Endoscopic submucosal dissection: an update on tools and accessories

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***Abstract*:** Endoscopic submucosal dissection (ESD) is a minimally invasive therapeutic procedure to remove larger polyps or early non-metastatic lesions. It has long been used in Asia, but is now fast growing in popularity in the West. There are multiple challenges faced by ESD practitioners. While the practice of ESD in gastric lesions is relatively well established, the oesophagus with its narrow lumen and challenging workspace, and the colon with its tortuous course and folds are more challenging frontiers. The nature of performing a procedure endoscopically means that conventional methods offer no mechanism for providing counter-traction while performing dissection, impeding visibility and increasing the rate of complications. There are a multitude of tools available to those performing ESD for the different stages of the procedure. This article reviews the accessories currently used in regular ESD practice including the knives used to cut and dissect lesions, the cap and hood devices used to improve visibility and safety, injection fluids to lift the submucosal plane, haemostatic devices, generators, and finally, emerging traction apparatus. There is some evidence behind the use of these tools, however, ESD remains the domain of a small number of practitioners and the practice relies heavily on expert experience. Evolution of the ESD toolbox will make the procedure more accessible to more endoscopists, which in turn will drive the development of a more substantial evidence base to evaluate efficacy and safety of the multitude of tools.

Keywords: accessories, endoscopic submucosal dissection, endoscopy, tools

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Introduction

Endoscopic submucosal dissection (ESD) is a minimally invasive therapeutic procedure to remove large polyps or early non-metastatic lesions. It has long been used in Asia, but is now fast growing in popularity in the West.[1] It involves the following steps:

1. Marking: The tip of the knife is used for marking the margin for resection.
2. Injection: A solution is injected into the submucosa to elevate the mucosa.
3. Incision: An incision is made around the circumference of the lesion.
4. Submucosal dissection: The submucosa is dissected with care to avoid perforation.
5. Haemostasis: Coagulation of bleeding vessels as required throughout.

ESD was developed in Japan in the late 1990s as a reaction to the shortcomings of endoscopic mucosal resection (EMR) in removing large superficial gastric malignancies.[2] EMR involves the use of a snare around the tissue and the passing of an electrosurgical current to transect it. For larger lesions (usually more than 20 mm in diameter), the use of EMR would require piecemeal removal, leading to high risk for local cancer recurrence and inadequate staging, whereas ESD allows complete *en-bloc* resection. ESD is technically more challenging than EMR, with longer procedural times and higher rates of complications, but the *en-bloc* resection allows good histopathological assessment of lesion margins, lower recurrence rate and a greater minimally invasive potential for cure.[3,4] The procedure is well established in Asia, but has been slow to spread into

the West for a number of reasons. These include lower availability of mentors for a technically challenging procedure, high complication rates, and a significantly lower prevalence of early gastric cancer.[5] Hybrid ESD involves ESD combined with the snaring of EMR, simplifying the most challenging ESD step: submucosal dissection. This is associated with shorter procedure times and lower complication rates, but with lower *en-bloc* resection rates.[6]

The European Society of Gastrointestinal Endoscopy recommends ESD be used first line in the removal of gastric superficial neoplastic lesions with very low risk of lymph node metastases (EMR may be considered if the lesion is <10 to15 mm with a very low probability of advanced histology). It is also recommended first line for superficial oesophageal squamous cell cancers (again, EMR can be considered in lesions <10 mm). For visible lesions in Barrett's oesophagus, EMR should be used first line, but ESD can be considered for lesions >15 mm, in a poorly lifting tumour, or in high risk of submucosal invasion. For colonic and rectal lesions, the majority can be safely removed by polypectomy or EMR; however, ESD can be considered if there is a high suspicion of limited submucosal invasion (indicated by depressed morphology and an irregular or non-granular surface pattern) – especially if >20 mm, or in lesions that otherwise cannot be optimally and radically removed by snare-based techniques.[7]

