Endoscopic Submucosal Dissection in the Stomach and Duodenum

Techniques, Indications, and Outcomes

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KEYWORDS

• Endoscopic submucosal dissection • Endoscopic resection • Stomach • Duodenum
• Early gastric cancer • Dysplasia

KEY POINTS

- Gastric endoscopic submucosal dissection (ESD) is well established for management of early gastric cancer (EGC).
- Diagnosis of EGC relies on adequate endoscopic assessment involving lesion size, histopathology, presence of ulceration, and depth of invasion.
- Absolute indications for endoscopic resection of EGC are if patients are presumed to have a less than 1% risk of lymph node metastasis, and long-term outcomes are similar to those with surgical gastrectomy.
- Several novel traction devices and strategies have been developed to facilitate ESD, including elastic band-assisted traction, double scope method, and multiloop traction.
- Duodenal ESD is more technically difficult and requires ESD expertise in other locations.

INTRODUCTION

Endoscopic resection (ER) techniques of gastric and duodenal neoplasms include endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD). These techniques have become first-line options for management of noninvasive lesions.[1] ESD allows for en bloc resection irrespective of lesion size and for those with high risk features of submucosal invasion (SMI) to allow for accurate

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histopathological assessment. This article discusses the indications, techniques, and outcomes of gastric and duodenal ESD.

GASTRIC ENDOSCOPIC SUBMUCOSAL DISSECTION

Background

Gastric cancer ranks the sixth most common malignant tumor and the fourth leading cause of cancer-related mortality worldwide.[18] Because of the frequently late disease diagnosis, 5-year survival of gastric cancer is about 32%.[19] Several histologic classifications for phenotypes of gastric carcinogenesis exist, such as the revised Vienna classification[20,21] and the World Health Organization classification. The most adhered to terminology comprises low-grade dysplasia (LGD), high-grade dysplasia (HGD), noninvasive carcinoma (carcinoma in situ), and intramucosal carcinoma (invasion into lamina propria or muscularis mucosa). The histologic entity of early gastric cancer (EGC) was based on the observation that gastric cancer of this type had a favorable prognosis, with a 5-year survival greater than 90%.[22] EGC is defined as invasive gastric adenocarcinoma confined to the mucosa or submucosa, irrespective of lymph node metastasis (LNM) (T1, any N as per American Joint Commission on Cancer classification[23]). Prognosis largely depends on the presence of LNM, which occurs in 2% to 5% of EGCs that are confined to the mucosa and increases to 10% to 25% when submucosal invasion is present.[24,25]

Treatment of EGC previously centered around surgical resection (gastrectomy and lymphadenectomy) to ensure complete resection. Currently, ER is standard of care for the treatment of EGC with negligible risk for LNM given their lesion size and are amenable to resection en bloc, owing to similar oncological outcomes. En bloc resection is crucial, as precise histopathological diagnosis is essential for risk assessment of LNM and to prevent the potential risk of local recurrence after piecemeal resection.[26] In well selected cases, endoscopic management has significant advantages over surgery, as it is less morbid and organ preserving. To ensure good outcomes of ER, knowledge regarding diagnosis and indications and long-term surveillance are critical. ER techniques include EMR and ESD. EMR was first reported in 1984 and has been widely accepted as an effective treatment for EGC. However, en bloc resection by EMR is limited in larger-sized lesions (>2 cm). ESD was pioneered for EGC in 1999 by Gotoda and colleagues.[27] ESD enables higher en bloc resection with lower local recurrence rates compared with EMR.[28,29]

DIAGNOSTIC STRATEGIES OF SUPERFICIAL GASTRIC NEOPLASIA

Appropriate lesion selection requires endoscopic diagnosis and assessment of high-risk features for SMI and is critical to help determine the best resection strategy. This includes assessment of lesion morphology, surface architecture, and vessel patterns that require endoscopic expertise and advanced technology. Most modern endoscopes contain optical diagnostic techniques using blue-light imaging (BLI) such as narrow-band imaging (NBI) or image-enhanced endoscopy (i-SCAN), combined with high-definition white-light imaging (HD-WLE). Dye-based chromoendoscopy (CE) using contrast dyes such as methylene blue (MB) or indigo carmine also plays a role in visual analysis. Dye and blue light imaging are complementary techniques as they provide subtly different information on surface integrity.

