Current and Emerging Instruments and Energy

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Introduction

Technological advancements and innovative techniques in endoscopic surgery have permitted peroral endoscopic myotomy (POEM), first described by Ortega [1] in 1980 and first performed on humans in a submucosal fashion by Inoue in 2008 [2], to become a more widely adopted and utilized technique in the treatment for esophageal motility disorders. The endoscopic technique and technology utilized for POEM were developed from the principles of endoscopic submucosal dissection (ESD), first described in 1988 as a nonoperative approach for the treatment of early gastric cancer [3]. The technique and equipment used for ESD have evolved continuously in this time. Similarly, device and instrument advancements have already been seen with POEM, and they are expected to continue with further adoption of POEM and other surgical endoscopic procedures. This chapter will highlight the current and emerging instruments and energy sources utilized for safe and efficient performance of POEM based on existing experiences.

Devices for POEM

The fundamental characteristics of instruments used for POEM must result in their ability to perform submucosal dissection and myotomy. The endoscope and electrosurgical unit (ESU) are similar to those utilized during standard interventional endoscopy. However, it is important to highlight that high-definition units are essential to optimize tissue

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differentiation for safety and efficacy during the submucosal dissection and myotomy. The electrosurgical knife is the device that performs the majority of the procedure during POEM. Other adjuvant tools are also required at various stages to optimize performance, given the complexity of this procedure. The instruments utilized for POEM are of single use, with diameters compatible with a 2.8 mm endoscopic instrument channel.

Endoscopes

Endoscopes with high-definition (HD) imaging contribute to safe performance of POEM. To obtain true HD image resolution, all components of the system including the video chip, processor, monitor, and transmission cables must be HD-compatible [4, 5]. HD endoscopes produce images with 850,000 to over one million pixels compared to 100,000–400,000 pixels on a standard endoscope [4]. During POEM procedures in particular, HD endoscopes permit optimal recognition of the anatomy in the submucosal plane, muscular layers, and potentially extramural thoracic and abdominal structures. Accurate identification of the mucosa, areolar tissue, circular, and longitudinal muscular layers is required for successful performance of POEM. Additionally, submucosal vessels must be adequately visualized and coagulated or avoided to prevent bleeding. The endoscope utilized by our group and the majority of groups is a forward-viewing HD gastroscope (GIF-H180, Olympus, Tokyo, Japan or GIF HQ190, Olympus Center Valley PA, USA) [6–10] (Fig. 3.1). This 103 cm long gastroscope has a 9.8 mm outside diameter and contains a single 2.8 mm instrument channel. It is compatible with CV-180/160/140/93 image processors [5]. The list price for this endoscope is $35,700 [5]. Others have described a single-channel GIF-H260 (Olympus, Tokyo, Japan) gastroscope for use during POEM [2, 11]. Although not described for POEM, a high-definition therapeutic gastroscope with a single large 3.7 mm instrument channel (eg, GIF-1TH190, Olympus America) has been used for ESD which combines the dual benefits of ideal optics and superior suctioning capacity, especially when a device is in the instrument channel [12]. Inoue has described benefit in using a gastroscope with a larger 3.2 mm working channel with water-jet function during POEM [13].

Fig. 3.1 GI endoscope used for POEM

Overtubes

Overtubes have the ability to facilitate luminal access during POEM and potentially limit oropharyngeal trauma with repeated esophageal intubation throughout a procedure. An overtube is a semirigid plastic sleeve-like conduit device with a soft, tapered, distal tip. The inner diameter is larger than the endoscope, with the distal end tapering to closely match the diameter of the endoscope to minimize the likelihood of mucosal entrapment between the two devices during exchanges [14]. Overtubes vary in length and caliber depending on the indication and route of access. To protect the cricopharyngeal area or airway, such as in POEM, the length needs to be 20–25 cm [14]. Overtubes are intended to facilitate endoscopy by protecting the mucosa from trauma during scope insertion, maintaining linear stability, and reducing the risk of aspiration [14]. Additionally, the sealed distal end may limit proximal gas loss (CO_2 or air) and maintain better insufflation during the procedure. We utilize a 25 cm Guardus overtube (US Endoscopy) (Fig. 3.2a) during POEM and secure it to the patient with umbilical tape (Fig. 3.2b).

Specifically for POEM, the overtube acts to stabilize the endoscope and maintain consistent access for repeated reinsertions. This limits transmission of pushing forces applied to the mucosa and may limit mucosal laceration and gaping, especially at the esophageal mucosotomy site during POEM [7, 13]. During POEM, a diagnostic upper endoscopy is first performed without the device to ensure that the overtube does not interfere with the initial insertion and obscure markings on the endoscope [14]. The overtube can be preloaded onto the endoscope, and once the diagnostic exam is complete, it is advanced over the endoscope to promote procedural efficiency and avoidance of reinsertion. Liberal use of lubricant to the endoscope and inner and outer surfaces of