There are multiple challenges faced by ESD practitioners. While the practice of ESD in gastric lesions is relatively well established and safe, the oesophagus with its narrow lumen and challenging workspace, and the colon with its tortuous course and folds are more challenging frontiers. The nature of performing this procedure endoscopically means that conventional methods offer no mechanism for providing counter-traction while performing dissection, impeding visibility, and increasing the rate of complications. Traction methods, and assistive devices such as caps and hoods have been developed in an attempt to improve procedural visibility, stability and speed, and thus patient safety.[8] In Japan, where the procedure is best established, the complication rates (including perforation, peritonitis, and bleeding) are 3.5% for gastric ESD, 3.3% for oesophageal ESD, and 4.6% for colorectal ESD.[9]

This article reviews the accessories currently used in regular ESD practice globally including the knives used to cut and dissect lesions, the cap and hood devices used to improve visibility and safety, injection fluids to lift the submucosal plane, haemostatic devices, generators, and finally, emerging traction apparatus.

Robotic platforms and novel artificial intelligence systems for polyp detection and characterisation provide exciting future potential with some success in benchtop, animal, and human trials. They, however, do not feature in the regular practice of ESD practitioners and is therefore beyond the scope of this article.

Methods

To collect the evidence presented in this review, the terms 'endoscopic submucosal dissection' and 'ESD' were inputted into the search engines of PubMed, Embase, Medline, and Cochrane. We looked for any abstract or article published up until November 2019 and selected only those relating to tools and accessories used in ESD. Only articles available in English were included. We found a total of 119 articles relating to accessories used in ESD, of which 85 are included. Articles excluded were those relating to experimental tools or techniques not available to the general practitioner, outdated articles and Cochrane trials that were never published.

Knives

There are a variety of products available on the knife market, and the field has evolved rapidly over the past two decades with efforts to improve efficacy, safety, and cost-effectiveness (see Table 1). In spite of this, the evidence differentiating them is sparse and choice often comes down to operator preference. Image 1 shows some of the knives on the market, which will be discussed further here.

Needle-type

- Description: Sharp tip and monopolar current.
- Advantages: Simple, easy to use.
- Disadvantages: Poor control, risk of unintended tissue trauma (thus primarily used for making initial incision) – although somewhat overcome with ball-tipped knives (ball like process at tip behind which the knife can be retracted, can also use ball to stabilise on surface before cutting, eg, Dual Knife).

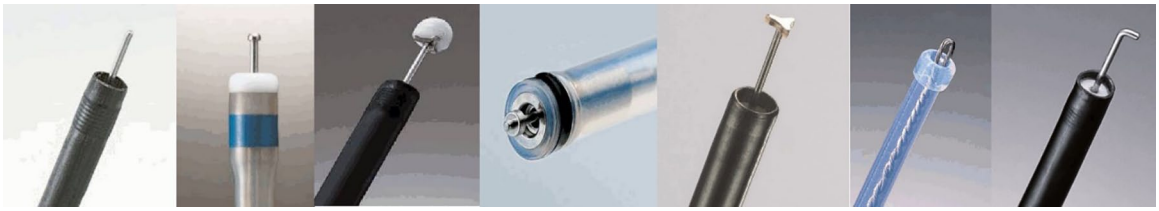

Image 1. Knives used in endoscopic submucosal dissection. From left to right: Needle Knife (Olympus, Tokyo, Japan), Dual Knife (Olympus, Tokyo, Japan), IT2 Knife (Olympus, Tokyo, Japan), Splash M Knife (PENTAX, Tokyo, Japan), TT knife (Olympus, Tokyo, Japan), Flex Knife (Olympus, Tokyo, Japan), and Hook Knife (Olympus, Tokyo, Japan).
Source: Images taken with permission from Choi and Chun.[8]

- Tools
  - Needle (Olympus, Tokyo, Japan).
  - Dual knife (Olympus, Tokyo, Japan).
  - Speedboat (Creo Medical, Chepstow, United Kingdom): integrated injection needle, bipolar electrodes and microwave coagulation – able to complete the entire procedure with one instrument.

