is recommended to maintain proficiency?

16 RECOMMENDATION
POEM competence should reflect the technical success rate, both the short- and long-term clinical success rates, and the rate of true adverse events.
Level of agreement 100 %.

17 RECOMMENDATION
A minimum of 15 POEM procedures per endoscopist annually is advisable to maintain proficiency.
Good practice statement.
Level of agreement 94 %.

18 RECOMMENDATION
A minimum of 25 POEM procedures per center annually is advisable to maintain proficiency.
Good practice statement.
Level of agreement 80 %.

19 RECOMMENDATION
A POEM center should maintain a prospective registry of all procedures performed, including patient work-up and outcomes, procedural techniques, and adverse events.
Good practice statement.
Level of agreement 97 %.

There are no data assessing how to define competence in performing POEM, and no performance measures or quality indicators have been defined thus far. Likewise, there are no data about the number of procedures needed to maintain proficiency.

A prospective registry that includes all procedures performed is an essential component for all POEM training centers to assess proficiency and outcomes. This registry serves several critical purposes.

- **Quality control and improvement** Training centers must monitor the quality of the procedures performed. This enables them to identify trends, both positive and negative, and implement changes to improve outcomes.
- **Research, training, and education** For trainees, having access to a comprehensive registry of procedures is a valuable tool. It allows them to learn from past cases, understand the variety of scenarios that can occur, and appreciate the nuances of different approaches.
- **Accountability and transparency** Keeping a record of all procedures ensures accountability. It shows that the training center is committed to maintaining high standards and is transparent about its practices.

5.2 Is the number of POEM cases an adequate marker of POEM competence?

20 RECOMMENDATION
The absolute number of procedures performed is not an accurate marker for competency in POEM. It should be combined with thresholds of procedural outcomes, including the technical and clinical success, and adverse event rates.
Level of agreement 97 %.

Studies evaluating the learning curve to establish proficiency in POEM suggest that 7–70 cases are needed to master the technique [34, 36, 37, 50, 60, 62, 63, 66, 71]; however, these studies exhibit several limitations. Firstly, they are all retrospective and conducted at single centers. Moreover, they encompass heterogeneous patient populations and procedures of different complexity. Predominantly, these studies focus on the learning curve of experienced endoscopists, which may not be representative of all POEM trainees. A significant concern is their reliance on procedural time, either total or per cm of myotomy, as a surrogate marker of competence. This approach is problematic because controlled studies have not demonstrated a correlation between procedural time and the clinical success or safety of POEM. Lastly, the consideration of AEs as a metric for assessing competence is often overlooked, which could lead to an incomplete evaluation of an endoscopist's proficiency.

Therefore, ESGE does not favor using a threshold number of procedures performed to define an endoscopist as being competent in POEM, advocating instead for a comprehensive assessment of skills, knowledge, and outcomes. A formal assessment tool to assess technical proficiency is provided in the POEM Curriculum Part II (Best Practice Technique).

6 Conclusions

This ESGE Position Statement was crafted by an international working group with diverse POEM-related expertise from Europe, Brazil, and the USA, including specialists in neurogastroenterology, educational methods, POEM techniques, and medical and educational research. Notably, the consensus-based statements, derived using the Delphi method, are mainly grounded in expert opinion rather than evidence-based data and are designed to guide best training practices without carrying legal weight.

The document offers current insights that are crucial for creating a structured POEM curriculum aimed at fostering expertise and competence in a standardized step-by-step approach (▶ **Fig. 1**). It outlines theoretical and technical pre-

▶ **Table 5** ESGE's recommended peroral endoscopic myotomy (POEM) report template.

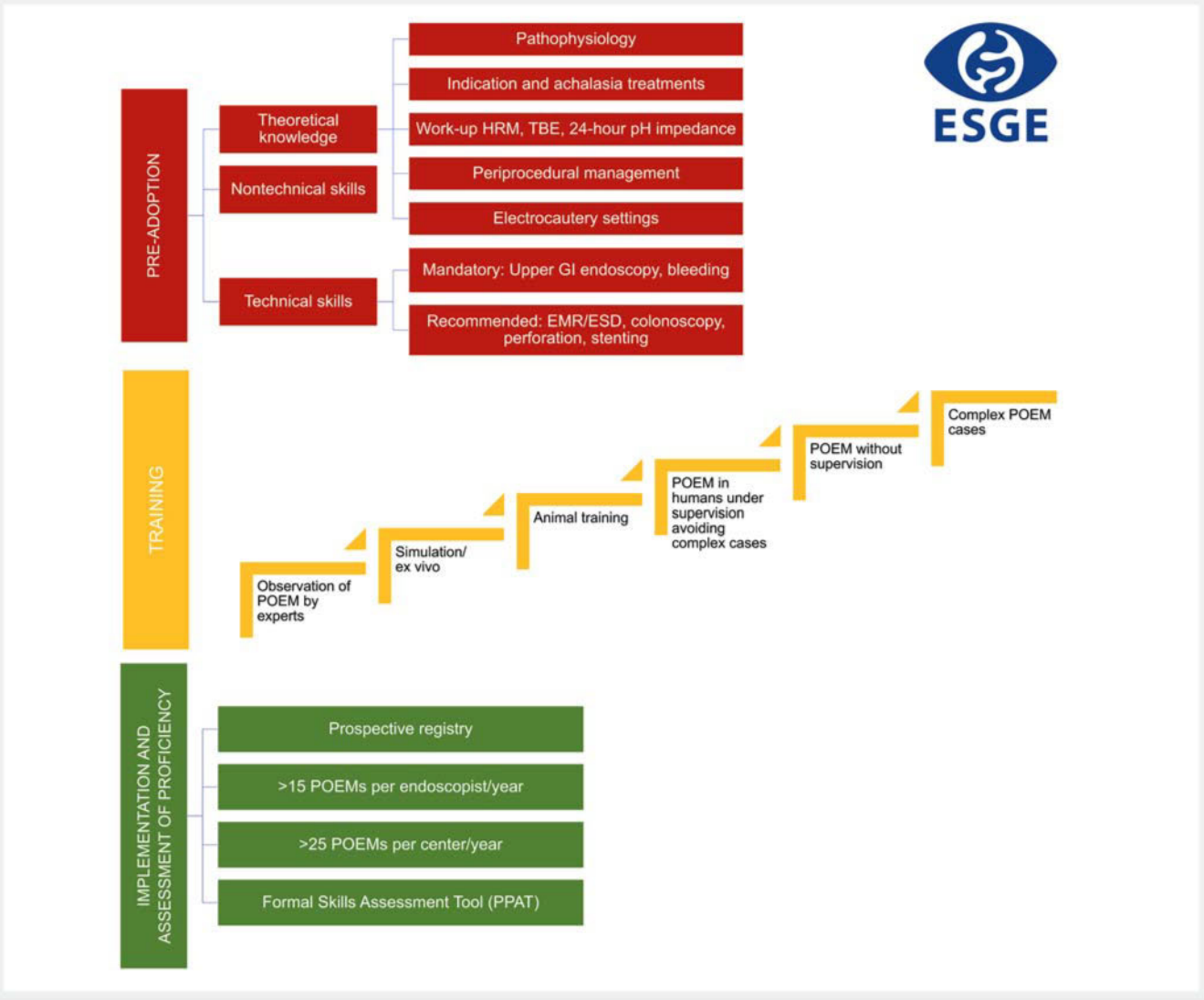
	Items to be included
Basic information	
Basic data	Patient identification, operators (including trainees)
Indication	Type of achalasia, hypercontractile disorder, etc.
Procedure time	Start of procedure till closure of mucosotomy
Medication	General anesthesia, intraprocedural antibiotics, others
Equipment	Endoscope, accessories, electrosurgical unit, and settings
Esophageal preparation	Describe presence of food remnants/time required for cleaning the esophagus
Anatomical landmarks	
Lower esophageal sphincter	Description of endoscopic appearance, location relative to the incisors
Esophageal anatomy	Description of appearance of the esophagus, tortuosity, sigmoid-type, straight lumen, spastic segments
Other landmarks	Visualization of the spine, aortic arch, left main bronchus
POEM steps	
Submucosal injection and mucosotomy	Type of submucosal solution
	Mucosotomy length and distance from the incisors
Tunnel length and intratunnel anatomical landmarks	## to ## cm from incisors
	Visualization of spindle veins, oblique muscle, and penetrating vessels
Esophageal myotomy length	## to ## cm from incisors
Gastric myotomy length	## cm
Type of myotomy	Selective vs. full-thickness myotomy
Location of myotomy	Anterior, posterior, greater curvature
Intraprocedural assessment of the LES	EndoFLIP, double-scope method, other
Mucosal closure	Number and type of clips, additional closure methods
Factors pertaining to difficulty	Fibrosis, orientation, distensibility of the tunnel, tortuosity, esophageal spasms, etc.
Adverse events	
Adverse events	Type, severity, and management of adverse events (bleeding, CO_2-related adverse events, mucosal perforation, etc.) specified
Summary and follow-up recommendations	
Summary	Diagnosis and summary of the procedure
Recommendations	Short term: post-procedural pharmacotherapy and diet plan
	Mid-term: clinical, endoscopic, and manometric follow-up

EndoFLIP, endoluminal functional lumen imaging probe; LES, lower esophageal sphincter.

requisites for POEM trainees and trainers, and underscores the importance of ongoing proficiency evaluation. We propose a set of indicators that require validation in prospective studies. This groundwork paves the way for future creation of an evidence-based educational framework [73]. Part II of the curriculum delivers a comprehensive technical guide, providing trainees with a detailed description of best practice techniques for performing POEM procedures.

Disclaimer

ESGE Position Statements represent a consensus of best practice based on the available evidence at the time of preparation. This is NOT a guideline but a proposal for training in POEM. The statements may not apply in all situations and should be interpreted in the light of specific clinical situations and resource availability. Further studies may be needed to clarify aspects of these statements, and revision may be necessary as new data appear. Clinical considerations may justify a course of action at



▶ **Fig. 1** Illustration of a standardized step-by-step approach to learning in peroral endoscopic myotomy (POEM).
EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; GI, gastrointestinal; HRM, high resolution manometry; PPAT, Precision POEM Assessment Tool; TBE, timed barium esophagogram.

variance with these recommendations. This ESGE Position Statement is intended to be an educational device to provide information that may assist gastrointestinal endoscopists in providing care to patients. The recommendations made are not rules and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment. The legal disclaimer for ESGE guidelines applies to the present position statement [74].