The Japanese Society of Gastroenterology (JGES) and Japanese Gastric Cancer Association (JGCA) jointly advocate the magnifying endoscopy simple diagnostic algorithm for gastric cancer (MESDA-G).[2] This algorithm involves determining whether a demarcation line (DL) is present between the mucosal lesion and the background

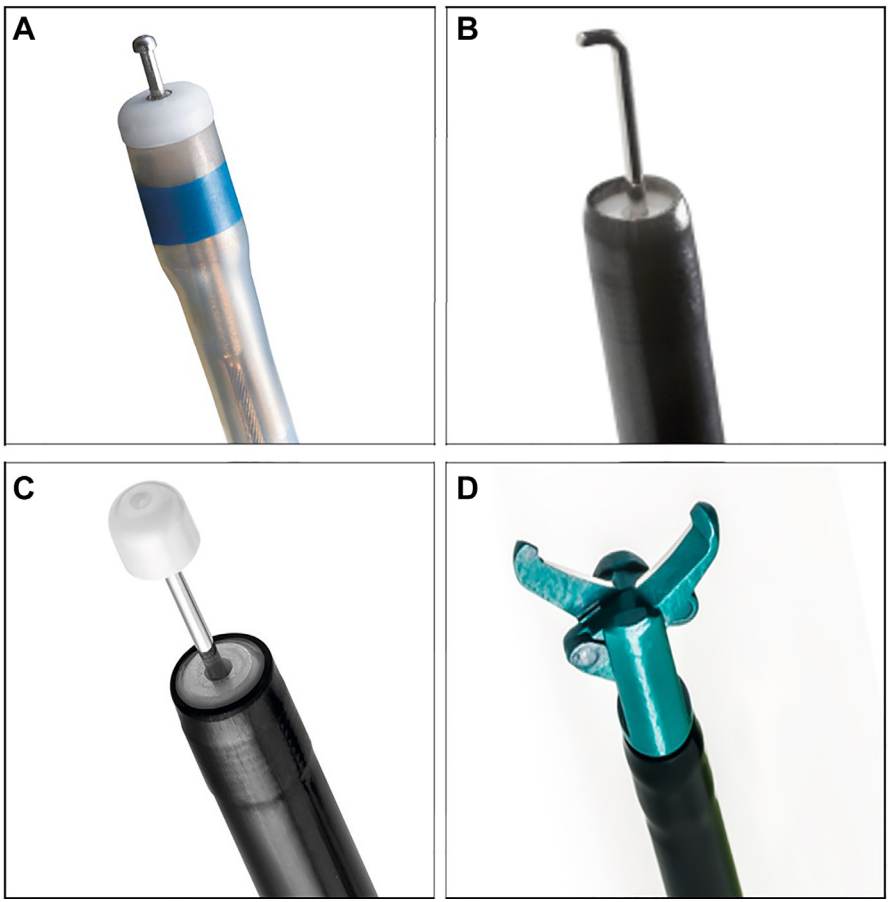

Fig. 1. Examples of ESD knives. (*A*, *B*) Needle-type knives. (*C*) Insulated-tip type knife. (*D*) Scissor-type knife. (*Courtesy of* Olympus, Center Valley, Pennsylvania.)

mucosa. If a DL is absent, the lesion is diagnosed as noncancerous. If a DL is present, an irregular microvascular (MV) pattern and/or an irregular microsurface (MS) pattern should be evaluated. If both an irregular MV pattern and an irregular MS pattern are absent, the lesion is diagnosed as noncancerous; if either pattern is present, the lesion is diagnosed as cancerous. The vessels plus surface (VS) classification is also used for the analysis of magnifying endoscopic findings.[3] The characteristic findings of high-grade dysplasia or early gastric cancer (EGC) are the presence of a clear DL between noncancerous and cancerous mucosa, and the presence of an irregular MV pattern and/or irregular MS pattern within the DL. Depth of tumor invasion is usually determined by lesion characteristics on conventional endoscopy. When depth of tumor invasion as measured using conventional endoscopy is uncertain, endoscopic ultrasound (EUS) occasionally has a role in adjunct to this method.