Insulation-tip (IT)

- Description: Insulator reduces risk of puncturing tissues and can be used for haemostasis.
- Advantages: More suitable for submucosal dissection than conventional needle-type knives.
- Disadvantages: Difficult to manoeuvre so sometimes requires dissection without direct visualisation of the lesion.
- Tools:
  - IT knife (Olympus, Tokyo, Japan).
  - IT knife 2 (Olympus, Tokyo, Japan): Electrode on the proximal side of the tip designed to improve cutting performance in the vertical and horizontal directions.
  - IT knife nano (Olympus, Tokyo, Japan): Shorter knife length for narrower lumens and smaller tip for thinner mucosa for example, oesophagus, colon.
  - Swanblade (PENTAX, Tokyo, Japan): Sloped distal end to protect the muscular layer while dissecting.
  - Mucosectom (PENTAX, Tokyo, Japan): Extended knife length aimed at faster procedures.

Hybrid/waterjet

- Description: central lumen in knife through which fluid can be flushed for needleless injection.
- Advantages: Shorter procedure times than knives without waterjet function, faster submucosal injection, no need to change tools.
- Disadvantages: More challenging to use, more equipment required.
- Tools:
  - Flush Knife (Fujifilm, Tokyo, Japan): Can fire a jet of fluid allowing irrigation and injection as well as improved haemostasis.
    - Flush Knife BT (ball tip), Flush Knife BTS (slim – for narrower endoscopes in challenging anatomy), Flush Knife NS (very slim needle-shaped tip).
  - Splash-M (PENTAX, Tokyo, Japan): Similar to flush with a metal plate on the knife sheath to assist with haemostasis.[10]
  - Hybridknife (ERBE Elektromedizin GmbH, Tübingen, Germany) has three subtypes as explained below:
    - T-type: Best for dissection and working under tension with good coagulation properties.
    - Type: Safety model with a spherical shape providing insulation.
    - I type: Enables large degree of freedom.

Scissor/grasping type

- Description: Scissor-style grasping grip with monopolar frequency that can cut the tissue being held.
- Advantages: Ability to grasp away from the submucosal plane and check position before cutting improves safety, good for more technically challenging anatomy for example, oesophagus and colorectal as well as gastric.[11–16]

- Disadvantages: The Clutch Cutter (Fujifilm, Tokyo, Japan) cannot make a sharp mucosal incision, whereas alternative SB knives struggle to control severe bleeding due to thin shape. An initial incision is still required by an ESD knife.
- Models
  - SB knife (Sumitomo Bakelite, Tokyo, Japan): Monopolar, external insulation, curved blades to protect muscle layer, for gastric lesions.
  - SB Knife Jr (Sumitomo Bakelite, Tokyo, Japan): Adapted for colorectal lesions, can also perform mucosal incision.
  - 3-in-1 SB Knife (Olympus, Tokyo, Japan).
  - Clutch Cutter (Fujifilm, Tokyo, Japan) – Monopolar blades and serrated cutting edge, external insulation.

Others

- Triangle tip/ TT Knife (Olympus, Tokyo, Japan): Diathermic disc at tip – allows for more detailed dissection at expense of procedure time.
  - Triangle Tip Knife J has waterjet capacity.
- Flex Knife (Olympus, Tokyo, Japan; MTW, Wesel, Germany; Kachu, Seoul, South Korea): Round tip with twisted wire of adjustable length (like a snare), soft nature reduces perforation risk but can attract carbonised particles reducing electrical current flow.
- Hook Knife (Olympus, Tokyo, Japan; MTW, Wesel, Germany): L-shaped hook that can cut horizontally and vertically, allowing for detailed dissection at expense of longer procedure time.
- Fork Knife (Kachu, Seoul, South Korea): Two interchangeable knives (fixed flexible snare plus fork-shaped knife with inlet for injection/irrigation) – switched with knob allowing one knife to perform entire procedure.
- Dissectors (Karl Storz, Tuttlingen, Germany; Ovesco, Tübingen, Germany): Perform blunt dissection to remove lesions.