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Conflicts of interest

P. Fockens has provided consultancy to Cook Endoscopy and Olympus (both 2022–2024). I.M. Gralnek is a consultant for Olympus (2024 to present). E. Rodríguez de Santiago has received speaker's and consultancy fees from Olympus (2017–2024), fees for advice from Adacyte Therapeutics (2023) and support for educational activities from Apollo Endoscopy (2023), Norgine (2023–2024), and ERBE (2024). A. Sethi is currently providing consultancy to Boston Scientific, Cook Medical, Medtronic, and Olympus, and was a consultant to Pentax until 2024; she has previously received research support from Boston Scientific, ERBE, and Fujifilm. D.J. Tate has provided consultancy to Olympus EMEA (2019 to present) and Fujifilm (2022 to present). E. Al-

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Supplementary material

ESGE Curriculum for training in POEM – part I

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Appendix 1s Taskforces and membership

Project leaders:

- Enrique Rodríguez de Santiago.
- David Tate

ESGE curricula Working Group Leader

- Tony Tham

Taskforce leaders

- Enrique Rodríguez de Santiago
- Alanna Ebibo
- Eduardo Guimarães Hourneaux De Moura
- Amritha Sethi
- Sandra Nagl

Taskforce 1: Best Practice Technique, Introduction, Methods

- **Enrique Rodríguez de Santiago**
- Tony Tham
- David Tate
- Joao Santos Antunes

Taskforce 2: Pre-adoption & Training (Steps to acquire competence)

- **Sandra Nagl**

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- Isis Araujo
- Zuzana Vackova
- Marcel Tantau

Taskforce 3: Training (Steps to acquire competence)

- **Eduardo Guimarães Hourneaux De Moura**
- Ian Gralnek
- Pietro Familiari
- Helmut Messmann

Taskforce 4: Training: requisites for training modules, trainers, and training centers

- **Alanna Ebigbo**
- Paul Fockens
- Henriette Heinrich
- Eduardo Albéniz

Taskforce 5: Autonomous implementation and assessment of proficiency

- **Amrita Sethi**
- Roy Soetikno
- Jan Martinek
- Oleksandr Kiosov

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Appendix 2s PICO questions and bibliographic searches

a Pre-adoption

(i) What is the theoretical knowledge needed before starting POEM training?

No PICO question format.

Bibliographic search
Bibliographic search strategies were performed in **PubMed and google scholar** from inception**.** References of the included articles were also reviewed manually. Search strategies:

PubMed - Search 27/08/2023
(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy OR myotomy OR cardiomyotomy) AND (trainees OR training support OR training OR fellow OR fellows OR fellowship OR observer OR observer ship) AND (theoretical OR theoretically OR knowledge OR theoretical knowledge OR expertise OR proficiency OR program OR educational OR observational OR learning OR educational program) AND (learning OR curve OR learning curve OR achalasia OR motility disorder OR pathophysiology OR pathophysiological OR pathophysiologically OR indication OR contraindication OR type OR types OR classification OR sub-classification OR pretreated OR failure OR sigmoid OR sigmoid-shaped OR sigmoid-type OR megaesophagus OR mega-esophagus OR end-stage OR difficult OR advanced OR advanced stage OR advanced stages OR challenges OR challenge OR treatment OR treatment modality OR treatment modalities OR therapy OR therapies OR pneumatic balloon dilatation OR balloon OR dilatation OR pneumatic dilatation OR LHM OR laparoscopic Heller myotomy OR intervention OR HRM OR high resolution manometry OR esophageal high resolution manometry OR oesophageal high resolution manometry OR pH-study OR 24-hour impedance-pH OR 24h pH-metry OR 24-hour pH-metry OR pH-metry OR impedance OR pH-metry/impedance OR EndoFLIP OR impedance planimetry OR esophagogram OR barium esophagogram OR timed barium esophagogram OR TBE OR swallow OR barium swallow OR timed barium swallow OR outcome OR clinical outcome OR result OR clinical OR complication OR complications OR adverse events OR adverse event OR CO2 or low flow OR flow OR insufflation OR anticoagulation management OR antiplatelet management OR antiplatelet therapy OR anticoagulation therapy OR antithrombotic management OR antithrombotic therapy OR knife OR knives OR coagulation OR grasper OR electrosurgery setting OR electrosurgery OR electrosurgical OR generator OR third space endoscopy OR anatomy OR mediastinal OR mediastinum OR landmark OR landmarks OR GERD OR reflux disease OR gastroesophageal reflux disease OR gastro-esophageal reflux disease OR reflux OR rate OR general anesthesia OR anesthesia OR aspiration OR congress OR congresses OR training course OR training courses OR online-learning)

Results: 434

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Google scholar - Search 27/08/2023

(Trainee AND theoretical knowledge OR Congress AND peroral endoscopic myotomy)

Results: 556

Duplicates: 7 (eliminated using Endnote)

Total after duplicates: 983
Results of the bibliographic searches
After removing duplicates (n=7), 983 titles and abstracts were screened. 8 studies were considered potentially relevant, 8 were acquired in full text.

Included studies:

1. Khashab, M. A. (2013). "Thoughts on starting a peroral endoscopic myotomy program." Gastrointest Endosc 77(1): 109-110.
2. Kishiki, T., et al. (2018). "Teaching peroral endoscopic myotomy (POEM) to surgeons in practice: an "into the fire" pre/post-test curriculum." Surg Endosc 32(3): 1414-1421.
3. Saxena, P. and M. A. Khashab (2016). "New NOTES Clinical Training and Program Development." Gastrointest Endosc Clin N Am 26(2): 385-400.
4. Schlachterman, A., et al. (2020). "Per-oral endoscopic myotomy (POEM) training and skills evaluation tool: a pilot study." Endosc Int Open 8(12): E1826-e1831.
5. Varma, P. and P. Saxena (2020). "Establishing a submucosal endoscopy program in a gastrointestinal unit." International Journal of Gastrointestinal Intervention 9(2): 36-41.
6. von Renteln, D., et al. (2013). "Training for peroral endoscopic myotomy." Techniques in Gastrointestinal Endoscopy 15(3): 153-156.
7. Waschke, K. A. and W. Coyle (2018). "Advances and Challenges in Endoscopic Training." Gastroenterology 154(7): 1985-1992.
8. Wong, H. J., et al. (2021). "Teaching peroral endoscopic pyloromyotomy (POP) to practicing endoscopists: An "into-the-fire" approach to simulation." Surgery 169(3): 502-507.

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(ii) What are the non-technical skills needed for POEM training?

PICO question

P: POEM trainees
I: An educational program focused on nontechnical skills for POEM
C: No educational program.
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt =<3), POEM adverse events.

Bibliographic search
Bibliographic search strategies were performed in **PubMed and Embase** from inception**.** References of the included articles were also reviewed manually. Search strategies:

PubMed - Search 16/08/2023
"non-technical"[All Fields] AND ("skill"[All Fields] OR "skilled"[All Fields] OR "skillful"[All Fields] OR "skillfulness"[All Fields] OR "skills"[All Fields]) AND ("endoscopie"[All Fields] OR "endoscopy"[MeSH Terms] OR "endoscopy"[All Fields] OR "endoscopies"[All Fields] OR "endoscopy s"[All Fields] OR (("peroral"[All Fields] OR "perorally"[All Fields]) AND ("endoscope s"[All Fields] OR "endoscoped"[All Fields] OR "endoscopes"[MeSH Terms] OR "endoscopes"[All Fields] OR "endoscope"[All Fields] OR "endoscopical"[All Fields] OR "endoscopically"[All Fields] OR "endoscopy"[MeSH Terms] OR "endoscopy"[All Fields] OR "endoscopic"[All Fields]) AND ("myotomy"[MeSH Terms] OR "myotomy"[All Fields] OR "myotomies"[All Fields])))
Results: 109

Embase - Search 16/08/2023
('endoscopy training' OR (('endoscopy'/exp OR endoscopy) AND ('training'/exp OR training)) OR 'trainee'/exp OR trainee) AND ('nontechnical skills' OR 'non technical skill'/exp OR 'non technical skill')

Results: 258
Duplicates: 10 (eliminated using Mendeley Library)

Total after duplicates: 357

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Results of the bibliographic searches

After removing duplicates (n=10), 357 titles and abstracts were screened. 23 studies were considered potentially relevant, 10 abstracts did not achieve full text publications (congress presentations only), 13 were acquired in full text. Two were excluded for focusing exclusively on pediatric population.

Excluded studies

1. Siau, K., Levi, R., Iacucci, M., et al. Paediatric Colonoscopy Direct Observation of Procedural Skills: Evidence of Validity and Competency Development. Gastroenterol Nutr. 2019 Jul;69(1):18-23.
2. Gabrani, A., Monteiro, I. M., & Walsh, C. M. (2020). Exploring Use of Endoscopy Simulation in North American Pediatric Gastroenterology Fellowship Training Programs. J Pediatr Gastroenterol Nutr. 2020 Jan;70(1):25-30.

Included studies:

1. Grover SC, Garg A, Scaffidi MA, et al. Impact of a simulation training curriculum on technical and nontechnical skills in colonoscopy: a randomized trial. Gastrointest Endosc. 2015 Dec 1;82(6):1072–9.
2. Siau K, Crossley J, Dunckley P, et al. Colonoscopy Direct Observation of Procedural Skills Assessment Tool for Evaluating Competency Development During Training. American Journal of Gastroenterology. 2020 Feb 1;115(2):234–43.
3. Hernandez L V., Klyve D, Feld L, et al. A. Do Nontechnical Skills Affect Legal Outcomes After Endoscopic Perforations? American Journal of Gastroenterology. 2020 Sep 1;115(9):1460–5.
4. Ravindran S, Cavilla R, Ashrafian H, et al. Development of the Teamwork in Endoscopy Assessment Module for Endoscopic Non-Technical Skills (TEAM-ENTS) behavioral marker system. Endoscopy. 2022 May 16;55(5):403–12.
5. Campos S, Devière J, Arvanitakis M. Who will excel in advanced endoscopy? A study assessing the criteria and perceptions of experts with regard to selection of ERCP and EUS trainees. Endosc Int Open. 2023 Mar;11(03):E268–75.
6. Patel K, Pinto A, Faiz O, et al. Factors defining expertise in screening colonoscopy. Endosc Int Open. 2017 Sep;05(09):E931–8.
7. Hitchins CR, Metzner M, Edworthy J, et al. Non-technical skills and gastrointestinal endoscopy: A review of the literature. Frontline Gastroenterol. 2018 Apr 1;9(2):129–34.
8. Ravindran S, Bassett P, Shaw T, et al. Improving safety and reducing error in endoscopy (ISREE): A survey of UK services. Frontline Gastroenterol. 2021 Dec 1;12(7):593–600.
9. Matharoo M, Haycock A, Sevdalis N, et al. Endoscopic non-technical skills team training: The next step in quality assurance of endoscopy training. World J Gastroenterol. 2014 Dec 14;20(46):17507–15.
10. Walsh CM, Scaffidi MA, Khan R, et al. Non-technical skills curriculum incorporating simulation-based training improves performance in colonoscopy among novice endoscopists: Randomized controlled trial. Digestive Endoscopy. 2020 Sep 1;32(6):940–8.
11. Siau K, Dunckley P, Feeney M, et al. ERCP assessment tool: Evidence of validity and competency development during training. Endoscopy. 2019;51(11):1017–26.