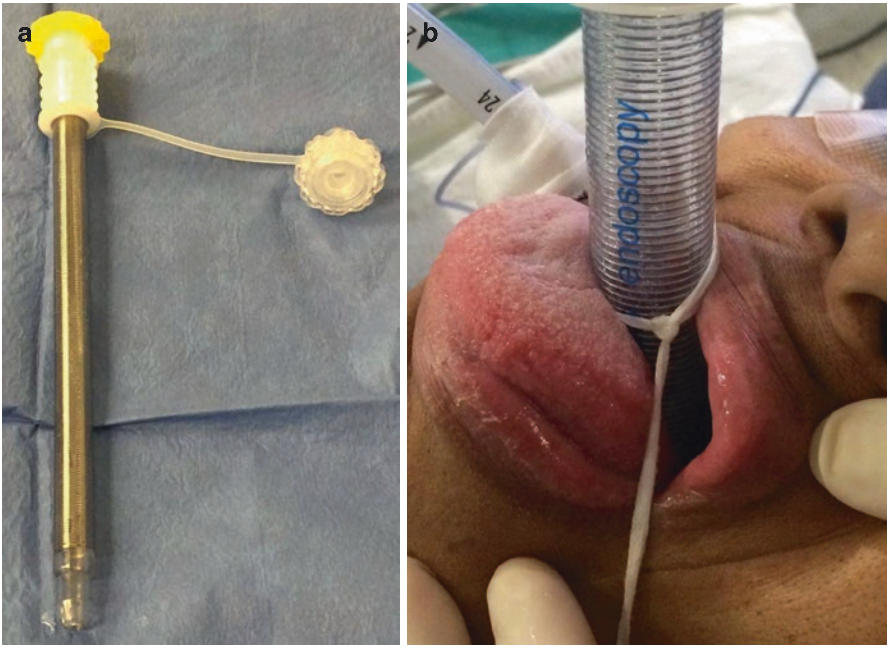

Fig. 3.2 (**a**) Guardus overtube (US Endoscopy) (**b**) Overtube secured with umbilical tape

the overtube prior to insertion is helpful, and any resistance during passage necessitates reassessment [14]. Although water-based lubricants are commonly used, they can desiccate during the extended time required to complete the POEM procedure in many cases. Medical grade olive or vegetable oils are available alternatives and maintain lubricant features for prolonged periods, thus facilitating device movement. Complications such as mucosal abrasion and tears have been reported, with overtube use secondary to the large diameter or pinching of the mucosa between the overtube and endoscope. Proper insertion techniques over a bougie or endoscope reduce this risk [14].

Gas Insufflation

Carbon dioxide (CO_2) gas insufflation is utilized during the procedure with a CO_2 insufflator CO_2MPACT™ (Bracco Diagnostics, USA) (Fig. 3.3) at our institution, or Olympus UCR (Olympus, USA) [2, 9, 11], and a standard low-flow insufflation

Fig. 3.3 CO_2 insufflation unit (CO_2MPACT™, Bracco Diagnostics, USA)

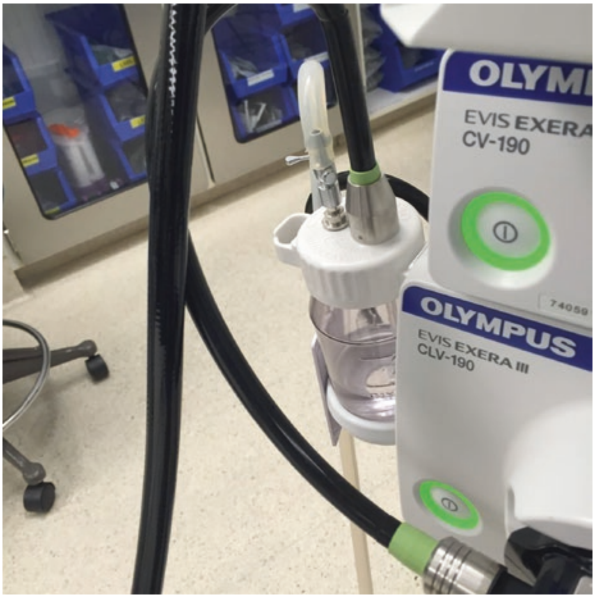

Fig. 3.4 Insufflation tube (MAJ-1742, Olympus America) with valve for precision flow

Fig. 3.5 Standard room air insufflator tuned off

tube (MAJ-1742, Olympus America) [2] (Fig. 3.4). The use of a CO_2 gas insufflation unit is preferred for performance of POEM as regular room air insufflation may lead to unique complications. Utilizing CO_2 insufflation with a low controlled gas flow of 1.2 L/min is beneficial for decreasing the risk of the gas dissecting through small holes in the longitudinal muscle causing pneumomediastinum, pneumoperitoneum, and air embolism [13, 15]. If dissection does occur, however, CO_2 is rapidly absorbed [15]. It is important to ensure that the standard endoscopic room air pump is turned off (Fig. 3.5) during the entire procedure to avoid room air being supplied in conjunction with CO_2 insufflation, thus eliminating the safety advantage of CO_2

utilization [16]. This differs from ESD where it may not be essential to turn the room airflow off, as the muscular layers are kept intact limiting mediastinal emphysema and pneumoperitoneum [13]. The abdomen should be exposed during the procedure to allow periodic examination to ensure no excessive distension is present, potentially representing capnoperitoneum. Large volumes of intraperitoneal CO_2 may result in abdominal compartment syndrome and potential hemodynamic collapse if left untreated. A decompression needle (typically large-gauge angiocatheter with cannula or Veress needle) should be readily available to perform abdominal wall puncture and aspiration if significant capnoperitoneum is present [13]. When needed, needle decompression is performed on either side of the abdomen in the subcostal area. Once successful decompression has been performed, the cannula or Veress needle is often left in place for the remainder of the procedure to evacuate any further accumulated gas.