Evidence

There are a number of comparative trials between the various knives, primarily examining end points of procedure time, resection rate and risk of complications. However, the published evidence base is not broad with choice of tools guided through user experience and local unit practices.

Two studies compare the Flush Knife with the Flush Knife BT, finding that the ball-tipped version is associated with longer time to initial bleeding and fewer points requiring the use of haemostatic forceps throughout the gastrointestinal (GI) tract – although some authors have suggested the original Flush Knife may still be more suited to severely fibrotic lesions.[17,18]

The Flush Knife has also been compared with the Flex Knife in colorectal ESD, finding that the Flex Knife was associated with longer procedure times, likely related to more device changes and increased fluid utilisation.[19]

There are multiple further trials comparing hybrid knives with conventional non-waterjet knives (most commonly IT, Dual, Hook, and Mucosectom knives) showing shorter procedure time with the hybrid knives (primarily related to fewer instrument changes) without any significant differences in adverse events.[20–25] A further study of hybrid knives use in trainees found that initial performance (in terms of resection rate with clear margins) with hybrid knives is lower than with conventional knives, but the learning curve is short and associated with rapid improvement over the course of 50 procedures.[26]

A 2016 trial comparing the Dual Knife with the IT knife nano for colorectal lesions found that the IT knife nano was associated with shorter procedure times and reduced perforation risk.[27] There are also current trials looking at procedure time and outcomes of use of the IT knife nano in colorectal lesions $>$ 30 mm.[28] In colorectal ESD, the Fork Knife has been compared with the Flex knife, finding that the Fork knife was associated with shorter procedure times (59.63 minutes vs 76.65 minutes) and higher complete resection rates (81.1% vs 73.6%).[29]

Numerous studies have compared the SB knives with the Hook Knife, and have shown that scissor-type knives have a similar or superior safety profile, with a shorter time to competency when used by novices,[30–32] and similar results when compared with the Flush Knife.[33] Further studies have compared the Clutch Cutter to conventional knives, with mixed results on whether the procedure time is shortened, prolonged, or not significantly different.[14,34–37]

Table 1. A comparison of ESD knives and their functionalities ([a]are those available to buy in the market in the United Kingdom).[38-46]

Knife type	Brand name	Manufacturer	Marking	Injection	Mucosal incision	Submucosal dissection	Haemostasis
Needle	Needle Knife	Olympus	x		x	x	
	Needle Controllable Knife[a]	MTW	x		x	x	
	Speedboat RS2	Creo Medical	x	X	x	x	x
Dual	DualKnife[a]	Olympus	x		x	x	x
	DualKnife J[a]	Olympus	x	X	x	x	x
	Splash-M knife[a]	PENTAX	x	X	x	x	x
IT	IT knife, IT2[a], IT nano	Olympus			x	x	x
	Swanblade[a]	PENTAX				x	
	Mucosectom[a]	PENTAX				x	
	Ball ESD Knife[a]	MTW			x	x	x
Hybrid	HybridKnife[a] (I-type, T-type, O-type), HybridAPC	ERBE	x	X	x	x	x
	Flush Knife, Flush Knife BT (ball-tip), Flush Knife BTS[a] (ball-tip slim), Flush Knife NS[a]	Fujifilm	x	X	x	x	x
Scissor-type	SB Knife, SB Knife Jr	Sumitomo Bakelite	x			x	x
	3-in-1 SB Knife	Olympus			x	x	x
	Clutch Cutter[a]	Fujifilm			x	x	x
Hook	Hook Knife[a]	Olympus	x		x	x	x
	Hook Knife J[a]	Olympus	x	X	x	x	x
	Hook Knife[a]	MTW	x		x	x	x
Fork	Endo FS	Kachu	x	X	x	x	x
Blunt dissectors	EndoDissector	Karl Storz	x			x	x
	Endo-Maryland Dissector[a]	Ovesco	x			x	x