Techniques of gastric endoscopic submucosal dissection

ESD techniques have greatly evolved since their introduction in the early 2000s. Proper planning and careful lesion assessment are imperative to choose the most appropriate technique and to ensure adequate resection margins.[4] A standard high-

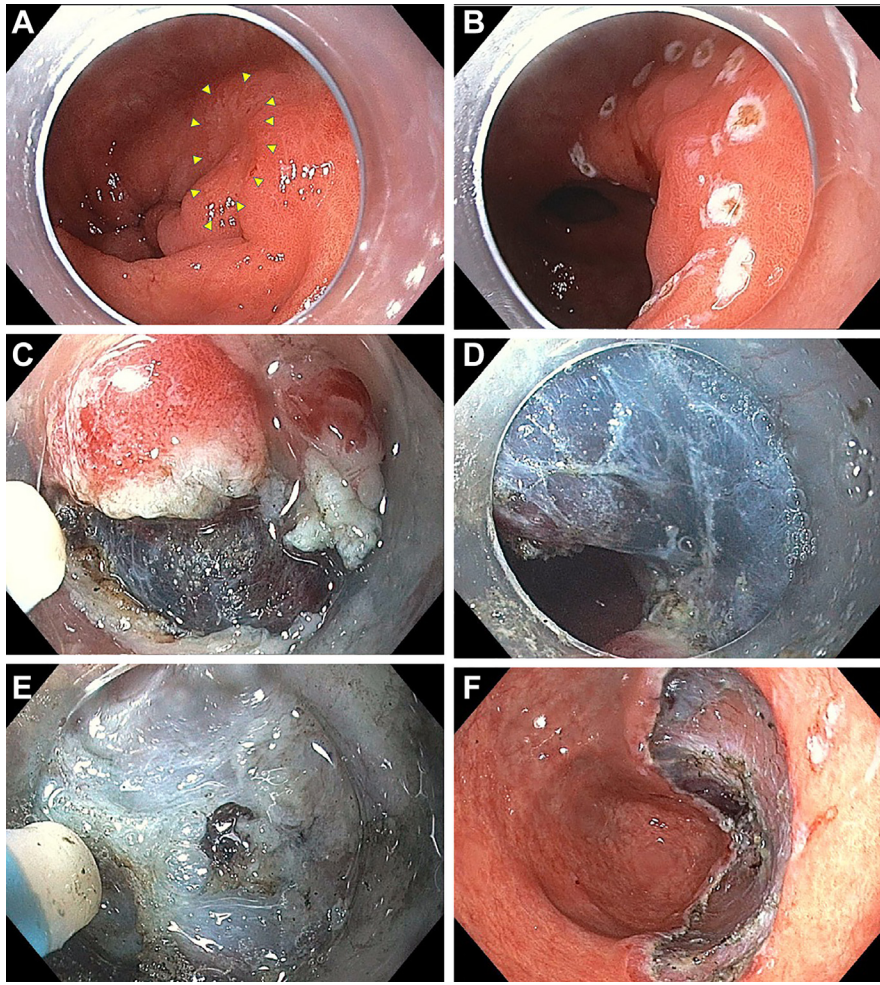

Fig. 2. ESD of lesion in gastric antrum. (*A*) Endoscopic assessment of 30 mm depressed lesion with no obvious ulceration. (*B*) Circumferential marking of lesion. (*C*) Circumferential incision. (*D*) Submucosal dissection. (*E*) Submucosal fibrosis during submucosal dissection. (*F*) Final ESD defect.

definition video gastroscope with magnification and image-enhanced technology is typically used. An auxiliary water jet channel is necessary to help enhance visualization. Normal saline is preferred over water to maintain effective electrosurgical dissection. The use of a transparent plastic distal attachment cap or hood aids in stabilization of scope position during submucosal dissection. A reliable electrosurgical unit is crucial, as ESD depends on safe and accurate electric current throughout the procedure. Carbon dioxide insufflation should be used for ESD procedures as it significantly reduces abdominal pain and analgesic usage compared with air insufflation.[5] Electrosurgical knives are used for mucosal incision and submucosal dissection. These are broadly categorized into needle type, insulated tip type, and scissor-type knives (**Fig. 1**), with some having an added water jet channel to minimize instrument exchanges during the procedure.

Generally, the steps of ESD include marking, submucosal injection, mucosal incision, submucosal dissection, and hemostasis[6] (Fig. 2). The margins of gastric lesion become indistinct after submucosal injection, necessitating circumferential marking (see Fig. 2A). Preprocedural marking of gastric lesions is therefore essential to facilitate the mucosal incision and ensure adequate lateral resection margins. Marking should be performed about 5 mm outside the lesion, with small gaps between each mark (see Fig. 2B). Occasionally, margins of EGC are difficult to delineate on initial endoscopic evaluation.