Knives

There are two main monopolar knives utilized during POEM. Depending on endoscopist preference, either of these knives can be used alone for both the initial mucosotomy, submucosal dissection and myotomy. The most commonly used endoscopic knives are the triangle-tip electrosurgical knife (KD-640 L, Olympus, USA) and the HybridKnife® (ERBE USA) Table 3.1.

The triangle-tip electrosurgical knife (Fig. 3.6) is a monopolar energy device with a noninsulated 1.6 mm triangular electrode plate at the tip of a 4.5 mm long cutting knife. The three sharp angulations at the tip permit smooth spraying of monopolar energy over a wide circumferential range [13]. This enables submucosal dissection and myotomy to be carried out without any direct contact of the knife with the tissue, which makes the dissection more efficient with less bleeding [13, 16]. This technique also minimizes tissue accumulation on the knife, thus decreasing the number of instrument exchanges needed for cleaning, and overall improving the visual field during dissection and muscle division. The triangle-tip electrosurgical knife was the knife used in the original description of POEM [2]. Care must be taken to avoid perforation due to the relatively large distal electrode. Additional knife tip shapes,

Table 3.1 Function comparison of the two most commonly used knives for POEM and list prices[a]

Manufacturer	Device	Injection	Mucosotomy	Submucosal dissection	Myotomy	Hemostasis	Price US$
Olympus[b]	Triangle-tip electrosurgical knife		●	●	●	●	709
ERBE[c]	HybridKnife T type	●	●	●	●	●	488

[a]Modified from [12]
[b]Olympus USA
[c]ERBE USA

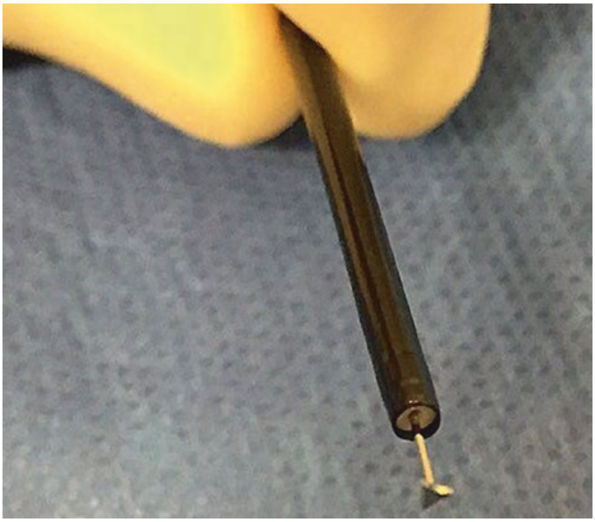

Fig. 3.6 Triangle-tip electrosurgical knife (KD-640 L, Olympus, USA)

Fig. 3.7 HybridKnife® (ERBE USA) T-type (erbe-med.com)

including L shape and ceramic-insulated triangle tip, are alternative options which can be selected based on operator preference.

The HybridKnife® has the potential ability to singularly accomplish all aspects of POEM including initial mucosal lift and dye injection during the submucosal dissection owing to its central capillary within the cutting knife. This feature allows the knife to function as an ultrafine 120-μm water jet that is powered by a foot pedal-activated, jet lavage unit: the ERBEJET®2 system (ERBE USA). The pressurized water jet has the ability to diffuse within the mucosal layer in a needleless fashion to create a submucosal lift [12]. There are three different tip configurations of the HybridKnife®, all with a 5 mm long cutting knife. The I-type is straight without an additional tip. The T-type has a noninsulated 1.6-mm diameter disk-shaped electrode at the tip. Finally, the O-type has an insulated, hemispherical, domelike tip. Only the I-type and T-type knives are approved by the US Food and Drug Administration and currently available in the United States [12], and the T-type has been the model described for use in POEM [10] (Fig. 3.7).

Bleeding during POEM is not uncommon and can significantly obscure visualization during dissection. Normally, minor bleeding can be controlled with the application of coagulation current from the triangle-tip electrosurgical knife or HybridKnife®. More significant bleeding may require management with an endoscopic coagulation forceps. Small vessels identified during submucosal dissection can also be coagulated prophylactically with the knife [12].

Electrosurgical Units (ESU)

The electrosurgical generator unit (ESU) facilitates therapeutic endoscopy by delivering high-frequency electrical current to the endoscopic device. The ESU transfers electrical current through the endoscopic device to thermal energy for use within the tissue [17]. Currently available ESUs contain sophisticated microprocessors and software that allow them to generate multiple different electrosurgical waveforms and settings based on the application specific to various endoscopic procedures, including POEM.