BT, ball-tip; BTS, ball-tip slim; ESD, endoscopic submucosal dissection; IT, insulation-tip.
Manufacturers: Creo Medical, *Chepstow, United Kingdom*; ERBE Elektromedizin GmbH, *Tübingen, Germany*; Fujifilm, *Tokyo, Japan*; Kachu, *Seoul, South Korea*; Karl Storz, *Tuttlingen, Germany*; MTW, *Wesel, Germany*; Olympus, *Tokyo, Japan*; Ovesco, *Tübingen, Germany*; PENTAX, *Tokyo, Japan*; Sumitomo Bakelite, *Tokyo, Japan*.

Distal attachments

The attachment of a transparent cap to the end of an endoscope allows fixing of the endoscope at a constant distance from the mucosa to aid in visualisation of the lesion and thus help in reducing the risk of complications. Caps may come with holes for drainage of blood and water, and also of different shapes (eg, straight, oblique) depending on the anatomy of the area in which they are being used (see Image 2) and user preference.

Image 2. Distal attachments. Left: Caps (Olympus, Tokyo, Japan). Right: Endolifter (Olympus, Tokyo, Japan).
Source: Images taken with permission from Chun,[8] and Jang.[47]

There is some evidence to suggest that cap-assisted EMR significantly shortens procedure time in comparison with EMR or ESD without a cap in removing rectal tumours.[48,49] There are as yet no head to head trials comparing cap versus non-cap assisted ESD. Hoods are a type of cap with a tapered tip that can be used to elevate mucous membranes following the initial incision to aid with submucosal dissection. Again, comparative trials are not present, and evidence is limited to case studies.[50]

The Endolifter (Olympus, Tokyo, Japan) is a cap with grasping forceps at the distal end which is able to lift the mucosa facilitating an easier dissection. This is a form of traction described further in the Traction Methods section. It has been shown to reduce procedure time, amount of submucosal injection and bleeding in pig models.[51,52]

Injection solution

There are several fluids that are used to elevate the submucosa. Sodium chloride (0.9% has the advantage of being cheap and is widely used for EMR, but it quickly absorbs into the surrounding tissue and ESD requires a more prolonged period of elevation.[53] Solutions such as hypertonic saline (3%-4.7%), dextrose (20%/50%) and hydroxypropyl methycellulose provide a longer duration of submucosal lift, but can cause local inflammation with tissue damage due to its raised osmolality.[54,55] Glycerol (10% glycerine plus 5% fructose) is a less inflammatory option, but has a tendency to generate smoke.[56]

At the more viscous end is hyaluronic acid, which has a long lasting cushion and can be diluted, but is expensive and may stimulate the growth of any residual tumour cells.[57–59] A randomised controlled trial comparing sodium alginate against hyaluronic acid showed non-inferiority of sodium alginate with regards to *en-bloc* complete resection and formation and maintenance of mucosal elevation, although a higher rate of adverse events.[60] Eleview (Cosmo Pharmaceuticals, Dublin, Ireland) and ORISE gel (Boston Scientific, Marlborough, USA) are synthetic solutions specifically designed for colorectal endoscopic resection and have been shown to have excellent cushion-forming ability and to have a very long duration of lift. They also contain dye to improve visualisation and highlight tissue planes, but are expensive.[61] Hydroxyethyl starch is an alternative that is reasonably safe and cheap as well as generating a long elevation duration.[62] Of note, a meta-analysis of injection fluids including sodium chloride (0.9%), dextrose, glycerol, hyaluronic acid, hydroxyethyl starch as described above, as well as fibrinogen mixture, succinylated gelatin and mesna (a medication typically used to inactivate urotoxic metabolites of some chemotherapy drugs), found no significant differences between non-saline injection fluids in terms of *en-bloc* and complete resection rates – although the data on fibrinogen, hydroxyethyl starch, and glycerol was limited.[63]