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(iii) What are the technical skills required before starting POEM training?

PICO question:

P: POEM trainees
I: Endoscopy technical skills (Upper GI endoscopy expertise; colonoscopy expertise; ESD expertise; EMR expertise; Biliopancreatic expertise; EUS expertise).
C: No expertise
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt =<3), POEM adverse events.

Bibliographic search
Bibliographic search strategies were performed in **PubMed and Google Scholar** from inception**.** References of the included articles were also reviewed manually. Search strategies:

PubMed - Search 08/10/2023
((((((POEM) OR (peroral endoscopic myotomy)) OR (per oral endoscopic myotomy)) OR (cardiomyotomy)) AND ((((((((((trainee) OR (trainees)) OR (training)) OR (fellow)) OR (fellows)) OR (novice)) OR (novices)) OR (learning)) OR (curriculum)) OR (fellowship))) AND ((((((((((((((((((((((((((((((((("technical skills") OR (skills)) OR ("endoscopic skills")) OR (experience)) OR ("endoscopic experience")) OR ("endoscopy experience")) OR ("endoscopy training")) OR ("endoscopy fellowship")) OR (EGD)) OR (esophagogastroduodenoscopy)) OR (gastroscopy)) OR ("upper gastrointestinal endoscopy")) OR ("upper GI endoscopy")) OR ("endoscopy training")) OR (EMR)) OR ("endoscopic mucosal resection")) OR (ESD)) OR ("endoscopic submucosal dissection")) OR ("advanced endoscopy")) OR ("ESD expert")) OR ("submucosal endoscopy")) OR ("third space endoscopy")) OR ("advanced endoscopy fellowship")) OR ("interventional endoscopy")) OR ("advanced therapeutic endoscopy")) OR (colonoscopy)) OR (polypectomy)) OR ("endoscopic polypectomy")) OR (ERCP)) OR ("endoscopic retrograde cholangiopancreatography")) OR (EUS)) OR ("endoscopic ultrasound")) OR ("endosonography")) OR ("EUS interventions")) OR ("interventional EUS"))) AND ((((((((((((outcome) OR ("clinical outcome")) OR (efficacy)) OR (effectiveness)) OR ("Eckardt Score")) OR ("clinical success")) OR ("treatment success")) OR ("learning curve")) OR ("procedural time")) OR ("adverse events")) OR ("complications")) OR (safety))
Results: 117

Google Scholar - Search 22/10/2023
POEM trainee skills experience outcome "learning curve" "advanced endoscopy" OR gastroscopy OR colonoscopy OR EMR OR ESD OR "adverse events" OR "procedure time" "peroral endoscopic myotomy"
Results: 219

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Duplicates: 31
Total after duplicates: 305

Results of the bibliographic searches
After removing duplicates (n=31), 305 titles and abstracts were screened. 9 studies were considered potentially relevant, 9 were acquired in full text.

Included studies:

1. Jawaid S, Draganov PV, Aihara H et al. Pilot prospective study on formal training in per-oral endoscopic myotomy (POEM) during advanced endoscopy fellowship. Endosc Int Open. 2021 Dec 14;9(12):E1890-E1899.
2. Kurian AA, Dunst CM, Sharata A et al. Peroral endoscopic esophageal myotomy: defining the learning curve. Gastrointest Endosc. 2013 May;77(5):719-25.
3. Kishiki T, Lapin B, Wang C et al. Teaching peroral endoscopic myotomy (POEM) to surgeons in practice: an "into the fire" pre/post-test curriculum. Surg Endosc. 2018 Mar;32(3):1414-1421.
4. Dacha S, Aihara H, Anand GS et al. Core curriculum for peroral endoscopic myotomy (POEM).Gastrointest Endosc. 2021 Mar;93(3):539-543.
5. Varma, P. and P. Saxena (2020). "Establishing a submucosal endoscopy program in a gastrointestinal unit." International Journal of Gastrointestinal Intervention 9(2): 36-41
6. Yang, D.,Wagh, M.,Draganov, PV. The status of training in new technologies in advanced endoscopy: from defining competence to credentialing and privileging. Gastrointest Endosc. 2020 Nov;92(5):1016-1025
7. Schlachterman, A., Aziz, A., Alajlan, B. et al. Per-oral endoscopic myotomy (POEM) training and skills evaluation tool: a pilot study. Endosc Int Open. 2020 Dec;8(12):E1826-E1831
8. Yang D, Draganov PV, Pohl H et al. Development and Initial Validation of a Video-Based Peroral Endoscopic Myotomy Assessment Tool Gastrointest Endosc. 2023 Jul 25: S0016-5107(23)02784-0.
9. Fujiyoshi Y, Inoue H, Fujiyoshi MRA et al. Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience. Dig Endosc. 2023 Mar;35(3):323-331.
10. Puli SR, Wagh MS, Forcione D, Gopakumar H. Learning curve for esophageal peroral endoscopic myotomy: a systematic review and meta-analysis. Endoscopy. 2023 Apr;55(4):355-360

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b Training

(i) Is simulation training recommended before starting POEM in humans?

PICO question:

P: POEM trainees
I: Simulation models
C: No simulation training
O: POEM learning curve, POEM clinical success, POEM adverse events

(ii) Is ex-vivo/animal training recommended before starting POEM in humans?

PICO question:

P: POEM trainees
I: Ex-vivo/Animal training
C: No ex-vivo/animal training
O: POEM learning curve, POEM clinical success, POEM adverse events.

Bibliographic search
Bibliographic search strategies were performed in **PubMed and Google Scholar** from inception**.** References of the included articles were also reviewed manually. Search strategies:

PubMed - Search 28/10/2023
(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy OR myotomy OR cardiomyotomy) AND (trainees OR training support OR training OR fellow OR fellows OR fellowship OR observer OR observer ship) AND (ex-vivo OR ex vivo OR model OR models OR simulation OR simulation model OR simulation model training OR endoscopic simulation OR endoscopic simulator OR animal OR animal training OR animal model OR porcine OR porcine model OR porcine training OR training strategy OR experience OR ex vivo experience) AND (learning OR curve OR learning curve OR clinical OR clinical success OR complication OR complications OR adverse events OR adverse event)
Results: 309

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Google scholar - Search 28/10/2023

(Trainee AND ex vivo OR simulation training OR animal training OR porcine model OR porcine training AND peroral endoscopic myotomy)
Results: 444

Duplicates: 11 (eliminated using Endnote)

Total after duplicates: 742
Results of the bibliographic searches
After removing duplicates (n=11), 742 titles and abstracts were screened. 27 studies were considered potentially relevant, 26 were acquired in full text.

Included studies:

1. Bhatt, A., et al. (2016). "Video-based supervision for training of endoscopic submucosal dissection." Endoscopy: 711-716.
2. Chan, D. K., et al. (2017). "A Training Model for Introducing a Novel Surgical Procedure into Clinical Practice: Our Experience on Peroral Endoscopic Myotomy for Achalasia." Ann Acad Med Singap 46(3): 111-114.
3. Chapelle, N., et al. (2018). "Efficacy of a three-day training course in endoscopic submucosal dissection using a live porcine model: a prospective evaluation." United European Gastroenterol J 6(9): 1410-1416.
4. Chiu, P. W., et al. (2013). "Peroral endoscopic myotomy for treatment of achalasia: from bench to bedside (with video)." Gastrointest Endosc 77(1): 29-38.
5. Dacha, S., et al. (2021). "Core curriculum for peroral endoscopic myotomy (POEM)." Gastrointest Endosc 93(3): 539-543.
6. El Zein, M., et al. (2016). "Learning curve for peroral endoscopic myotomy." Endosc Int Open 4(5): E577-582.
7. Eleftheriadis, N., et al. (2012). "Training in peroral endoscopic myotomy (POEM) for esophageal achalasia." Ther Clin Risk Manag 8: 329-342.
8. Fujiyoshi, Y., et al. (2023). "Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience." Digestive Endoscopy 35(3): 323-331.
9. Gonzalez, J. M., et al. (2023). "Training in esophageal peroral endoscopic myotomy (POEM) on an ex vivo porcine model: learning curve study and training strategy." Surg Endosc 37(3): 2062-2069.
10. Gromski, M. A., et al. (2016). "Pre-clinical training for new notes procedures: from ex-vivo models to virtual reality simulators." Gastrointestinal Endoscopy Clinics 26(2): 401-412.
11. Gulati, S., et al. (2017). OC-084 Feasibility of endogel (tm) simulation training for per-oral endoscopic myotomy (poem): first united kingdom experience, BMJ Publishing Group.

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12. Hernández Mondragón, O. V., et al. (2015). "The Per Oral Endoscopic Myotomy (POEM) technique: how many preclinical procedures are needed to master it?" Endosc Int Open 3(6): E559-565.
13. Huang, J., et al. (2023). "Endoscopic submucosal dissection training: evaluation of an ex vivo training model with continuous perfusion (ETM-CP) for hands-on teaching and training in China." Surg Endosc 37(6): 4774-4783.
14. Kishiki, T., et al. (2018). "Teaching peroral endoscopic myotomy (POEM) to surgeons in practice: an “into the fire” pre/post-test curriculum." Surg Endosc 32: 1414-1421.
15. Küttner-Magalhaes, R., et al. (2018). "Training in endoscopic mucosal resection and endoscopic submucosal dissection: Face, content and expert validity of the live porcine model." United European Gastroenterol J 6(4): 547-557.
16. Li, J., et al. (2019). "[The animal models using live pigs in the application and development of endoscopic submucosal dissection training]." Zhonghua Wei Chang Wai Ke Za Zhi 22(7): 697-700.
17. Mahmood, T. and A. Darzi (2004). "The learning curve for a colonoscopy simulator in the absence of any feedback: no feedback, no learning." Surg Endosc 18(8): 1224-1230.
18. Miranda-García, P., et al. (2021). "Implementation of a peroral endoscopic myotomy program." Rev Esp Enferm Dig 113(5): 339-344.
19. Mittal, C. and M. S. Wagh (2017). "Training pathways and competency assessment in peroral endoscopic myotomy (POEM)." Techniques in Gastrointestinal Endoscopy 19(3): 170-174.
20. Mondragón, O. V. H., et al. (2015). "The Per Oral Endoscopic Myotomy (POEM) technique: how many preclinical procedures are needed to master it?" Endosc Int Open 4: E559-E565.
21. Parra-Blanco, A., et al. (2013). "Animal models for endoscopic training: do we really need them?" Endoscopy 45(6): 478-484.
22. Peñaloza-Ramírez, A., et al. (2018). "In vivo experience with peroral endoscopic myotomy: An essential activity for developing the technique in humans." Rev Gastroenterol Mex (Engl Ed) 83(2): 86-90.
23. Ren, Y., et al. (2015). "A stepwise approach for peroral endoscopic myotomy for treating achalasia: from animal models to patients." Scand J Gastroenterol 50(8): 952-958.
24. Schlachterman, A., et al. (2020). "Per-oral endoscopic myotomy (POEM) training and skills evaluation tool: a pilot study." Endosc Int Open 8(12): E1826-E1831.
25. Tantau, M. and D. Crisan (2015). "Peroral endoscopic myotomy: Time to change our opinion regarding the treatment of achalasia?" World J Gastrointest Endosc 7(3): 237-246.
26. von Renteln, D., et al. (2013). "Training for peroral endoscopic myotomy." Techniques in Gastrointestinal Endoscopy 15(3): 153-156.
27. Wang, A., et al. (2018). "Optimal simulation and tissue platforms for acquiring surgical endoscopy skills to perform per oral endoscopic myotomy (POEM)." Journal of Surgical Simulation 5: 24-30.