Indigo carmine chromoendoscopy assists margin delineation before ESD. Magnifying endoscopy with narrow-band imaging can also be used and has been found to successfully delineate margins in over 70% of cases that initially show unclear margins.[7] Alternatively, biopsies of the surrounding normal-appearing mucosa can be taken to confirm horizontal margins. After marking the lesion, submucosal injection is performed using a viscous solution. Mucosal incision is then performed using a needle-type ESD device beginning at the near or far side, depending on type of knife and preferred ESD technique (see Fig. 2C). Mucosal incision can be completed by a needle-type or insulated-type knife. The incision should traverse the muscularis mucosa and reach the submucosa. The conventional ESD technique begins with completion of a circumferential incision, whereas the pocket creation method begins with a partial mucosal incision on the near/oral side of the lesion.[8] The partial incision is typically one-third to one-half of the lesion circumference and is followed by submucosal

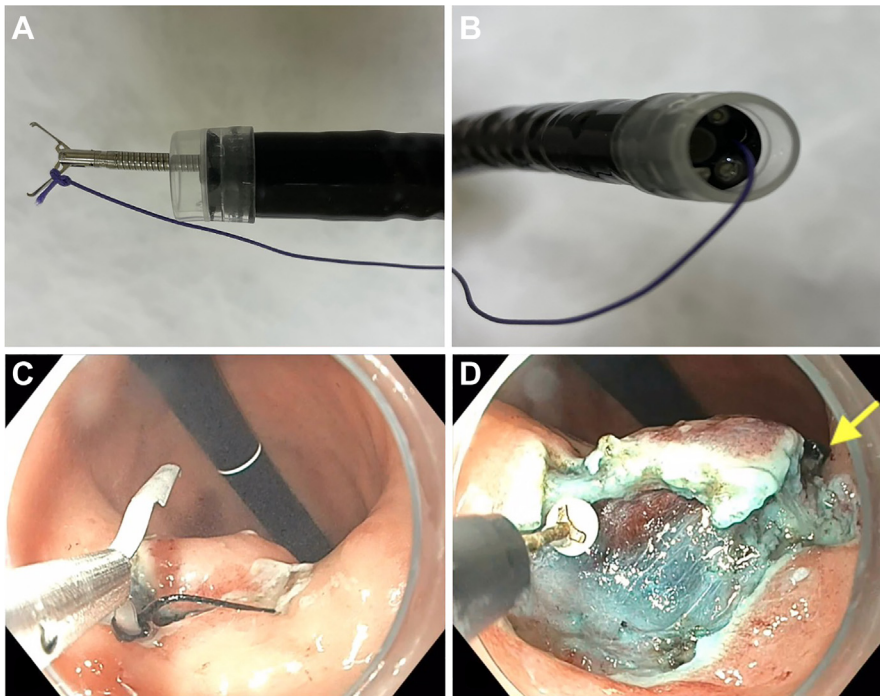

Fig. 3. Clip-with-line traction technique. (*A*) Clip tied by a dental floss outside the scope. (*B*) The clip is pulled back into the scope while the dental floss remains alongside the scope. (*C*) The clip is deployed on the edge of the lesion. (*D*) Improved visualization of the submucosal layer after pulling on the line from the oral side to place traction on the mucosal flap.

dissection underneath the lesion prior to completion of the mucosal incision. The pocket creation method has been found to facilitate ESD by helping to stabilize the scope position.[9] Submucosal dissection is then performed using either a needle-type or insulated-type knife (see **Fig. 2**D,E). The latter method is beneficial in gastric lesions owing to the thick nature of gastric submucosa. During submucosal dissection, the submucosal space is expanded using an injection solution. The optimal layer for dissection is the deep submucosa just above the muscularis propria. This provides a thicker specimen that may reduce the chance of vertical margin involvement, especially in EGC with submucosal invasion. During submucosal dissection, large penetrating submucosal vessels should be prophylactically coagulated using the dissection knife or coagulation forceps.

Several novel traction devices and strategies have been developed to facilitate ESD and have been found to result in shorter procedure time, improved R0 resection rates, and lower risk of perforation when compared with conventional ESD without traction.[10] Clip line traction is the most commonly used traction technique in gastric ESD.[11] A clip-with-line can be easily assembled by attaching a string (eg, dental floss or silk surgical suture) to a standard endoscopic clip (**Fig. 3**). An endoclip is inserted into the accessory channel of the endoscope, and a nylon string or dental floss is tied to 1 arm of the clip by a surgeon's knot (see **Fig. 3**A). Before intubation of the esophagus, the endoclip is withdrawn inside the channel to avoid trauma during insertion of the endoscope (see **Fig. 3**B). When the scope reaches the lesion, the clip is deployed to the oral edge of the lesion (see **Fig. 3**C), and the line is pulled gently in the oral direction by the endoscopist or an assistant for traction (see **Fig. 3**D). Other traction methods include elastic band-assisted traction, a double scope method, and a novel multiloop traction device.[12]