Haemostasis

A major complication of ESD is bleeding, both interprocedural and delayed. Prophylactic coagulation and rapid treatment are important for successful patient outcomes, and there are a variety of tools available. All knives have at least a limited capacity for haemostasis on small bleeding points, depending on the generator setting used (see Generators section). As mentioned previously, ball tip knives typically have improved haemostatic efficiency compared with standard needle

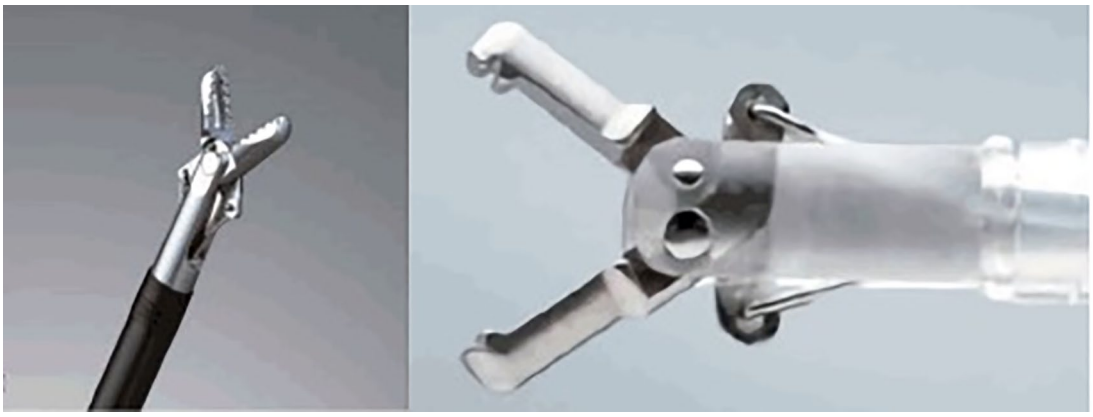

Image 3. Haemostasis devices. Left: Coagrasper (Olympus, Tokyo, Japan). Right: Hemostat-Y (PENTAX, Tokyo, Japan).
Source: Images taken with permission from Choi and Chun.[8]

knives.[17] Hybrid knives have been demonstrated to reduce the need for haemostatic devices and regular haemostasis compared with conventional knives.[20] The Splash-M knife (PENTAX, Tokyo, Japan) was designed with a metal plate on its distal sheath to facilitate improved haemostasis.[10] Most knives perform monopolar anticoagulation, which is versatile, quick and easy to use; conversely, bipolar anticoagulation – as seen in the Speedboat, for example – can be more targeted and thus reduces the risk of thermal injury.[64–66]

For larger vessels and associated bleeds, specific haemostatic devices may be necessary. Clips are not widely used for bleeding control in ESD because they can interfere with the procedure, and tend to be reserved for uncontrolled bleeding or at the end of dissection.[8] More widely used are haemostatic forceps. These are similar to hot biopsy forceps, but have smaller clips and thus increased precision. The Coagrasper (Olympus, Tokyo, Japan) is a monopolar forceps while the HemoStat-Y (PENTAX, Tokyo, Japan) is bipolar (see Image 3). A comparison of the HemoStat-Y with endoscopic hemoclipping on non-variceal GI bleeding found a higher successful treatment rate with the Hemostat-Y (100% vs 78.2%) and a shorter time to haemostasis (6.8 vs 13.4 minutes).[67] However, we found no papers directly comparing different forceps against each other.