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(iii) Is observation of live cases at expert centers recommended before starting POEM in humans?

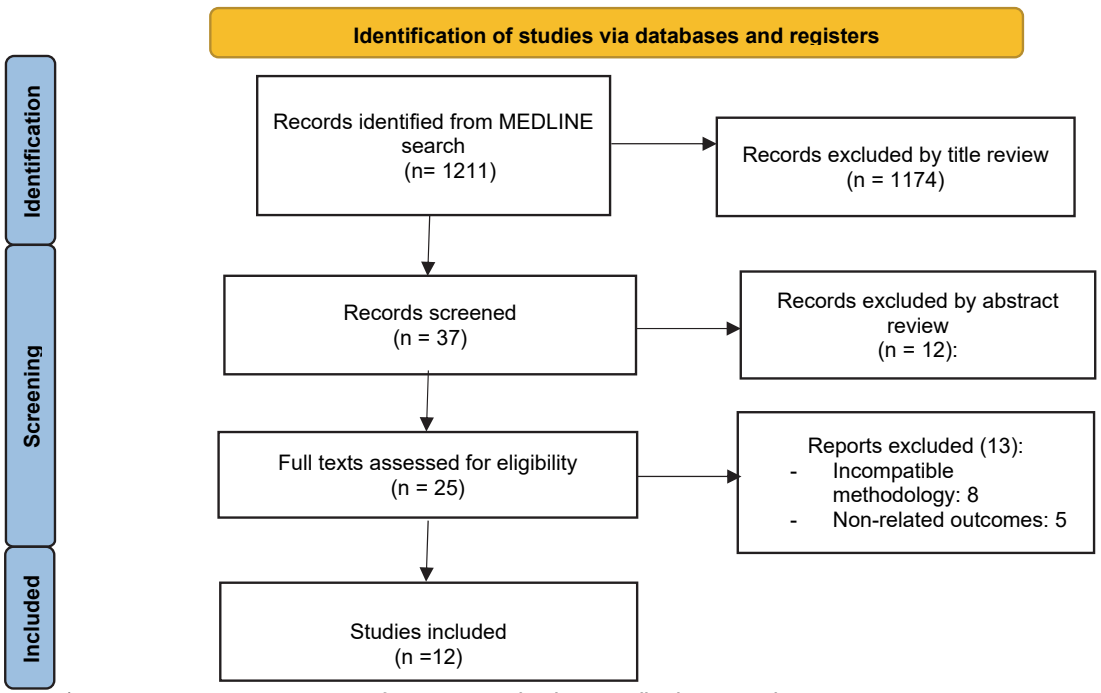
PICO question:

P: POEM trainees
I: Observing live POEM cases
C: No observation of live POEM cases
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt ≤ 3), POEM adverse events.

Search strategy:

(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy) AND (trainees OR training OR fellow OR follow OR fellowship OR observer OR live cases OR program OR observational OR learning OR curve)

PRIMA Flowchart



RESULTS:

- PMID: 36725765, “Successful Design and Implementation of a POEM Program for Achalasia in an Integrated Healthcare System. Dig Dis Sci. 2023 Jun”

- PMID: 23394838, “Peroral endoscopic esophageal myotomy: defining the learning curve. Gastrointest Endosc. 2013 May”

- PMID: 25597422, “The light at the end of the tunnel: a single-operator learning curve analysis for per oral endoscopic myotomy. Gastrointest Endosc. 2015 May”

- PMID: 29208537, “Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy. Clin Gastroenterol Hepatol. 2018 Sep”

- PMID: 29208537, “Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy. Clin Gastroenterol Hepatol. 2018 Sep”

- PMID: 34917458, “Pilot prospective study on formal training in per-oral endoscopic myotomy (POEM) during advanced endoscopy fellowship. Endosc Int Open. 2021 “

- PMID: 27227118, “Learning curve for peroral endoscopic myotomy. Endosc Int Open. 2016 May”

- PMID: 27859721, “Analysis of the learning curve for peroral endoscopic myotomy for esophageal achalasia: Single-center, two-operator experience. Dig Endosc. 2017 May”

- PMID: 36097829, “Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience. Dig Endosc. 2023 Mar

- PMID: 29380066, “Outcomes and quality of life assessment after per oral endoscopic myotomy (POEM) performed in the endoscopy unit with trainees. Surg Endosc. 2018 Jul”

- PMID: 24002767, “Analysis of a learning curve and predictors of intraoperative difficulty for peroral esophageal myotomy (POEM). J Gastrointest Surg. 2014 Jan”

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(iv) Is stepwise POEM training recommended?

PICO question:

P: POEM trainees
I: Stepwise training
C: Performing all POEM steps from the beginning
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt ≤ 3), POEM adverse events.

Search strategy:

(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy) AND (trainees OR training OR fellow OR follow OR fellowship OR steps OR step OR stepwise OR step-by-step OR gradual OR stages OR learning OR curve)

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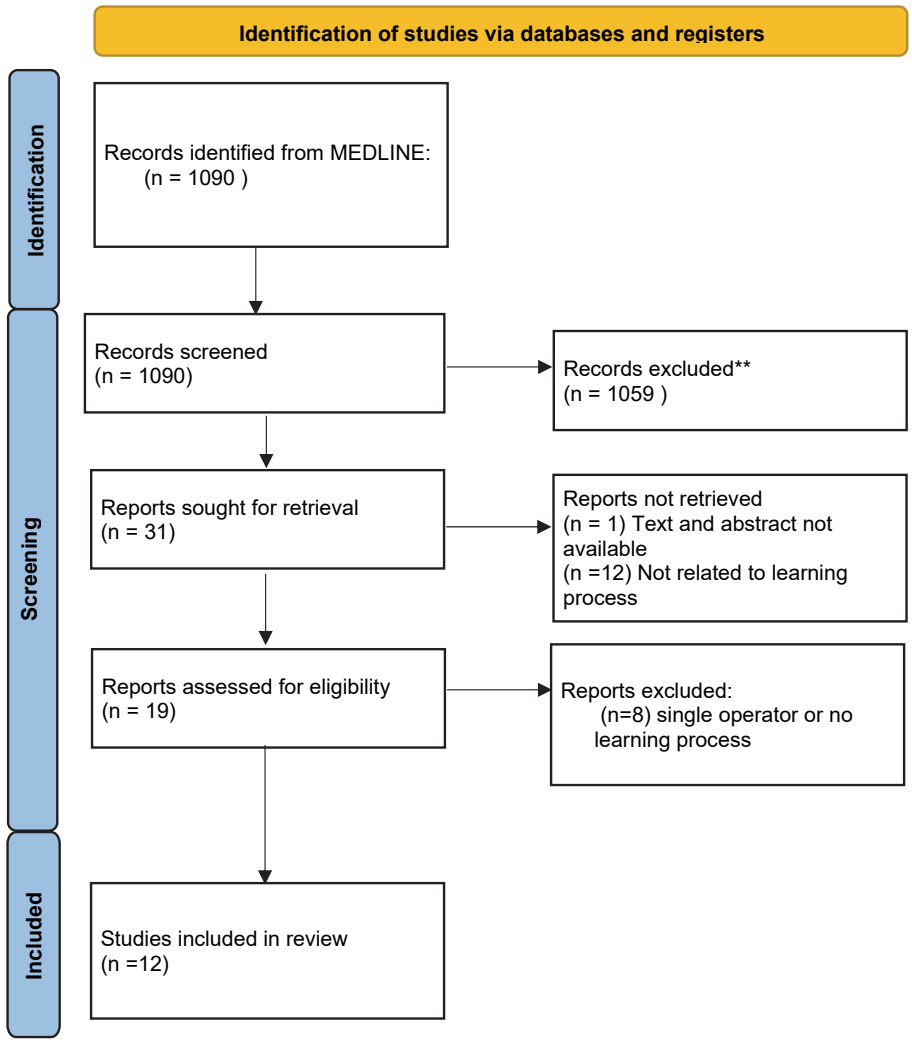
PRIMA Flowchart



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RESULTS:

PMID: 36289086, “Training in esophageal peroral endoscopic myotomy (POEM) on an ex vivo porcine model: learning curve study and training strategy. Surg Endosc. 2023 Mar”

PMID: 36097829, “Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience. Dig Endosc. 2023 Mar”

PMID: 34917458, “Pilot prospective study on formal training in per-oral endoscopic myotomy (POEM) during advanced endoscopy fellowship. Endosc Int Open. 2021 Dec”

PMID: 34570074, “Long-term Outcome of Per-oral Endoscopic Myotomy Performed in the Endoscopy Unit With Trainees. Surg Laparosc Endosc Percutan Tech. 2021 Sep”

PMID: 33269316, “Per-oral endoscopic myotomy (POEM) training and skills evaluation tool: a pilot study. Endosc Int Open. 2020 Dec;8(12):E1826-E1831. doi: 10.1055/a-1264-7542. Epub 2020 Nov

PMID: 27859721, “Analysis of the learning curve for peroral endoscopic myotomy for esophageal achalasia: Single-center, two-operator experience. Dig Endosc. 2017 May”

PMID: 27513156, “Per-oral Endoscopic Myotomy (POEM) After the Learning Curve: Durable Long-term Results With a Low Complication Rate. Ann Surg. 2016 Sep”

PMID: 27227118, “ Effects of a salivary stimulant, slaframine, on ruminal fermentation, bacterial protein synthesis and digestion in frequently fed steers. J Anim Sci. 1989 Mar”

PMID: 25597422, “The light at the end of the tunnel: a single-operator learning curve analysis for per oral endoscopic myotomy. Gastrointest Endosc. 2015 May”

PMID: 24002767, “Analysis of a learning curve and predictors of intraoperative difficulty for peroral esophageal myotomy (POEM). J Gastrointest Surg. 2014 Jan”

PMID: 23394838, “Peroral endoscopic esophageal myotomy: defining the learning curve. Gastrointest Endosc. 2013 May”

(v) Is expert supervision needed during the first POEM cases?