Closure of ESD defects can be technically difficult using standard endoscopic clips. Several endoscopic suturing techniques were devised and have been clinically applied to mucosal defects after gastric ESD. These include the Overstitch suturing system (Apollo Endosurgery, Incorporated, Austin, Texas),[13] the through-the-scope X-tack suturing system (Apollo Endosurgery, Incorporated),[14] both of which are available in the United States. Also available in Japan are the endoscopic ligation technique with O-ring closure[15] and the double-arm bar suturing system and endoscopic hand-suturing (EHS) using the through-the-scope type flexible needle holder (Olympus Company, Ltd., Tokyo)[16]. These were found to provide reliable closure and potentially decrease the risk of delayed postoperative bleeding.

Following en bloc resection, the specimen is retrieved and pinned onto a flat board. This is to ensure appropriated histopathologic evaluation to ensure adequate endoscopic resection. Important parameters that should be reported include lesion size, the presence of ulceration, histologic cellular type, differentiation, involvement of lateral and vertical margins, depth of invasion, and lymphovascular invasion. Standardized reporting is important to confirm curative resection.[17]

Preoperative Assessment

In order to determine whether ER (ESD or EMR) is indicated, it is necessary to determine histopathological type, lesion size, presence of ulceration, and depth of invasion. Histopathological type is determined through histopathological examination of a biopsy specimen obtained during endoscopy. Lesion size as assessed during endoscopic evaluation is frequently inaccurate, so final measurements are determined from the resected specimen. The presence of ulceration (either active ulceration or an ulcer scar) is also assessed at preoperative endoscopy. Active ulceration refers to open ulcers with adherent white exudates and is histopathologically deeper than

the muscularis mucosa. Superficial erosions are not included, as these are histopathologically confined to the surface epithelium. A healing or scarred ulcer contains mucosal folds or rugae converging on 1 point and is also considered ulceration. Depth of invasion is generally assessed using conventional endoscopy with or without dye spraying. Characteristic features of SMI include irregular or nodular surface protrusion or depression, deep ulcer with marked marginal elevation, fusion of converging folds, and abrupt cutting or clubbing of converging folds. Several studies determined that the overall accuracy of conventional endoscopy in terms of distinguishing lesions with and without SMI was about 62% to 78%.[30,31]

EUS can also be used as an adjunct to aid in determining the depth of invasion. Various reports on the diagnostic ability of EUS to distinguish T stage have been published. EUS staging is typically performed using a radial or miniprobe. In 1 prospective study, the accuracy of miniprobe EUS was significantly higher than that of radial EUS (79.5% vs 59.6%, $P<.001$), but did not differ significantly from that of conventional endoscopy (79.0%). A meta-analysis that included 54 studies and 5601 patients with gastric cancer undergoing disease staging with EUS revealed that this was highly accurate in differentiating T1-2 from T3-4 gastric cancer.[32] Furthermore, EUS had a high sensitivity and low specificity for differentiating T1a and T1b gastric cancer.[33,34] In a meta-analysis of 20 studies (n = 3321) on accuracy of EUS in differentiating between T1a (mucosal) versus T1b (submucosal) gastric cancers, the summary sensitivity and specificity were 0.87 (95% confidence interval [CI] 0.81–0.92) and 0.75 (95% CI 0.62–0.84), respectively.[32]

In 2019, the American Gastroenterological Association (AGA) recommended that ESD should be considered as first-line therapy for visible, endoscopically resectable, superficial gastric neoplasia.[35] The European Society of Gastrointestinal Endoscopy (ESGE) recommends ER for the treatment of gastric superficial neoplastic lesions that possess a low risk of lymph node metastasis.[36] Moreover, JGES, in collaboration with JGCA guidelines, define absolute and expanded criteria for endoscopic resection of EGC.[1]

Indications of Gastric Endoscopic Submucosal Dissection

According to the 2021 JGES guidelines, lesions are considered absolute indications for endoscopic resection if they are presumed to have a less than 1% risk of LNM and long-term outcomes similar to those with surgical gastrectomy. Absolute indications for endoscopic resection include differentiated type adenocarcinomas without ulcerative findings (UL-), of which the depth of invasion is clinically diagnosed as intramucosal (cT1a), and cT1a undifferentiated type adenocarcinomas when the diameter is less than 2 cm (**Fig. 4**). For lesions with ulcerative findings (UL+), absolute indications include cT1a differentiated type and a diameter of 3 cm or less.[1] Of note, in the first version of these guidelines, lesions categorized as expanded indications according to tumor-related factors have been integrated into absolute indications in the 2021 guidelines.