Argon plasma coagulation (APC) is a non-contact method of achieving anticoagulation by using ionised argon gas to conduct electrical current from a probe to the bleeding point. The advantage of not directly touching the tissue is a reduced risk of re-bleeding and perforation on removal of the probe. However, it can be more challenging to stop active large vessel bleeding compared with haemostatic forceps.

Prophylactic cauterisation of visible vessels in the floor of the wound has been suggested to reduce bleeding.[68] Some practitioners take this a step further, and also perform clipping. This has been suggested to be safe in some studies.[69] However, increasing use of electrocoagulation in preventing bleeding is not without its risks; it is estimated around 7% to 8% of ESD procedures are associated with coagulation syndrome – a transmural burn causing localised peritonitis that typically can be managed conservatively, although 0.1% to 0.4% of patients undergoing ESD may develop delayed perforation potentially requiring emergency surgery.[70]

Various barriers have been marketed for preventing bleeding following anticoagulation in ESD. One such medical adhesive, COMPONT (Beijing Compont Medical Devices, Beijing, China), was trialled against conventional wound management in 171 ESD cases demonstrating significantly reduced postoperative bleeding and hospital stay.[71] PuraStat (3-D Matrix Ltd, Tokyo, Japan), a transparent barrier that forms a gel coat inducing haemostasis, is currently undergoing clinical trials and it is hoped will provide a further alternative to thermal haemostasis.[72]

Perforation management

Another key risk of the ESD procedure is perforation. Risk estimates range from 0 to 6.9% in oesophageal ESD, 2.4 to 9.6% in gastric ESD,

and 1.4 to 20.4% in colorectal ESD.[73–75] Perforation may be classified as immediate (ie, seen during the procedure as a definite defect) or delayed (ie, diagnosed after the procedure on radiograph or computed tomography (CT) demonstrating pneumoperitoneum, usually following the complaint of abdominal pain).

The European Society of Gastrointestinal Endoscopy sets out recommendations for the management of iatrogenic endoscopic perforations, with an emphasis on managing endoscopically rather than surgically wherever possible because it is both feasible and limits post-surgical adhesions, although they note that holes larger than 3 cm are unlikely to be amenable to endoscopic management.[76]

The use of nasogastric or nasoduodenal tubes to divert gastrointestinal fluid (in oesophageal/gastric perforations), and the switching from air to carbon dioxide for insufflation to reduce risk of tension pneumothorax/pneumomediastinum may be appropriate. Small defects can generally be treated by clips. Through the scope clips will usually suffice for defects less than 1 cm in diameter, while over the scope clips (or endo-looping plus clipping if not available) should be considered for holes less than 2 cm. This management is successful in $>$ 90% of cases, avoiding further surgical management.[77] Endoscopic suturing devices, such as the Overstitch (Apollo Endosurgery Inc, Austin, USA) may be used for larger luminal defects with success rates of $>$ 95% – however, such devices currently require a double channel endoscope and high operator skill level.[78] For suspected delayed perforation, a CT scan is recommended. A normal CT should be treated conservatively with observation, as should extraluminal air without extravasation in duodenal perforations. Otherwise, surgical input should be sought.

Generators

The modern generators that are required for ESD have multiple power settings and have both monopolar and bipolar capabilities. ERBE Elektromedizin GmbH (Tübingen, Germany) manufactures the ICC series as well as the VIO 300D. Cut modes include Auto Cut (standard), Endo Cut (with some coagulation effect – better for fibrosis/strictures[79]), and Dry Cut (high power mode for faster cutting). Coagulation modes include Swift Coag (similar to Dry Cut with more haemostasis), Forced Coag (higher voltage – can be used for submucosal dissection), Spray Coag (non-contact surface coagulation with low penetration – good for post procedure haemostasis) and Soft Coag (low voltage resulting in coagulation only with no cutting).