The electrosurgical generator utilized for POEM at our institution is the ERBE VIO 300D (ERBE USA) (Fig. 3.8). This is a radiofrequency surgical energy system, which supports spray-coagulation mode for noncontact tissue dissection during both the submucosal dissection and myotomy [13]. This unit is compatible with both the triangle-tip electrosurgical knife and the HybridKnife. The settings can be adjusted as needed during the procedure. The most frequently reported settings for the various stages of POEM are depicted in Tables 3.2 and 3.3. In general,

Fig. 3.8 ERBE VIO® 300D (Olympus, Germany)

Table 3.2 Settings reported for ERBE VIO® 300D (ERBE USA) utilizing triangle-tip electrosurgical knife (TT knife) (KD-640 L, Olympus, USA) for different stages of POEM [2, 6, 11, 13, 16]

POEM stage	Device	ESU mode	ESU setting	ESU power
Mucosal incision	TT Knife	ENDO CUT® Q	E2	Cutting duration 1, cutting interval 4
Submucosal dissection	TT Knife	SPRAY COAG	E2	50 W
Hemostasis	TT Knife for vessels <1.5 mm or hemostatic forceps for vessels >1.5 mm	FORCED COAG or SOFT COAG	E2 or E5	50–80 W
Myotomy	TT Knife	SPRAY COAG	E2	40–50 W

Table 3.3 Settings reported for ERBE VIO® 300D (ERBE USA) utilizing the HybridKnife® (ERBE USA) for different stages of POEM

POEM stage	Device	ESU mode	ESU setting	ESU power
Mucosal elevation	HybridKnife	ERBEJET® 2	Effect 30–60	
Mucosal incision	HybridKnife	ENDO CUT® Q	E2	Cutting duration 3, cutting interval 3
Submucosal dissection	HybridKnife	ENDO CUT® Q, or SWIFT COAG®	E3	Cutting duration 2–3, cutting interval 3–4
			E3–E4	70 W
Hemostasis	HybridKnife for vessles <1.5 mm or hemostatic forceps for vessels >1.5 mm	FORCED COAG® or SOFT COAG®	E2	50–60 W
Myotomy	HybridKnife	ENDO CUT Q or SWIFT COAG	E3	Cutting duration 2, cutting interval 4
			E3, E4	70 W

Fig. 3.9 ERBEJET®2 system (ERBE USA) (erbe-med.com)

low-voltage (>200 V) settings are used for tissue coagulation, medium-voltage settings (200–600 V) are used for tissue cutting, and high-voltage settings (>600 V) are used for tissue ablation.

When the multifunctional HybridKnife is used for POEM, the integrated electrosurgical and waterjet ERBEJET®2 (Fig. 3.9) functions can improve procedural efficiency. A recently published study comparing the triangle-tip electrosurgical knife and the HybridKnife® during POEM found the HybridKnife to significantly shorten procedural time and decrease device exchanges, while achieving similar treatment success [18].

The use of electrosurgical energy facilitates therapeutic endoscopy, and ESUs possess features that augment patient safety and ease of use. Knowledge of the basic principles of electrosurgical energy and the various settings and applications of the ESU is critical for safe and effective performance of POEM and other advanced endoscopic procedures.

Fig. 3.10 Coagrasper (FD-411QR, Olympus America) hemostatic forceps

Hemostatic Forceps

Bleeding in the submucosal space during POEM is typically from the muscular layers and occurs during the development of the submucosal plane, or more often, during the myotomy. The muscular layers of the esophagus contain an abundance of blood vessels and collateral circulation that may be encountered during the procedure [11]. Monopolar and bipolar hemostatic forceps may be used for hemostasis of submucosal vessels during POEM through coaptive thermoregulation [6, 8, 12]. The Coagrasper (FD-411QR, Olympus America) (Fig. 3.10), commercially available in the United States, is a monopolar hemostatic forceps that comes in a length of 165 cm for the purpose of gastroscopy, and has been used for POEM [2, 9, 12, 16]. It features serrated jaws that open to a width of 5 mm [12]. During submucosal dissection, minor bleeding is generally treated by forced coagulation with the knife, while pulsating bleeding from larger vessels may require hemostatic forceps to grasp and coagulate the vessel using the soft coagulation mode [11]. If larger vessels are identified in the submucosal space during dissection, it is advantageous to precoagulate these vessels with hemostatic forceps [11]. Generally, vessels <1.5 mm can be successfully coagulated with the tip of the knife using FORCED COAG E2, 60 W, while vessels >1.5 mm are best treated with coagulation forceps using FORCED COAG E2, 50 W [11]. Others have described coagulation of larger vessels with Coagrasper in soft coagulation mode (E5, 80 W) [2, 9, 16] and (E2, 80 W) [13]. Use of endoscopic clipping devices are rarely used in the submucosal space, secondary to the small working space and the potential deleterious effects of leaving a foreign body within the layers of the esophageal wall [11].

Adjuvant Tools for Tissue Retraction and Enhanced Visualization

A transparent distal attachment cap fitted to the end of the gastroscope is utilized in POEM to facilitate submucosal tissue dissection and exposure similar to the principles with ESD [10, 15]. Caps come in many different shapes and configuration, tailored to the needs of specific parts of any procedure. During POEM procedures, one or more caps may be utilized during the procedure, and change of caps occurs at a specific step of the operation. The purpose and benefit of the cap are in maintaining improved visualization during dissection in the submucosal tunnel as it keeps the flap of mucosa off of the endoscope lens, thus reducing the "red out" effect [12]. During initial access of the submucosal plane, we prefer a softer, smaller, and tapered cap. This design facilitates entrance into this plane with less maneuvering and potential tissue damage. Once the submucosal tunnel is established and progressed, we prefer to change caps to a larger diameter oblique cap. The cap affords radial tension that assists with submucosal dissection [6] and also protects the mucosa from the knife coagulation spray. The majority of caps have drainage holes, which may need to be fashioned, that permit an outlet for water, tissue debris, and blood to clear from the endoscopic lens, therefore optimizing visualization [12].