Several factors are taken into consideration when determining the most appropriate resection strategy. These include patient comorbidities, likelihood of LNM, cost, local expertise, and expected disease-free survival. This decision requires a multidisciplinary approach involving gastroenterologists, surgeons, oncologists, pathologists, and radiologists. For EGC lesions that meet absolute criteria for endoscopic resection, current consensus is that ER should be the standard of care to avoid unnecessary surgical intervention. EMR and ESD are both reasonable options for lesions less than 1 cm in size, as long as en bloc resection can be achieved. For larger lesions, the indistinct lesion margins and relative thickness of the gastric mucosa make ESD superior to

Depth of invasion	Ulceration	Differentiated		Undifferentiated	
T1a (M)	UL (-)	≤2cm	>2cm	≤2cm	>2cm
		Absolute indication for EMR/ESD	Absolute indications for ESD		Relative indication
	UL (+)	≤3cm	>3cm		
		Absolute indication for ESD	Relative indications		
T1b (SM)		Relative indications			

Fig. 4. Classification of indications for endoscopic resection of EGC according to tumor-related factors. UL (–) no ulceration, UL (+) ulceration present; M, intramucosal cancer; SM, submucosally invasive cancer. (*Adapted from* Ono H, Yao K, Fujishiro M, et al. Guidelines for endoscopic submucosal dissection and endoscopic mucosal resection for early gastric cancer (second edition). *Dig Endosc* 2021;33(1):4-20.)

EMR. Although there are no randomized controlled trials comparing therapeutic outcomes between gastric EMR and ESD, a meta-analysis found that better en bloc resection rates are achieved with ESD than with EMR.[29] It has also been reported that for lesions larger than 1 cm, en bloc resection rates are significantly lower for EMR than for ESD.[37,38]

There have been no randomized controlled trials comparing ESD and surgery for EGC to date. However, a systematic review and meta-analysis that included 18 retrospective studies found that ESD had several benefits over surgery, including shorter procedure time, shorter hospital stay, lower risk of procedure-related death, and lower risk of overall complications.[39] ESD was also found to be more cost effective and had better quality of life. However, ESD had a lower rate of en bloc resection, curative resection, and a higher rate of local recurrence. Another recent propensity score-matched study on 84 patients from a tertiary referral center compared short- and long-term outcomes between surgery and ESD.[40] The study showed comparable results in terms of overall and disease-free survival between both approaches during a 5-year follow up period. Regarding lesions within the expanded criteria (which have been integrated into absolute indications in the most recent 2021 JGES guidelines[1]), surgery has traditionally been the treatment of choice. A multicenter retrospective study from South Korea of patients treated with ESD or surgical resection within the expanded criteria over a 2-year period showed shorter procedure times and hospital stay in the ESD group.[41] However, the 5-year cancer recurrence rate was higher in the ESD group, and the 5-year disease-free survival rate was higher in the surgical group.

Undifferentiated histology has a higher rate of LNM compared witho differentiated histology, reaching up to 10.6% in SM1 lesions.[1] A multicenter retrospective study from 18 centers in Korea compared between ESD and surgery for curative resection of undifferentiated type EGC within expanded indications; ESD showed comparable overall and 5-year survival to surgery.[42] However, the recurrence rate was higher in the ESD group than the surgery group. Appropriate lesion selection is therefore critical for expanded criteria to establish noninferior outcomes.

Evaluation of Curability

Evaluation of endoscopic curability is based on local factors and risk factors for LNM. A risk-scoring system name the eCura system[43] was developed to help predict LNM using 5 factors including lymphatic invasion, tumor size greater than 3 cm, vertical margin involvement, venous invasion, and submucosal invasion greater than 500 mm. This model may help treatment decision in patients who do not meet curative criteria for ER of EGC, which is referred to as eCura C-2 in the latest guidelines. Based

on these criteria, ER is considered curative when all of the following conditions are fulfilled: en bloc resection, predominantly differentiated type histology (or predominantly undifferentiated with long diameter measuring $\leq$2 cm) with no ulcerative findings, pT1a, negative horizontal and vertical margins, and absence of lymphovascular infiltration. In lesions with ulcerative findings, only predominantly differentiated type, pT1a lesions with a long diameter of no more than 3 cm are considered for endoscopic curability A or eCuraA.[1] Lesions that are resected en bloc, are no more than 3 cm in long diameter, predominantly of the differentiated type, and satisfy the following criteria: pT1b1(SM1) (within <500 μm from the muscularis mucosae), with negative margins and no lymphovascular invasion are considered endoscopic curability B (eCuraB). Curability can be expected in these lesions.