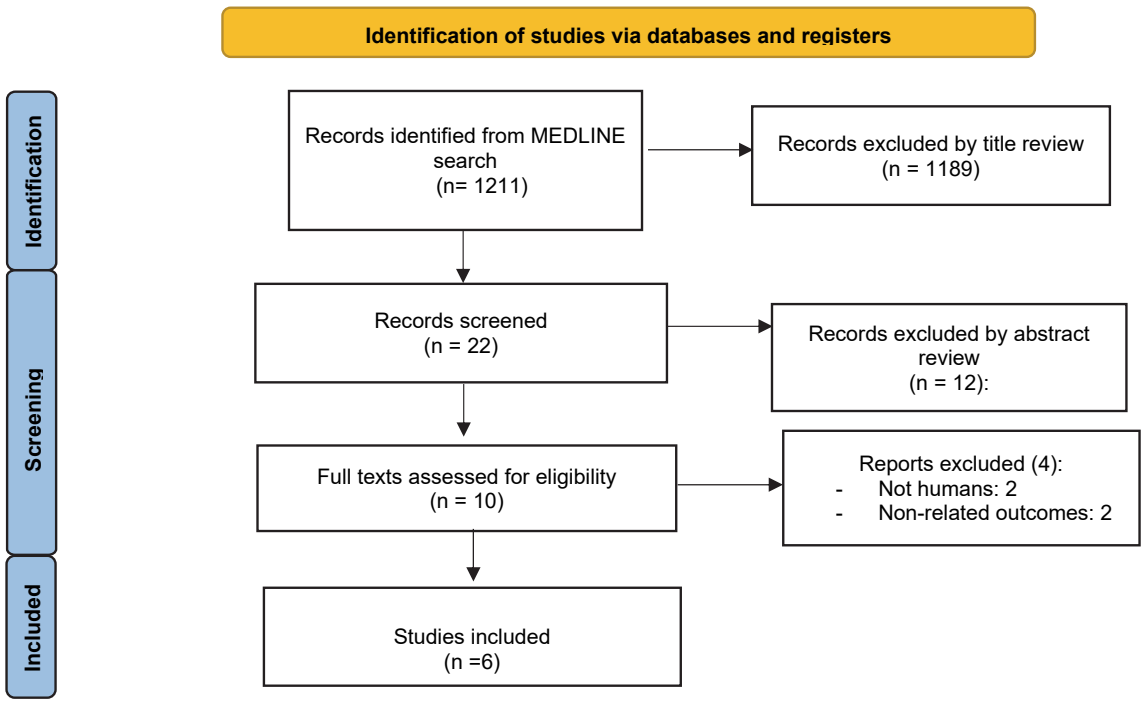
PICO question:

P: POEM trainees
I: Expert supervision
C: No supervision
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt ≤ 3), POEM adverse events.

Search strategy:

(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy) AND (supervision OR teaching OR training trainees OR follow OR fellowship OR observer OR live cases OR program OR observational OR learning OR curve)

PRIMA Flowchart



Endoscopy | DOI 10.1055/a-2568-7473 |

RESULTS:

PMID: 36097829, “Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience. Dig Endosc. 2023 Mar”

PMID: 34917458, “Pilot prospective study on formal training in per-oral endoscopic myotomy (POEM) during advanced endoscopy fellowship. Endosc Int Open. 2021 Dec”

PMID: 34570074, “Long-term Outcome of Per-oral Endoscopic Myotomy Performed in the Endoscopy Unit With Trainees. Surg Laparosc Endosc Percutan Tech. 2021 Sep”

PMID: 33222485, “Implementation of a peroral endoscopic myotomy program. Rev Esp Enferm Dig. 2021 May”

PMID: 29208537, “Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy. Clin Gastroenterol Hepatol. 2018 Sep”

PMID: 23394838, “Peroral endoscopic esophageal myotomy: defining the learning curve. Gastrointest Endosc. 2013 May”

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(vi) Should complex POEM cases be avoided during the early training phase?

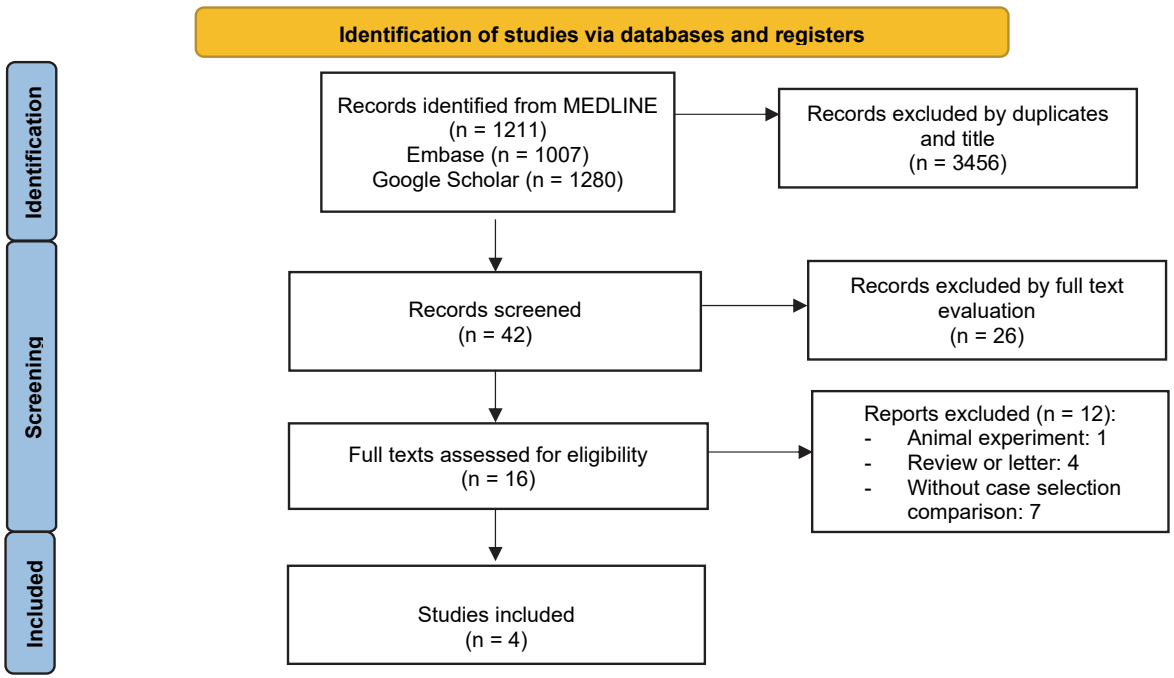
PICO question:

P: POEM trainees
I: Case selection based on anticipated complexity
C: No case selection
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt ≤ 3), POEM adverse events.

Search strategy:

(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy OR Cardiomyotomy) AND (Trainees OR Training OR Fellow OR Fellowship OR Observer OR Live cases OR Program OR Observational OR Learning OR Curve OR Case selection OR Patient selection OR Patient Recruitment OR Selection Criteria OR Subjects Selection OR Subjects Selection OR Selection for Treatment OR Research Subject Selection OR Research Subject Recruitment OR Selection of Research Volunteers)

PRIMA Flowchart



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RESULTS:

An editorial letter commenting the difficult cases in the training curve for POEM:

PMID 34521161, “Issues to be Considered for Learning Curve for Peroral Endoscopic Myotomy”, Shiwaku H, Clin Endosc. 2021 Sep. “After the trainees have learned how to accomplish these parts of the procedure, they begin to perform POEM from beginning to end under the supervision of an expert. This part of the training begins with less difficult cases (straight type, young patients, Chicago classification type II achalasia). If these are performed without any problems, the training progresses to more difficult cases (sigmoid type, older people, Chicago classification type III achalasia).”

Comparative articles:

PMID 34078028,"The Learning Curve for Peroral Endoscopic Myotomy in Latin America: A Slide to the Right?", Kahaleh M, Clin Endosc. 2021 Sep “There was no statistically significant difference (p=0.35) in the mean procedure duration of the Chagas group (mean =108 min; range, 48-196 min), when compared to that in the non-Chagas patients (mean=100.36 min; range, 46-175 min).” Considering Chagas disease as a difficult case.
PMID 29208537,"Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy", Liu Z, Clin Gastroenterol Hepatol. 2018 Sep “Another common deficiency of prior studies was that they did not adjust for case complexity, which could have considerable variation along the series. As shown in supplementary table 1, the distribution of several risk factors was unbalanced along the case sequence. In the initial stage of using a new technique, technical failure and adverse events are expected to be high because of the operator’s lack of proficiency; the probability of failure and adverse events decreases as the operator’s skill develops. Using risk-adjusted CUSUM analysis, we were able to perform appropriate adjustments for the discordance between patient- and surgeon-related factors over time.”
PMID 27227118,"Learning curve for peroral endoscopic myotomy", El Zein M, Endosc Int Open. 2016 May “There was no significant association between the other variables (i.e., patient age, type of achalasia, previous therapy, and length of myotomy) and procedure times (table 2).”
PMID 24002767,"Analysis of a learning curve and predictors of intraoperative difficulty for peroral esophageal myotomy (POEM)", Teitelbaum EN, J Gastrointest Surg. 2014 Jan “Separate multivariate regression analyses were then performed, that included (1) the three variables (prior treatment, symptom duration, esophageal width) with bivariate significance, (2) those three variables plus case number, and (3) those three variables plus 1/case number (i.e., case number contribution according to a learning curve). Each analysis confirmed the independent contributions of prior treatment, symptom duration, and esophageal width to predict total operative time, while case number and 1/case number were again found not to be significant determinants of operative time.”

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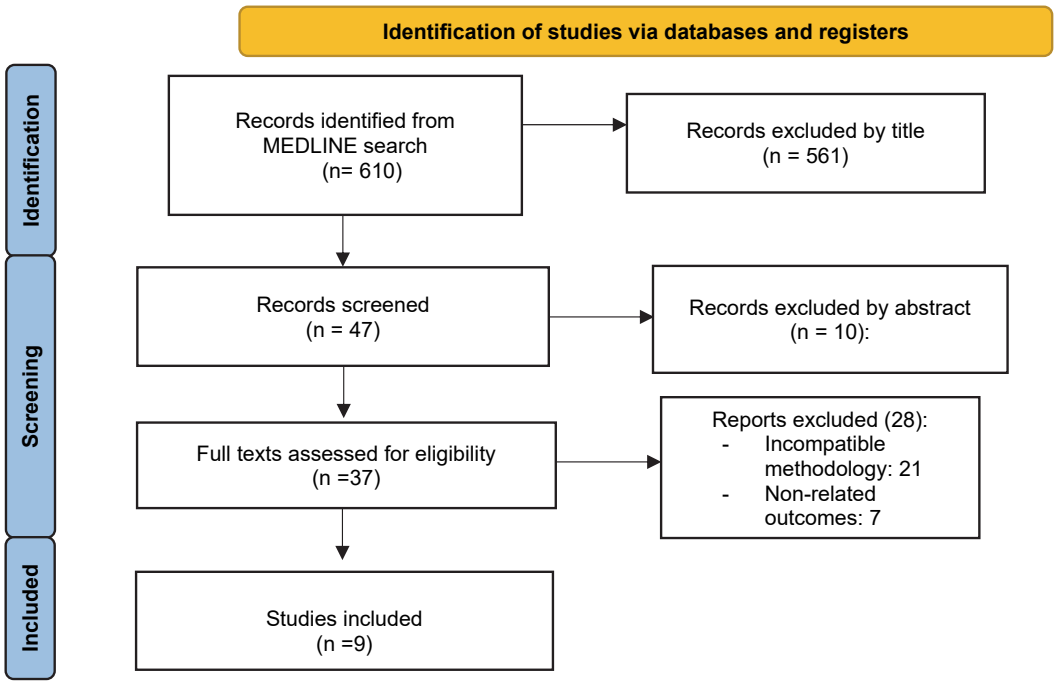
(vii) What are the requisites for a POEM trainer?