Caps are available from a variety of manufacturers. The caps typically utilized for POEM are the 4-mm long and 12.4-mm diameter soft straight distal attachment (D201-11804, Olympus America) [9, 10] (Fig. 3.11), tapered ST hood (Fujifilm, Tokyo, Japan) [13] (Fig. 3.12a), and the oblique distal attachment MH-588 (Olympus) (Fig. 3.12b).

We utilize both the tapered ST hood (Fujifilm, Tokyo, Japan) and the oblique distal attachment cap. The tapered orifice promotes an easier insertion of the endoscope into the submucosa space with a smaller mucosal incision and helps maintain endoscopic visualization in this space [7, 16, 19]. We then switch to the oblique design, which has an orifice with the longer end of the bevel posterior and extends a distance of 1 cm beyond the distal end of the endoscope. It can be helpful for widening the submucosal tunnel to aid dissection and it also effectively effaces the lumen for assistance with clipping the esophageal opening [13]. Dislodgement of the cap within the submucosal tunnel during POEM has been described, and therefore a highly adhesive water-resistant tape to secure the cap to the end of the endoscope is recommended [10]. Our group utilizes standard electrical tape for this purpose (Fig. 3.13).

Fig. 3.11 Olympus (D201-11804, Olympus America) soft straight distal attachment

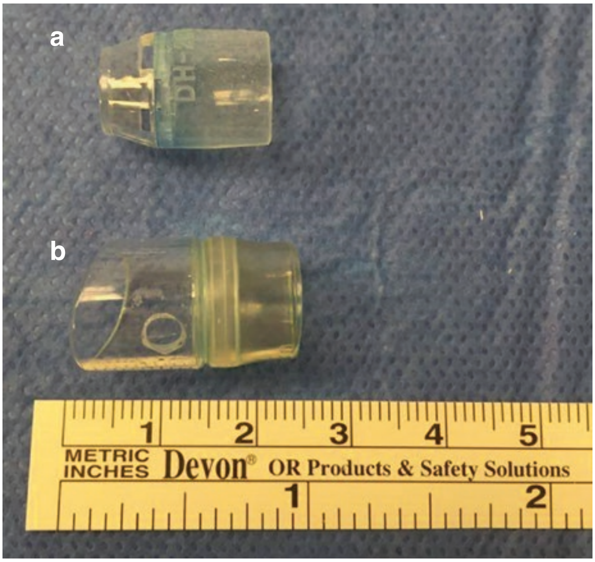

Fig. 3.12 Tapered ST hood (Fujifilm, Tokyo, Japan) and oblique distal attachment caps utilized at our institution. Upper cap is (**a**) and is the oblique cap, Lower cap is (**b**) and oblique cap

Injection Agents and Devices

Injection agents are utilized in the submucosa plane at the site of planned mucosotomy to create an elevated wheel. This separates the mucosa from the submucosa, which provides a margin of safety when performing the mucosotomy [12]. The

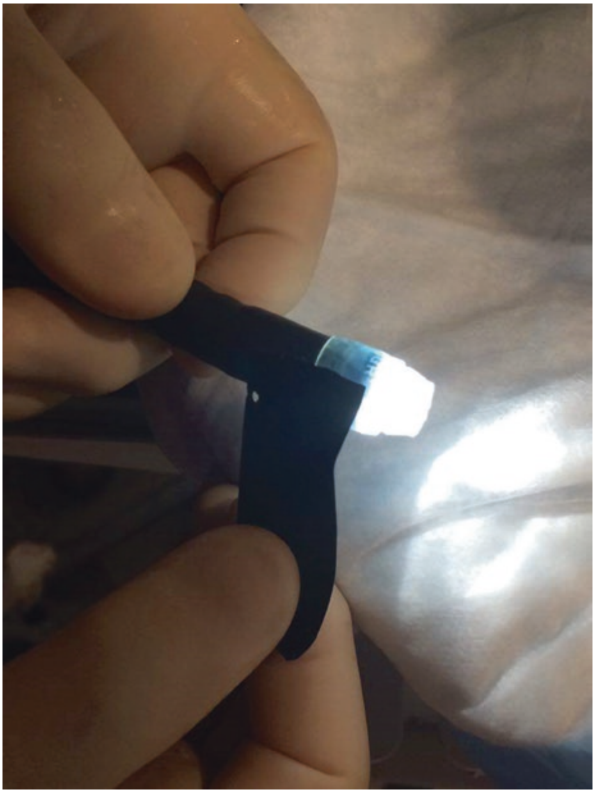

Fig. 3.13 Standard electrical tape to secure the cap to the end of the endoscope

initial submucosal injection is typically delivered with a 21–25 gauge endoscopic needle injection catheter [12].

An Olympus InjectorForce Max™ (Olympus America) single-use disposable 4-mm, 23-gauge injection needle has been described for use with POEM [10, 11]. We utilize the Articulator™ (US Endoscopy) injection needle at our institution (Fig. 3.14). The HybridKnife® is unique in that it features an ultrafine 120-µm water jet that is powered by a foot pedal-activated, jet lavage ERBEJET®2 unit that has the ability to penetrate the mucosal layer in a needleless fashion to create the submucosal wheel and facilitate the initial incision [12].