Noncurative resection (or endoscopic curability C, eCuraC) is subclassified into ‘eCuraC-1 and ‘eCuraC-2. When eCuraC lesions are differentiated-type lesions and fulfill other criteria to be classified into either eCuraA or eCuraB but are either not resected en bloc or have positive horizontal margins, they are considered eCuraC-1. All other eCuraC lesions are considered eCuraC-2 and require additional surgery with lymph node dissection following ER because of the risk of metastasis and recurrence. However, additional gastrectomy with lymphadenectomy in all these patients may be excessive, as LNM was seen in only 2.2% to 11%.[38,44–46] Less-invasive function-preserving surgery and further less invasive treatment such as ER with chemotherapy is therefore considered in patients who prefer to avoid additional gastrectomy. A systematic review and meta-analysis that included 24 studies comprising 3877 patients (311 of whom had LNM) aimed to identify the prevalence and risk factors of LNM in patients with noncurative resection after endoscopic resection for EGC.[47] The study found that the most notable pathologic factors associated with LNM in patients with noncurative resection were lymphatic invasion and lymphovascular invasion.

Post-treatment Follow-Up

Following curative gastric ESD, scheduled endoscopic surveillance is recommended. ESGE suggests an endoscopy after 3 to 6 months and then annually.[36] Following ESD of ulcerated, submucosal, or undifferentiated tumors, a staging abdominal CT should be considered. After piecemeal resection or presence of positive lateral margins not meeting criteria for surgery, an endoscopy with biopsies is recommended at 3 and 9 to 12 months and then annually.

Outcomes of Gastric Endoscopic Submucosal Dissection

Although most outcome data originate from the East, several studies support the feasibility and safety of ESD in the West as long as an adequate learning curve is accomplished.[48] Overall, long-term outcomes have been found to be comparable to Eastern data.[40,49] Local recurrence rates ranged from 0% to 1.8% for absolute indications, and 0.9% to 7% for expanded indications.[49] Metachronous gastric cancer occurred in 3% to 20.2% of lesions with absolute indications, and 1.9% to 25.4% of lesions with expanded indications for ER.

Metastatic recurrence occurred in 0.2% to 0.6% of lesions, all of which were within expanded indications. A systematic review and meta-analysis compared outcomes from 13 retrospective studies between absolute indication and expanded indication groups. The expanded indication group had lower rates of en bloc resection (93.6% vs 97.0%, P<.0001) and complete resection (87.8% vs 95.8%, P<.00001) than the absolute indication group.[50] Local recurrence rates were lower in the absolute indication group than in the expanded indication group (0.6% vs 1.5%, P=.03).

In a prospective multicenter cohort study from 12 centers in Korea,[51] authors found that 5-year disease-free survival was not significantly different between the curative and noncurative group, but 5-year overall survival was significantly higher in the curative group. Local recurrence and metachronous rates were not different between curative and noncurative groups, but the rate of distant metastasis was significantly higher in the noncurative resection group.

DUODENAL ENDOSCOPIC SUBMUCOSAL DISSECTION

Background

Duodenal polyps are identified in as many as 4.6% of upper endoscopies.[52] They are commonly defined on the basis of their location–either in the duodenal bulb, ampullary, or periampullary region or distal duodenum. Most duodenal polyps are nonneoplastic (eg, inflammatory or regenerative/hyperplastic) and occur in the duodenal bulb. Neoplastic lesions such as adenomas are more commonly found in the second portion of the duodenum and may involve the ampullary area. Approximately 60% of nonampullary adenomas are associated with familial adenomatous polyposis (FAP) or MUTYH-associated polyposis (MAP), while sporadic duodenal adenomas are found in only 0.3% to 0.5% of upper endoscopies. EMR is a safe and effective technique for most nonampullary duodenal adenomas.

Duodenal ESD is also technically difficult because of its unique anatomic features. The risks include intraprocedural complications, delayed bleeding, and perforation.[49] With the advances in devices and techniques, duodenal ESD has been more feasible and safer.