The ESG 100 (Olympus) has three standard monopolar cutting modes as well as PulseCut Slow and PulseCut Fast (equivalent to Endo-Cut). It has three monopolar coagulation modes (Soft and Forced 1 and 2). It also has three bipolar cutting modes, and three coagulation modes (Soft, RFCoag and RFCap). RFCoag is a form of controlled coagulation with acoustic resistance feedback and an automatic end of procedure detection. RFCoag and RCAP are particularly suited for deep tissue coagulation without significant tissue destruction.

Traction methods

One issue with ESD in comparison with conventional surgery is that the entire procedure is performed through a single endoscope, and thus there is no second 'hand' to provide traction on the submucosal layer after cutting and thus there can be difficulties visualising the dissection plane. There are various traction methods that have been developed to apply external traction in an attempt to overcome this, and various studies have shown these methods to be faster with higher rates of resection and lower rates of complications.[80]

One of the simplest traction methods involves a silk line tied to a clip attached to the edge of a lesion, and then the lesion pulled proximally using the line. The advantage of this method is its simplicity, the lack of need for specialist equipment, and its versatility across oesophageal, gastric and colorectal lesions.[81,82] However, it does require reinsertion of the scope, and traction can only be applied by pulling.[83] The internal traction method modifies this somewhat, by attaching a band, ring or nylon to a clip attached to the lesion as well as a second clip on the opposite side. No re-insertion of the endoscope is required for this, and there is good evidence supporting its use in colorectal lesions[84,85]; however, it does require more space and may not translate well to smaller working spaces such as oesophageal lesions.

A method of traction that allows both pushing and pulling is the external forceps method, whereby

external forceps gripped by second forceps are inserted into the accessory port and anchored to the edge of the lesion. It has been shown to be effective in gastric and rectal lesions, although not in the deep colon and has the potential to cause injury.[86,87] The Endolifter (Olympus, Tokyo, Japan) described in the caps/hoods section works in a similar way. Another such method allowing both pushing and pulling is the clip and snare with pre-loop, in which the endoscope is withdrawn and a snare pre-looped around the distal end. A clip is inserted through the port to grasp the mucosal flap, then the snare is moved along forceps to the clip to grasp the mucosa and the clip is released. There is some evidence for its use in gastric lesions, and can be used in the colon with a balloon overtube.[88,89]

A further technique that allows traction in any direction is the double endoscope method, whereby a second smaller endoscope is inserted alongside the main scope with grasping forceps. However, this clearly requires a lot of space, and so far is useful only in gastric and rectal lesions.[90] For rectal ESD, another method generating excellent traction for rectal lesions is the GelPOINT (Applied Medical, Amersfoort, Netherlands), whereby a transanal access port is created for the endoscope, plus two retractors passed by a laparoscopic surgeon – although clearly this method requires a lot of manpower. The ORISE Tissue Retractor System (Boston Scientific, Marlborough, USA) is an overtube with two separate flexible channels, down which graspers can be deployed, allowing independent traction in a separate plane to the endoscope – however, it is relatively new with little real world use so far.[91]

Other potential traction methods include magnetic traction (magnet placed internally and manipulated using an external magnet), which has shown promise in animal models, but concerns remain with regard to usefulness in obese patients as well as interaction of the magnet with patient blood vessels and equipment.[92]

Conclusion

ESD is an advanced technique with multiple technical challenges. A wide range of tools are available and more continue to be developed in an attempt to speed up procedure times and reduce complications. However, it is currently limited to the expert endoscopist, and comparative studies, particularly in non-knife tools, are limited in number. This means selection often comes down to clinician preference with evidence of efficacy from clinician user experience and case reports. Evolution of the ESD toolbox will make the procedure increasingly accessible to more endoscopists. As the number of ESD practitioners increase, expert experience cannot be solely relied on, and a more substantial evidence base will be required to evaluate efficacy and safety of the multitude of tools.

Conflict of interest statement

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