Dyes such as Indigo Carmine and Methylene Blue are often used for POEM. Differential uptake by mucosal, submucosal, and muscular layers during submucosal injection allows for better tissue plane recognition during dissection. Injection agent mixtures that have been utilized for POEM include 10 mL of saline with 0.3% Indigo Carmine dye [13, 16] or a solution of 250 mL saline, 3 mL Indigo Carmine, with and without the addition of dilute epinephrine, which may aid in

Fig. 3.14 Articulator™ (US Endoscopy) injection needle

hemostasis (1:250,000) [11]. We use a mixture of 500 mL saline with 2 amps of Methylene Blue and 2.5 amps of dilute (1:10,000) epinephrine.

Repeated injection in the submucosal tunnel during dissection is beneficial whenever the submucosal layer and muscular layer demarcation becomes unclear. Differential uptake of the blue dye facilitates identification of the mucosa and orientation as well as enhances the demarcation between tissue layers [16, 19] (Fig. 3.15). During initial endoscopic inspection of the patient's anatomy at the beginning of the POEM procedure, a small volume (1 mL) of full concentration dye is commonly

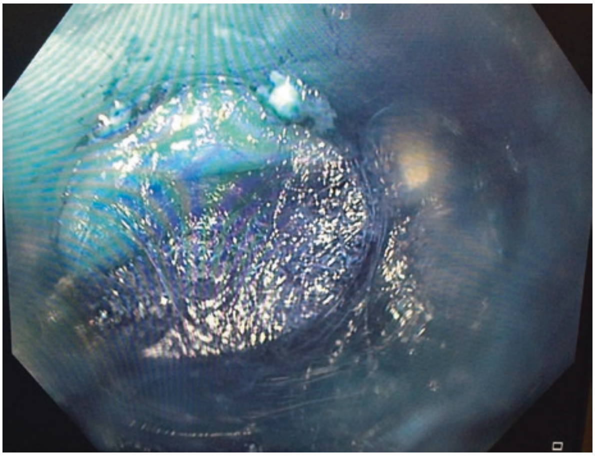

Fig. 3.15 Differential uptake of injection agent by mucosal, submucosal, and muscular layers during submucosal injection for tissue differentiation

injected in the submucosal space of the target endpoint of dissection within the gastric cardia. This is done using a retroflexed position. Later in the procedure, the deep blue discoloration of the gastric cardiac mucosa and submucosa aids in confirming the adequacy of extension of the submucosal tunnel beyond the lower esophageal sphincter [9].

We also inject a mixture of 250 mL saline with 250,000 units of bacitracin into the submucosal space prior to mucosal closure.

Biliary Extraction Balloon

Gentle submucosal balloon dilatation with a 12 mm biliary extraction balloon can facilitate initial entry to the submucosal space [8, 15]. (This is an off-label use of this product.) Care must be employed when inserting the balloon catheter bluntly to avoid mucosal or muscular injury [10]. The balloon is carefully inserted into the submucosal space parallel to the true lumen after the mucosotomy, and dilated up to 12–15 mm to initiate the creation of the submucosal tunnel [10]. Our group utilizes the Olympus V-System single-use stone-extraction balloon (Olympus America) (Fig. 3.16), while others have described the use of a Boston Scientific (Natick, MA, US) controlled radial expansion balloon dilator (12 mm) [10]. Previously, some Western groups utilized the submucosal balloon dilation technique for completion of the submucosal tunnel, but due to the risk of bleeding, have since adopted and become proficient using the knife for submucosal dissection [10, 11, 20].

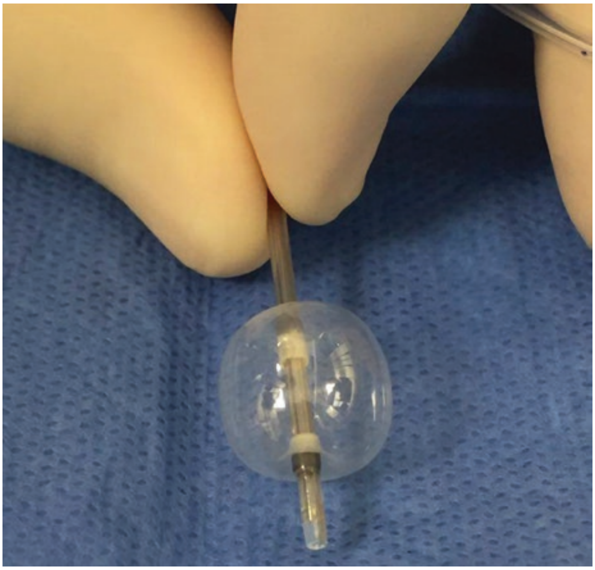

Fig. 3.16 Stone extraction balloon (V-System, Olympus America)

Mucosal Closure Devices

Adequate closure of the initial mucosal entry site during POEM is important to prevent passage of esophageal contents into the submucosal plane, peritoneal cavity, and mediastinum [7, 16]. The optimal closure device is safe, efficient, inexpensive, reliable, and durable [21].