PICO question:

P: POEM trainee
I: Supervision by a skilled POEM trainer (technical/nontechnical skills and theoretical knowledge)
C: Supervision by a non-skilled POEM trainer.
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt =<3), POEM adverse events.

Search strategy:
(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy) AND (trainer OR mentor OR expert OR training OR learning curve OR Experience)

PRISMA Flowchart



Endoscopy | DOI 10.1055/a-2568-7473 |

RESULTS:

PMID: 36097829: Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience.

Fujiyoshi Y, Inoue H, Fujiyoshi MRA, Rodriguez de Santiago E, Nishikawa Y, Toshimori A, Tanabe M, Shimamura Y, Sumi K, Ono M, Shiwaku H, Ikeda H, Onimaru M.Dig Endosc. 2023 Mar;35(3):323-331. doi: 10.1111/den.14435. Epub 2022 Oct 26.

PMID: 34917458: Pilot prospective study on formal training in per-oral endoscopic myotomy (POEM) during advanced endoscopy fellowship.

Jawaid S, Draganov PV, Aihara H, Khashab MA, Yang D. Endosc Int Open. 2021 Dec 14;9(12):E1890-E1899. doi: 10.1055/a-1610-8962. eCollection 2021 Dec.

PMID: 34570074: Long-term Outcome of Per-oral Endoscopic Myotomy Performed in the Endoscopy Unit With Trainees. Abdelfatah MM, Calderon LF, Koldhekar A, Kapil N, Noll A, Shah R, Mekaroonkamol P, Patel V, Dacha S, Philips G, Shahnavaz N, Keilin S, Willingham FF, Christie J, Cai Q. Surg Laparosc Endosc Percutan Tech. 2021 Sep 27;32(1):114-118. doi: 10.1097/SLE.0000000000001014.

PMID: 29208537: Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy. Liu Z, Zhang X, Zhang W, Zhang Y, Chen W, Qin W, Hu J, Cai M, Zhou P, Li Q. Clin Gastroenterol Hepatol. 2018 Sep;16(9):1420-1426.e2. doi: 10.1016/j.cgh.2017.11.048. Epub 2017 Dec 5.

PMID: 29380066: Outcomes and quality of life assessment after per oral endoscopic myotomy (POEM) performed in the endoscopy unit with trainees. Dacha S, Wang L, Li X, Jiang Y, Philips G, Keilin SA, Willingham FF, Cai Q. Surg Endosc. 2018 Jul;32(7):3046-3054. doi: 10.1007/s00464-017-6015-x. Epub 2018 Jan 29.

PMID: 27227118: Learning curve for peroral endoscopic myotomy. El Zein M, Kumbhari V, Ngamruengphong S, Carson KA, Stein E, Tieu A, Chaveze Y, Ismail A, Dhalla S, Clarke J, Kalloo A, Canto MI, Khashab MA. Endosc Int Open. 2016 May;4(5):E577-82. doi: 10.1055/s-0042-104113. Epub 2016 Mar 30.

PMID: 28916889 Teaching peroral endoscopic myotomy (POEM) to surgeons in practice: an "into the fire" pre/post-test curriculum. Kishiki T, Lapin B, Wang C, Jonson B, Patel L, Zapf M, Gitelis M, Cassera MA, Swanström LL, Ujiki MB. Surg Endosc. 2018 Mar;32(3):1414-1421. doi: 10.1007/s00464-017-5823-3. Epub 2017 Sep 15.

PMID: 27513156: Per-oral Endoscopic Myotomy (POEM) After the Learning Curve: Durable Long-term Results With a Low Complication Rate. Hungness ES, Sternbach JM, Teitelbaum EN, Kahrilas PJ, Pandolfino JE, Soper NJ. Ann Surg. 2016 Sep;264(3):508-17. doi: 10.1097/SLA.0000000000001870.

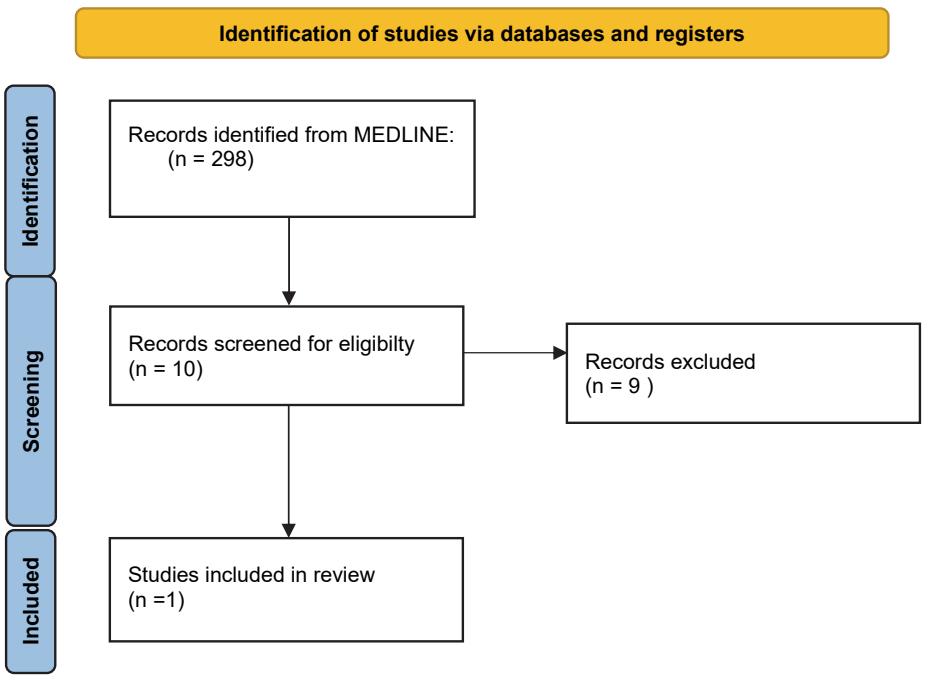
PMID: 25597422: The light at the end of the tunnel: a single-operator learning curve analysis for per oral endoscopic myotomy. Patel KS, Calixte R, Modayil RJ, Friedel D, Brathwaite CE, Stavropoulos SN. Gastrointest Endosc. 2015 May;81(5):1181-7. doi: 10.1016/j.gie.2014.10.002. Epub 2015 Jan 16.

(viii) What are the requisites for a POEM Training Center?

PICO not applicable

Search strategy:
(POEM OR peroral endoscopic myotomy OR per oral endoscopic myotomy) AND (training center OR training OR expertise OR training program OR Curriculum)

PRIMA Flowchart



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RESULTS:

PMID: 23549760

The International Per Oral Endoscopic Myotomy Survey (IPOEMS): a snapshot of the global POEM experience.

Stavropoulos SN, Modayil RJ, Friedel D, Savides T.

Surg Endosc. 2013 Sep;27(9):3322-38. doi: 10.1007/s00464-013-2913-8. Epub 2013 Apr 3.

(ix) How long should a POEM training program take?

PICO question:

P: POEM trainees
I: POEM training program 3 months
C: 6 months vs 12 months vs 18 months
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt =<3), POEM adverse events.

(x) Should POEM-trainees be involved in the selection of patients for POEM?

PICO not applicable. Expert-based review

(xi) What are the minimum requirements for a POEM endoscopy Report?

PICO not applicable. Expert-based review

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c Autonomous implementation and assessment of proficiency

(i) What is the definition of POEM competence? Is the nº of POEM cases an adequate marker of POEM competence?

PICO not applicable. Expert-based review.

(ii) What volume of POEM procedures (cases/year) is recommended to maintain proficiency?

PICO question:

P: POEM operator
I: Volume of cases
C: Quantitative variable. Compare different cut-offs.
O: POEM learning curve (procedural time and time per centimeter of myotomy), POEM clinical success (Eckardt =<3), POEM adverse events.

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Table 1s Main details of the included studies

a Pre-adoption

Author, publication year	Study type	Study objective	Participants (n)/ settings	Intervention	Comparisons	Outcomes	Main results	Conclusion	Quality assessment High/mod/ low quality
Jawaid, 2021 [1]	Prospective (July 2018 to March 2021). University of Florida, United States.	To evaluate the feasibility of a structured POEM training curriculum and the endoscopist performance during independent practice afterwards.	• One trainee performed 35 POEM cases during the advanced endoscopy fellowship and 16 POEM cases in his first year of independent practice. Total 51 POEM cases.	Structured training: 1. Formal didactic training: observation of at least 20 cases. H 2. Hands-on training: at least 5 animal model POEM cases. Limited portions of POEM cases. Live cases with proctorship.	POEMAT: structured assessment tool including cognitive core skills, technical core skills and management of adverse events.	The training curriculum was considered adequate if the threshold of competence was met in ≥ 80% of the hands-on cases. A rating ≥7 in POEMAT was the minimal score required for competence. Clinical success was defined as Eckardt score < 3.	**18-month training**: competence in their overall performance score was attained in 83.3% of the cases of phase 3. 1 year of independent practice: 100% clinical success.	Results from this pilot study support the adoptability of his proposed core curricula for POEM training.	Low
Kurian, 2013 [2]	Prospective cohort study (from October 2010 to 2013). Portland, United States.	To determine the learning curve for POEM.	3 operators: one senior surgeon and 2 trainees.	Outcomes of the first 40 cases performed by 3 surgeons.	Length of procedure, technical errors and adverse events were compared between the consecutive procedures.	Mastery of POEM was defined by a plateau of length of the procedure, minutes per cm of myotomy and incident of inadvertent mucosotomies.	• Median length of procedure: 126min. Length of procedure per cm of myotomy and inadvertent mucosotomies decreased as experience progressed.	Mastery of POEM technique plateaued after **20 procedures.**	Low