Indications and Outcomes

The 2019 AGA clinical practice update states that duodenal ESD should be limited to endoscopists with extensive experience in performing ESD in other locations.[35] To date, there are no randomized studies assessing duodenal ESD versus EMR outcomes. However, EMR has been reported to be an effective therapeutic option in sporadic nonampullary duodenal tumors.[53] En bloc resection is preferred, as piecemeal resection may lead to a non-negligible recurrence rate of 0% to 37%.[54] A systematic review and meta-analysis that included 14 studies and 794 patients assessed the characteristics and outcomes of ESD and EMR procedures for nonampullary superficial duodenal tumors.[55] The authors found that duodenal ESD for nonampullary lesions may achieve higher en bloc and R0 resection rates than EMR. ESD had a greater intraoperative and delayed perforation rate compared with EMR. The impact on local recurrence remains uncertain and requires further prospective studies.

The rate of intraoperative perforation in duodenal ESD was reported to be 6.0% to 31.6%, while the rate of delayed perforation was 1.5% to 4.8%, both significantly higher than with gastric ESD.[56] The largest study to date revealed that additional intervention is only required in 3.1% of cases with perforation, similar to the rate following perforation in gastric ESD.[57] Complete mucosal closure diminished the need for additional intervention. The rate of delayed bleeding was reported to be 0.0% to 18.4%. A meta-analysis revealed that complete closure of the mucosal defect following duodenal ESD significantly reduced delayed bleeding.[58]

Techniques of Duodenal Endoscopic Submucosal Dissection

Basic techniques of ESD in the duodenum are largely similar to ESD in other locations. Several other techniques have been described to facilitate ESD in the duodenum. The water pressure method is performed after filling the duodenal lumen with normal saline

while the mucosal flap is opened to improve visualization of the submucosa by the water stream from the water jet function. A prospective study also found that the water pressure method and using an ESD knife with waterjet function significantly shortened procedure times for duodenal ESD.[59] The water pressure method also significantly reduced the intraprocedural perforation rate. ESD techniques are continuously evolving as uptake continues to expand worldwide.

The pocket-creation method (PCM) is an attractive alternative technique for duodenal ESD as it allows stability at the tip of the endoscope even in difficult locations such as at the duodenal angles. In a study that evaluated the safety and usefulness of PCM for duodenal ESD, PCM was associated with higher en bloc resection rate, faster dissection speed, and lower rates of perforation.[9]

The use of scissor-type knives in duodenal ESD has been reported to decrease intraoperative perforation. In a retrospective study by Dohi and colleagues,[60] the intraoperative perforation rate was significantly lower in the ESD group using the Clutch Cutter knife (Fujifilm Medical, Tokyo) than in the group using Flush knife (0% vs 13.5%, respectively, P=.014).

Complete closure of duodenal ESD defects was found to reduce delayed complications including bleeding and perforation. Techniques include closure with clips, clips with string or endoloop, over-the-scope clips, and shielding with a polyglycolic acid sheets and fibrin glue.[61] In the event of duodenal perforations, a study by Fukuhara and colleagues showed the utility of endoscopic retrograde cholangiopancreatography (ERCP) with placement of nasobiliary and nasopancreatic drains to protect the site from the damaging effect of bile and pancreatic juice. Placement of nasobiliary and nasopancreatic drains was especially important for lesions in the descending part of the duodenum near the papilla of Vater.[57]

SUMMARY

ESD is the only endoscopic treatment that can reliably achieve R0 resection of precancerous lesions and mucosal cancer of the entire gastrointestinal tract regardless of their size or shape. Gastric ESD is well established for management of EGC and has promising outcomes and a good safety profile. Further studies assessing long-term outcomes will allow for more thorough risk stratification of patients who would benefit from gastric ESD over surgery. Duodenal ESD remains a more challenging procedure with a higher risk profile, even in the most experienced hands. Future studies are needed to evaluate the most effective and feasible techniques to prevent adverse events. Prospective studies are still needed to determine if ESD can become integrated into the standard of care of duodenal lesions.

CLINICS CARE POINTS

- For ESD in the stomach and duodenum, appropriate lesion selection using endoscopic diagnosis and assessment of high-risk features for SMI is critical.
- Endoscopic resection using ESD is standard of care for the treatment of EGC with negligible risk for lymph node metastasis.
- ER is considered curative when all of the following conditions are fulfilled: en bloc resection, predominantly differentiated type histology (or predominantly undifferentiated with long diameter measuring $\leq$2 cm) with no ulcerative findings, pT1a, negative horizontal and vertical margins, and absence of lymphovascular infiltration.

- Due to its technical difficulty, duodenal ESD should be limited to endoscopists with extensive experience in performing ESD in other locations.

DISCLOSURES

S.S. Al Ghamdi: none to declare. Saowanee Ngamruengphong is a consultant for Boston Scientific.

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