Most centers, including our institution, utilize standard hemostatic clips such as the EZ Clip™ (HX-110QR, Olympus) or Resolution™ Clip (Boston Scientific, Natick, MA, USA (Fig. 3.17) [9, 10, 15, 16]. Several through-the-scope hemostatic clips are currently available in the United States. Typically 5–10 clips are necessary [16, 19], and an average of seven clips has been described during POEM [6]. The total number of clips used varies based on the initial mucosotomy size, and an appropriate amount should be used to completely close the defect, when possible. Our preferred technique for closure commences by placing the first clip in a vertical orientation at the distalmost portion of the mucosal incision. This aligns the mucosal edges to facilitate subsequent proximal clip placement [15]. This approach for mucosal closure is efficient and has been described taking 6 min when performed by an experienced endoscopist [8].

Some have described mucosal closure during POEM with an endoscopic suture device, the OverStitch™ Endoscopic Suturing System (Apollo Endosurgery, USA) (Fig. 3.18). In experienced groups, this technique has good results and no significant difference in mean closure time and cost when compared to standard endoscopic

Fig. 3.17 Resolution™ clip (Boston Scientific, USA)

Fig. 3.18 OverStitch™ endoscopic suturing system (Apollo Endosurgery, USA)

clipping technique [20]. The OverStitch™ Endoscopic Suturing System is a disposable, single-use device that is affixed to a double-channel therapeutic endoscope. It permits placement of either running or interrupted full-thickness sutures. A limitation of this device is that it is only compatible with a single endoscope, the Olympus

Fig. 3.19 OTSC® Clip (Ovesco Endoscopy)

GIF-2T160 gastroscope (Olympus America) [21]. Use of the OverStitch™ suturing device has also been successful in closing inadvertent full-thickness esophagotomy in a two-layered fashion by approximating the muscular layer and then the mucosa separately [22].

Some have also reported mucosal closure with an over-the-scope clipping device, OTSC® clip (Ovesco Endoscopy) [7] (Fig. 3.19) or fibrin sealant [23]. Saxena et al. described an alternative method of mucosal flap closure during POEM, when closure was unsuccessful with hemostatic clips alone. In these case reports, the proximal portion of the mucosa was successfully approximated utilizing a OTSC® Twin Grasper® (Ovesco Endoscopy) followed by placement of OTSC® clip [7]. The OTSC® clip may provide a more durable mucosal closure than standard hemoclips owing to its wider mouth span, capacity to grasp larger amounts of tissue, and ability to apply greater compressive force [24].

Summary

As with all advanced endoscopic and surgical procedures, familiarity with and expertise of use of tools and equipment are important components to the success of the intervention. POEM procedures utilize both commonly and relatively less frequently used devices. Mastering these techniques, including POEM, is incumbent upon understanding of the spectrum of tools available and appropriate and skilled implementation (Table 3.4).

Table 3.4 POEM: OR equipment checklist

Device	Brand
EGD Videoscope (1)	GIF-HQ190 (OLYMPUS)[a]
Overtube (1)	Guardus overtube for esophagus—25 cm (US Endoscopy)[a]
Umbilical tape (1)	
CO_2 insufflator (1)	CO_2MPACT™ (Bracco Diagnostics, USA)[a] or UCR (OLYMPUS)
Low-flow tube for UCR (1)	MAJ-1742 (OLYMPUS)
Needle for removal of excessive CO_2 pressure (1)	Veress needle[a] or 14G IV catheter
Endotherapy (ET) knife (2)	Triangle-tip knife [KD-640L] (OLYMPUS)[a] or HybridKnife® (ERBE)
Endoscopy tower (1)	EVIS EXERA III CV-190 (OLYMPUS)[a]
Electrogenerator (1)	ERBE VIO® 300D (ERBE)[a]
Endotherapy (ET) grasper (1)	Coagrasper [FD-411QR] (OLYMPUS)[a]
Distal attachment (cap) (1, 2)	Tapered ST hood (FUJIFILM)[a] and/or oblique distal attachment MH-588 (OLYMPUS)[a]
Adhesive tape (1)	
Injection needle (1)	Articulator™ (US Endoscopy)[a] or Olympus InjectorForce Max™ (OLYMPUS) (23 G or 25 G)
Saline (1) plus Indigo Carmine or Methylene Blue (1) +/– Epinephrine (1)	
Bowl (2)	
Disposable hemostatic clips (5+)	Resolution clip [M00522610] (BOSTON)[a] or EZ Clip™ [HX-110QR] (OLYMPUS)
Syringe (30 mL) (2)	
Antifog solution (1)	
Alcohol swab (1)	
Water/oil-based lubricant	

[a]Used at our institution

References

1. Ortega JA, Madureri V, Perez L. Endoscopic myotomy in the treatment of achalasia. Gastrointest Endosc. 1980;26(1):8–10. doi:10.1016/S0016-5107(80)73249-2.
2. Inoue H, Minami H, Kobayashi Y, et al. Peroral endoscopic myotomy (POEM) for esophageal achalasia. Endoscopy. 2010;42(4):265–71. doi:10.1055/s-0029-1244080.
3. Hirao M, Masuda K, Asanuma T, et al. Endoscopic resection of early gastric cancer and other tumors with local injection of hypertonic saline-epinephrine. Gastrointest Endosc. 1987;34(3):264–9. doi:10.1016/S0016-5107(88)71327-9.
4. Bhat YM, Abu Dayyeh BK, Chauhan SS, et al. High-definition and high-magnification endoscopes. Gastrointest Endosc. 2014;80:919–27. doi:10.1016/j.gie.2014.06.019.
5. Varadarajulu S, Banerjee S, Barth BA, et al. GI endoscopes. Gastrointest Endosc. 2011;74(1):1–6. doi:10.1016/j.gie.2011.01.061.