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Kishikil, 2018 [3]	Prospective assessment of a POEMS curriculum in surgeons North Shore University Health System, The Oregon Clinic United States	Assessment of POEMs pre/post test curriculum	11 endoscopist with more than 50 POEM cases Taught 65 trainees with previous endoscopy experience in ESD.	Assessment of Course quality by trainees			Uptaske of POEMS at Trainees center		Low
Fujiyoshi 2023 [4]	Retrospective (April 2014 to December 2020). Showa University Koto Toyosu Hospital Digestive Diseases Center, Japan.	To assess the number of cases required to achieve POEM proficiency.	555 cases performed by 15 ESD experts. 566 cases performed by 14 nonexperts. Total: 29 endoscopists.	POEM performance in ESD experts (endoscopist with > 100 ESD cases including > 20 esophageal cases) vs non experts.	Measure of operation time: minutes from inserting the scope into the mouth to withdrawing the scope.	Primary outcome: operation time and time to reach target time (83 min). Secondary outcomes: clinical success rate, adverse events, post-POEM GERD.	In both groups, operation time decreased significantly as experience increased ($p < 0.001$). No differences in clinical success rate, adverse events, and post-POEM GERD.	Nonexperts required 41-60 cases to achieve proficiency. Experts required 21-40 cases.	Low
Puli, 2023 [5]	Meta – Analysis Literature search until November 2021.	To conduct a systematic review and meta-analysis of current data to evaluate the learning curve for POEM in new adopters of this technique.	• 8 studies met the inclusion criteria. 1904 POEM cases.	POEM learning curve.	Intervention details: number of POEM procedures, indications, length of procedure including total and subdivisions, number of operators, specialty, and experience. Outcomes: learning curve, definition of learning, complication.	Primary outcome: pooled estimates of the number of procedures necessary to attain proficiency, pooled estimates of the total procedure time, and mean procedure time per cm of myotomy. Secondary outcomes: clinical success, adverse events.	Once proficiency was achieved, the pooled total procedure time plateaued at a mean of 85.38 min, 6.25min per cm of myotomy with a pooled mean length of myotomy 11.49cm.	New adopters of POEM with previous advance endoscopy experience required 25 procedures to attain proficiency.	Moderate/ High Include Literature search until November 2021. (only one large observational series)

Miranda-García, 2021 [6]	Prospective (March 2017 to June 2018) Madrid, Spain.	To develop a POEM program	One endoscopist performed **15 POEM cases in live animal** model and **11 POEM human cases.**	Outcomes of first 11 POEM cases performed in a single center, after a training program on animal model	Technical success: the myotomy was completed. Clinical success: Eckardt score of ≤ 3 at the end of follow-up. Procedural time and adverse events	The primary outcome was technical and clinical success.	• **9 procedures in animal model** were necessary to reach the plateau of adverse events. • Technical success 100% Clinical success 91%	Training in animal models and supervision by an experienced endoscopist during the first cases are necessary.	Very low
Gonzalez, 2023 [7]	Prospective (2018-2019). Ex-vivo model. Marseille, France	To evaluate the learning curve of POEM prior to live human cases	• 4 endoscopist who had already observed > 30 cases. • All of them performed 30 POEM cases on ex vivo porcine model.	30 POEM cases performed by each endoscopist in porcine model.	The following data were collected and compared: total and subdivisions time, number and volume of injections, number of clips, length of the myotomy, perforations.	Dissection speed (mm/min) Dedicated performance score: dissection speed, length of myotomy, depth of myotomy, and mucosal perforation.	• Trainees completed all cases within **4 months.** • According to dissection speed: learning rate was at 12.2 cases. • According to the composite performance score: 10.4 cases.	**12 procedures in animal model** are needed to start supervised cases on real patients. Following this training, the 4 endoscopist performed 10 supervised POEM cases successfully.	Very low
Hernández Mondragón, 2015 [8]	Prospective study (November 2012 to October 2013) Mexico City, Mexico.	To determine the number of procedures required to master POEM in an **animal model.**	• 1 endoscopist performed 50 POEM cases in animal model (30 ex-vivo followed by 20 live animals). Endoscopist with previous experience in ESD.	Outcomes of the 50 first POEM cases in animal model performed by a single endoscopist.	Procedure time, velocity of tunnelization and myotomy, incidence of complications.	Mastery of POEM: performance of the 5 steps of the technique without complications.	• Median procedure time was 90.17 min in ex-vivo cases and 89.5min in live cases.	**26 procedures in animal model** are recommended to master POEM before performing it in patients.	Very low

b Training

Author, publication year	Study Type	Study objective	Participants (n)/ Settings	Intervention	Comparisons	Outcomes	Main Results	Conclusion	Quality assessment High/mod /low quality
Puli, 2023 [5]	Meta – Analysis Literature search until November 2021.	To conduct a systematic review and meta-analysis of current data to evaluate the learning curve for POEM in new adopters of this technique.	• 8 studies met the inclusion criteria. • **1904 POEM cases.**	POEM learning curve.	Intervention details: number of POEM procedures, indications, length of procedure including total and subdivisions, number of operators, specialty, and experience. Outcomes: learning curve, definition of learning, complication.	Primary outcome: pooled estimates of the number of procedures necessary to attain proficiency, pooled estimates of the total procedure time, and mean procedure time per cm of myotomy. Secondary outcomes: clinical success, adverse events.	• Once proficiency was achieved, the pooled total procedure time plateaued at a mean of 85.38 min, 6.25min per cm of myotomy with a pooled mean length of myotomy 11.49cm.	New adopters of POEM with previous advance endoscopy experience required **25 procedures to attain proficiency.**	Moderate/ High Include Literature search until November 2021. (only one large observational series)
Gonzalez, 2023 [7]	Prospective (2018-2019). **Ex-vivo model.** Marseille, France	To evaluate the learning curve of POEM prior to live human cases	• 4 endoscopist who had already observed > 30 cases. • All of them performed 30 POEM cases on **ex vivo porcine model**.	30 POEM cases performed by each endoscopist in porcine model.	The following data were collected and compared: total and subdivisions time, number and volume of injections, number of clips, length of the myotomy, perforations.	Dissection speed (mm/min) Dedicated performance score: dissection speed, length of myotomy, depth of myotomy, and mucosal perforation.	• Trainees completed all cases within **4 months.** • According to dissection speed: learning rate was at 12.2 cases. • According to the composite performance score: 10.4 cases.	**12 procedures in animal model** are needed to start supervised cases on real patients. Following this training, the 4 endoscopist performed 10 supervised POEM cases successfully.	Low

Fujiyoshi 2023 [4]	Retrospective (April 2014 to December 2020). Showa University Koto Toyosu Hospital Digestive Diseases Center, Japan.	To assess the number of cases required to achieve POEM proficiency.	**555 cases** performed by 15 ESD experts. **566 cases** performed by 14 nonexperts. • Total: 29 endoscopists.	POEM performance in ESD experts (endoscopist with > 100 ESD cases including > 20 esophageal cases) vs non experts.	Measure of operation time: minutes from inserting the scope into the mouth to withdrawing the scope.	Primary outcome: operation time and time to reach target time (83 min). Secondary outcomes: clinical success rate, adverse events, post-POEM GERD.	• In both groups, operation time decreased significantly as experience increased ($p < 0.001$). No differences in clinical success rate, adverse events, and post-POEM GERD.	Nonexperts required **41-60 cases** to achieve proficiency. Experts required **21-40 cases**.	Moderate
Leung, 2023 [9]	Retrospective (January 2019 to December 2020). Oakland Medical Center, United States.	To design a POEM formative program and describe its implementation in a single center.	• 3 endoscopists performed 41 POEM cases.	Outcomes of the 41 first POEM cases performed in a POEM service. Description of the steps necessary to stablish a POEM program.	Technical success: successful tunneling into the gastric cardia and myotomy of LES muscle fibers. Clinical success: post-procedure Eckardt score ≤ 3) at 3–6 months and 12 months.	Primary outcomes: technical success, clinical success.	• **9-month period of training** in ex-vivo model and observation of cases • **2-year period** of POEM performance. 100% technical success, 90% clinical success. 2.4% adverse events.	The steps involved to establish a POEM service in a large integrated healthcare system are outlined in this study.	Low

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Kahaleh, 2021 [10]	Prospective registry (June 2013 to August 2017) Latin America: Argentina, Bolivia, Brazil, Colombia, Ecuador, Mexico, and Nicaragua.	To determine the learning curve for POEM among operators in Latin America	• One endoscopist performed 125 POEM cases. The endoscopist was previously proficient in ESD. • 30% Chagas disease (difference from other series), making POEM more challenging.	Outcomes of the first POEM cases performed in Latin America by one endoscopist.	Technical success: successful completion of the myotomy. Clinical success: Eckardt score of ≤ 3 at 3 months. Procedural time Adverse events rate	Primary outcome: learning curve, estimated by non-linear regression: case number as an independent variable and procedure time as the dependent variable CUSUM analysis.	• Median procedure time: 97 min. Plateau was reached after 61 procedures. • Technical success: 93,5% • Clinical success: 88.8%. Clinical failure was higher in Chagas group (21% vs 7%) • Adverse events: 22%, higher in the Chagas group (18% vs 7%).	**61 cases** are required to master POEM in Latin America population.	Low
Jawaid, 2021 [1]	Prospective (July 2018 to March 2021). University of Florida, United States.	To evaluate the feasibility of a structured POEM training curriculum and the endoscopist performance during independent practice afterwards.	• One trainee performed 35 POEM cases during the advanced endoscopy fellowship and 16 POEM cases in his first year of independent practice. Total 51 POEM cases.	Structured training: 3. Formal didactic training: **observation of at least 20** cases. H 4. Hands-on training: at least **5 animal model** POEM cases. Limited portions of POEM cases. Live cases with proctorship.	POEMAT: structured assessment tool including cognitive core skills, technical core skills and management of adverse events.	The training curriculum was considered adequate if the threshold of competence was met in ≥ 80% of the hands-on cases. A rating ≥7 in POEMAT was the minimal score required for competence. Clinical success was defined as Eckardt score < 3.	• **18-month training**: competence in their overall performance score was attained in 83.3% of the cases of phase 3. **1 year of independent practice**: 100% clinical success.	Results from this pilot study support the adoptability of his proposed core curricula for POEM training.	Low

Miranda-García, 2021 [6]	Prospective (March 2017 to June 2018) Madrid, Spain.	To develop a POEM program.	One endoscopist performed **15 POEM cases in live animal** model and **11 POEM human cases.**	Outcomes of first 11 POEM cases performed in a single center, after a training program on animal model	Technical success: the myotomy was completed. Clinical success: Eckardt score of ≤ 3 at the end of follow-up. Procedural time and adverse events	The primary outcome was technical and clinical success.	• **9 procedures in animal model** were necessary to reach the plateau of adverse events. • Technical success 100% • Clinical success 91%	Training in animal models and supervision by an experienced endoscopist during the first cases are necessary.	Low
Tefas, 2020 [11]	Prospective study (November 2013 to February 2019). Cluj-Napoca, Romania	To analyze a single-series POEM learning curve, safety, and efficiency over short, medium and long-terms	• 1 operator performed 136 POEM cases. • Prior ESD experience not specified.	Outcomes of the first POEM cases performed in Romania.	Technical and clinical success, adverse events.	Learning curve estimated by the plateau of minimum incidence of major adverse events.	• Technical success: 100% • Clinical success: 87.5% Major complications: 13.2%	The learning curve had a cut-off of **20 POEM cases:** first 20 procedures had a higher risk of adverse events.	Low
Liu, 2018 [12]	Retrospective (August 2010 to July 2015). Shanghai Zhongshan Hospital, China.	To evaluate the POEM learning curve, and the effect of patient-related factors and operator experience.	• **1346 POEM**: 192 performed by and expert endoscopist and 1154 performed by 6 learners supervised by this expert endoscopist.	Outcomes of 1346 POEM performed by 6 trainees during their learning curve.	Incidence of technical failure (inability to finish the operation) or major perioperative adverse events. Clinical failure was defined as an Eckardt score ≥ 4 after the procedure. Long procedure time: > 60 min.	Primary outcome: a composite of **technical failure + adverse events**. Secondary outcome: procedure time.	• 54 patients (4%) reached the primary outcome: 10 technical failure and 44 adverse events. • Risk factors: number of cases previously performed by the endoscopist, full thickness myotomy and procedure time.	**100 cases** were required to decrease the risk of technical failure, adverse events and clinical failure. **70 cases** were required for decreasing procedure time (55 vs 45 min, ($p < 0.001$).	Moderate

Lv, 2017 [13]	Retrospective (August 2011 to June 2014). Tianjin Medical University General Hospital, China	To investigate the learning curve for POEM for consecutive patients.	• 2 endoscopists carried out 35 and 33 POEM cases. • Total 68 POEM cases. • Both had experience of > 100 ESD including esophageal cases.	Outcomes of the first 33 and 35 POEM cases of 2 expert endoscopists.	The corrected operative time was analyzed using moving average and CUSUM methods along the consecutive cases. Perioperative outcomes were compared among distinct learning curve phases.	Moving average method Cumulative sum (CUSUM) method	• Operative time reached a plateau at the 29th case and at the 24th case for operators A and B, respectively. • **Three phases:** initial learning period (13 and 9 cases), efficiency period (after the following 12 and 14 cases) and mastery period (> 26 y > 24 cases).	Expert endoscopists reached a plateau in learning of POEM after **approximately 25 cases.**	Low
El Zein, 2016 [14]	Retrospective (May 2011 to September 2014). Johns Hopkins Hospital, United States.	To define the learning curve for POEM. To determine which factors predict procedure time.	1 endoscopist performed 60 POEM cases in consecutive patients. Prior to these patients, the endoscopist completed 5 ex-vivo animal cases and 5 live animal cases.	Outcomes of the first consecutive 60 POEM cases performed by a single endoscopist.	The learning curve was assessed by a nonlinear regression model: case number as the independent variable and procedure time as dependent.	Procedure time Learning rate: number of trials required to reach 90% of potential. Clinical response was defined as Eckardt score ≤ 3.	• Learning plateau at 102 minutes and learning rate of 13 cases. Significant difference was observed between procedures 11–15 vs 16–20. 92% clinical response.	The minimum number of cases required for an expert interventional endoscopist to reach a plateau was **13 cases.**	Low
Patel, 2015 [15]	Prospective cohort study (October 2009 to November 2013). Winthrop University Hospital, United States.	To define the POEM learning curve of a gastroenterologist.	1 endoscopist performed 93 POEM cases. • The endoscopist has extensive prior experience in ESD.	Outcomes of the first 93 POEM cases performed by a single endoscopist.	Analysis of technical errors, clinical outcomes, analyze patient factors that may affect the procedure time.	CUSUM method. Efficiency: gradual decrease in procedure time. Mastery: no further change in procedure time is observed.	• Technical success: 100% • Adverse events: 2% • 96% clinical success. • Median procedure time: 97 min.	Efficiency was attained after **40 POEM procedures**, and mastery after 60 POEM cases.	Low

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Hernández Mondragón, 2015 [8]	Prospective study (November 2012 to October 2013) Mexico City, Mexico.	To determine the number of procedures required to master POEM in an **animal model.**	• 1 endoscopist performed 50 POEM cases in animal model (30 ex-vivo followed by 20 live animals). • Endoscopist with previous experience in ESD.	5. Outcomes of the 50 first POEM cases in animal model performed by a single endoscopist.	Procedure time, velocity of tunnelization and myotomy, incidence of complications.	Mastery of POEM: performance of the 5 steps of the technique without complications.	• Median procedure time was 90.17 min in ex-vivo cases and 89.5min in live cases.	**26 procedures in animal model** are recommended to master POEM before performing it in patients.	Low
Teitelbaum, 2014 [16]	Retrospective study (August 2010 to January 2013). Chicago, United States.	To analyze a single series POEM learning curve.	• 2 surgeons. • 36 POEM cases performed, conjointly by the 2 operators.	Outcomes of the first 36 cases performed by 2 surgeons.	Duration of procedure including total time and subdivisions.	Nonlinear regression was used to determine the learning curve	• Total procedure time did not decrease over the study.	Learning rate of **7-9 cases** according to different POEM phases.	Low
Kurian, 2013 [2]	Prospective cohort study (from October 2010 to 2013). Portland, United States.	To determine the learning curve for POEM.	• 3 operators: one senior surgeon and 2 trainees.	Outcomes of the first 40 cases performed by 3 surgeons.	Length of procedure, technical errors and adverse events were compared between the consecutive procedures.	Mastery of POEM was defined by a plateau of length of the procedure, minutes per cm of myotomy and incident of inadvertent mucosotomies.	• Median length of procedure: 126min. • Length of procedure per cm of myotomy and inadvertent mucosotomies decreased as experience progressed.	Mastery of POEM technique plateaued after **20 procedures.**	Low

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Fujiyoshi 2023 [4]	Retrospective (April 2014 to December 2020). Showa University Koto Toyosu Hospital Digestive Diseases Center, Japan.	To assess the number of cases required to achieve POEM proficiency.	**555 cases** performed by 15 ESD experts. **566 cases** performed by 14 nonexperts. • Total: 29 endoscopists.	POEM performance in ESD experts (endoscopist with > 100 ESD cases including > 20 esophageal cases) vs non experts.	Measure of operation time: minutes from inserting the scope into the mouth to withdrawing the scope.	Primary outcome: operation time and time to reach target time (83 min). Secondary outcomes: clinical success rate, adverse events, post-POEM GERD.	• In both groups, operation time decreased significantly as experience increased ($p < 0.001$). No differences in clinical success rate, adverse events, and post-POEM GERD. •	Nonexperts required **41-60 cases** to achieve proficiency. Experts required **21-40 cases**.	Low
Stavroupoulos 2013 [17]	Survey conducted among POEM 16 centers around the world July 2012	To assess the number of cases including training, patient selection, techniques, periprocedural management, efficacy, complications, and future perspectives	**197 questions** **16 centers** **841 POEM cases** **High Volume center <30 cases/y**		Differences in periprocedural, procedural management, techniques Efficacy and complications between centers		841 Cases Slight differences in periprocedural and procedural management High Efficacy and safety of POEMs • In all centers surveyed	Excellent efficacy and safety of POEMS in all centers surveyed	Low

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c Learning curve studies

Publication	Published	Main of publication	Results
Peroral Endoscopic Myotomy; Novice Surgeon Learning Curve[18]	Am Surg. 2022 Jun 16	Surgeon providing laparoscopic heller myotomy learns POEM	Surgeon learning curve is comparable to interventional endoscopist after 12-14 POEM procedures
Learning curve for esophageal peroral endoscopic myotomy: a systematic review and meta-analysis [5]	Endoscopy. 2023 Apr	Meta-analysis - 8 publications, 1904 patients	New adopters of POEM attained proficiency at a mean of 25 POEM Pooled total procedure time plateaued at a mean of 85,38 minutes Pooled mean procedure time per centimeter of myotomy is 6,25 minutes Pooled mean length of myotomy is 11,49 cm
Training in esophageal peroral endoscopic myotomy (POEM) on an ex vivo porcine model: learning curve study and training strategy [7]	Surg Endosc. 2023 Mar	4 operations observed > 30 cases performed by experts, then performed 30 standardized POEMs on ex vivo porcine model	12 procedures to reach the plateau
Learning curve for peroral endoscopic myotomy in therapeutic endoscopy experts and nonexperts: Large single-center experience [4]	Dig Endosc. 2023 Mar	Comparison learning curve of POEM by non-experts and ESD experts	Non-experts have achieved expertise for 41–60 POEM ESD experts for 21–40 POEM
Learning curve for peroral endoscopic myotomy [14]	Endosc Int Open. 2016 May	Evaluation learning curve of POEM after 60 standardized POEM procedures	"learning plateau" at 102 minutes "learning rate" of 13 POEM

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The Learning Curve for Peroral Endoscopic Myotomy in Latin America: A Slide to the Right? [10]	Clin Endosc. 2021 Sep	Prospective register in Latin America, POEM for achalasia and Chagas disease	median procedure time 97 minutes, which was achieved at the 61st procedure - minimal POEM procedure to achieve plateau is 13
Comprehensive Evaluation of the Learning Curve for Peroral Endoscopic Myotomy [12]	Clin Gastroenterol Hepatol. 2018 Sep	Retrospective analysis, 1346 patients, single center China	„quality of POEM“ increased after 100 procedure „time of procedure“ was running out after 70 POEM
Peroral endoscopic esophageal myotomy: defining the learning curve [2]	Gastrointest Endosc. 2013 May	Prospective cohort study	Median time POEM procedure was 126 ± 41 minutes Median length of myotomy was 9 cm POEM in expert hands – plateau after 20 POEM
Training in peroral endoscopic myotomy (POEM) for esophageal achalasia [19]	Ther Clin Risk Manag. 2012	Japanese center (prof. Inoue), first 200 POEM procedures from 2008	Appropriate to include an animal model in POEM training
Per-oral Endoscopic Myotomy (POEM) After the Learning Curve: Durable Long-term Results With a Low Complication Rate [20]	Ann Surg. 2016 Sep		POEM performed by experienced surgeons provided durable symptomatic relief in 94% of patients with nonspastic achalasia and 90% of patients with type 3 achalasia/spastic esophageal motility disorders, with a low rate of complications. The rate of gastroesophageal reflux was comparable with prior studies of both POEM and laparoscopic Heller myotomy.
POEM: Five Years of Experience in a Single East European Center [11]	J Gastrointest Liver Dis. 2020 Sep	Observational prospective study	

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Appendix 3s Results of the voting rounds

Round 1

27 statements were voted:

- 15 reached consensus and included in the final version of the manuscript
- 1 reached consensus but was refined based on comments (nº 7)
- 4 did not reached consensus. These statements (nº 3, 6 and 9, 20) were refined and voted in round 2.
- 7 statements related to POEM key performance measures reached consensus. However, after the review of the manuscript by the ESGE governing board, it was agreed by the panel to remove this section from the manuscript.

Round 2

- 5 statements reached consensus regarding sentence structure. However, there was no consensus about the nº of cases required for statements 7, 8 and 10.

Round 3

A third voting round took place for statements 7, 8 and 10. All achieved consensus

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