6. Swanström LL, Rieder E, Dunst CM. A stepwise approach and early clinical experience in peroral endoscopic myotomy for the treatment of achalasia and esophageal motility disorders. J Am Coll Surg. 2011;213(6):751–6. doi:10.1016/j.jamcollsurg.2011.09.001.
7. Saxena P, Chavez YH, Kord Valeshabad A, Kalloo AN, Khashab MA. An alternative method for mucosal flap closure during peroral endoscopic myotomy using an over-the-scope clipping device. Endoscopy. 2013;45(7):579–81. doi:10.1055/s-0032-1326398.
8. Rieder E, Dunst CM, Kastenmeier AS, Makris KI, Swanström LL. Development and technique of per oral endoscopic myotomy (POEM) for achalasia. Eur Surg. 2011;43(3):140–5. doi:10.1007/s10353-011-0017-z.
9. Kumta NA, Mehta S, Kedia P, et al. Peroral endoscopic myotomy: establishing a new program. Clin Endosc. 2014;47(5):389–97. doi:10.5946/ce.2014.47.5.389.
10. Stavropoulos S, Iqbal S, Modayil R, Dejesus D. Per oral endoscopic myotomy, equipment and technique: a step-by-step explanation. Video J Encycl GI Endosc. 2013;1(1):96–100. doi:10.1016/S2212-0971(13)70043-8.
11. Zhou P. Atlas of digestive endoscopic resection, vol. 148. Dordrecht: Springer; 2014. doi:10.1007/978-94-007-7933-4.
12. Maple JT, Abu Dayyeh BK, Chauhan SS, et al. Endoscopic submucosal dissection. Gastrointest Endosc. 2015:1–15. doi:10.1016/j.gie.2014.12.010.
13. Inoue H, Santi EG, Onimaru M, Kudo SE. Submucosal endoscopy: from ESD to POEM and beyond. Gastrointest Endosc Clin N Am. 2014;24(2):257–64. doi:10.1016/j.giec.2013.12.003.
14. Tierney WM, Adler DG, Conway JD, et al. Overtube use in gastrointestinal endoscopy. Gastrointest Endosc. 2009;70(5):828–34. doi:10.1016/j.gie.2009.06.014.
15. Ponsky JL, Marks JM, Pauli EM. How I do it: per-oral endoscopic myotomy (POEM). J Gastrointest Surg. 2012;16(6):1251–5. doi:10.1007/s11605-012-1868-8.
16. Inoue H, Tianle KM. Peroral endoscopic myotomy for esophageal achalasia: technique, indication, and outcomes. Thorac Surg Clin NA. 2011;21(4):519–25. doi:10.1016/j.thorsurg.2011.08.005.
17. Tokar JL, Barth BA, Banerjee S, et al. Electrosurgical generators. Gastrointest Endosc. 2013;78(2):197–208. doi:10.1016/j.gie.2013.04.164.
18. Tang X, Gong W, Deng Z, Zhou J, Ren Y, Zhang Q, Chen Z, Jiang B. Comparison of conventional versus Hybrid knife peroral endoscopic myotomy methods for esophageal achalasia: a case-control study. Scand J Gastroenterol. 2016;51(4):494–500. doi:10.3109/00365521.2015.1059878.
19. Inoue H, Zorron R. POEM and Emerging NOTES Applications. In: Kalloo AN, Marescaux J, Zorron R. (eds.), Natural Orifice Translumenal Endoscopic Surgery (NOTES). Published Online: 4 JUL 2012. doi:10.1002/9781118307915.ch19.
20. Friedel D, Modayil R, Stavropoulos SN. Per-oral endoscopic myotomy: major advance in achalasia treatment and in endoscopic surgery. World J Gastroenterol. 2014;20(47):17746–55. doi:10.3748/wjg.v20.i47.17746.
21. Banerjee S, Barth BA, Bhat YM, et al. Endoscopic closure devices. Gastrointest Endosc. 2012;76(2):244–51. doi:10.1016/j.gie.2012.02.028.
22. Kurian AA, Bhayani NH, Reavis K, Dunst C, Swanström L. Endoscopic suture repair of full-thickness esophagotomy during per-oral esophageal myotomy for achalasia. Surg Endosc. 2013;27(10):3910. doi:10.1007/s00464-013-3002-8.
23. Li H, Linghu E, Wang X. Fibrin sealant for closure of mucosal penentration at the cardia during peroral endoscopic myoomy (POEM). Endoscopy. 2012;44 Suppl 2 UCTN:E215–6. doi: 10.1055/s-0032-1309358.
24. Von Renteln D, Vassiliou MC, Rothstein RI. Randomized controlled trial comparing endoscopic clips and over-the-scope clips for closure of natural orifice transluminal endoscopic surgery gastrotomies. Endoscopy. 2009;41(12):1056–61. doi:10.1055/s-0029-1215241.