Endoscopic submucosal dissection and tunneling procedures using novel image-enhanced technique

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Background and Aims: Recent innovations in image-enhanced endoscopy allow early detection and management of GI lesions. In this study, we aim to analyze the utility of texture and color enhancement imaging (TXI) and red dichromatic imaging (RDI) during endoscopic submucosal dissection (ESD) and submucosal tunneling procedures.

Methods: Patients who underwent ESD, submucosal tunneling endoscopic resection, and peroral endoscopic myotomy (POEM) using the novel imaging technique including TXI and RDI were included in the study.

Results: Twenty-five patients (13 male; age 43 ± 15.69 years) underwent POEM for achalasia (n = 20), submucosal tunneling endoscopic resection for esophageal subepithelial lesions (n = 3), and ESD for gastric neuroendocrine tumors (n = 2). All of the procedures were successfully performed. Mean procedure duration was 55.52 ± 21.61 minutes. TXI mode was used in all the cases, whereas RDI mode was used on 15 occasions. While using RDI mode, hemostasis was achieved in 1 attempt on 12 (80%) occasions. The site of mucosal incision was revised in 3 cases during POEM based on TXI and RDI modes.

Conclusions: Submucosal tunneling and endoscopic dissection procedures can be conveniently performed using a new image-enhanced technique. RDI is useful in localizing the site of bleeding during endoscopic dissection. (VideoGIE 2022;7:158-63.)

INTRODUCTION

The field of diagnostic and therapeutic endoscopy has expanded with recent innovations in devices and accessories. Improved imaging techniques allow for early detection of suspicious lesions. In this regard, a novel endoscopy processing system (EVIS X1, Olympus, Tokyo, Japan) has been introduced recently. The key features of this system include texture and color enhancement imaging (TXI) and red dichromatic imaging (RDI). TXI enhances the texture, brightness, and color to clearly define subtle tissue differences.[1] Improved visibility of mucosal atrophy and gastric neoplasm while using TXI mode has been demonstrated in a recent study.[2] Similarly, it improves the visualization of blood vessels and actively bleeding points.[3,4] RDI mode uses amber light in addition to red and green wavelengths. Amber light is strongly absorbed by deeper blood vessels, enabling better visualization. In addition, it increases the contrast between diluted and concentrated blood, enabling the identification of actively bleeding points.

Data on the utility of TXI and RDI modes during submucosal tunneling procedures are limited. In this study, we present our experience of endoscopic submucosal dissection (ESD) and tunneling procedures using a novel endoscopy processor equipped with TXI and RDI modes.

METHODS

The data of consecutive patients who underwent ESD, submucosal tunneling endoscopic resection (STER), and peroral endoscopic myotomy (POEM) from November 2020 to December 2020 using the new imaging modes were analyzed, retrospectively.

The study was conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Primary objective

The primary outcome of the study was to determine the utility of new imaging technique while performing ESD and submucosal tunneling procedures. The impact of RDI mode was evaluated using the number of attempts at hemostasis using coagulation forceps. The secondary outcomes included procedure duration and adverse events.

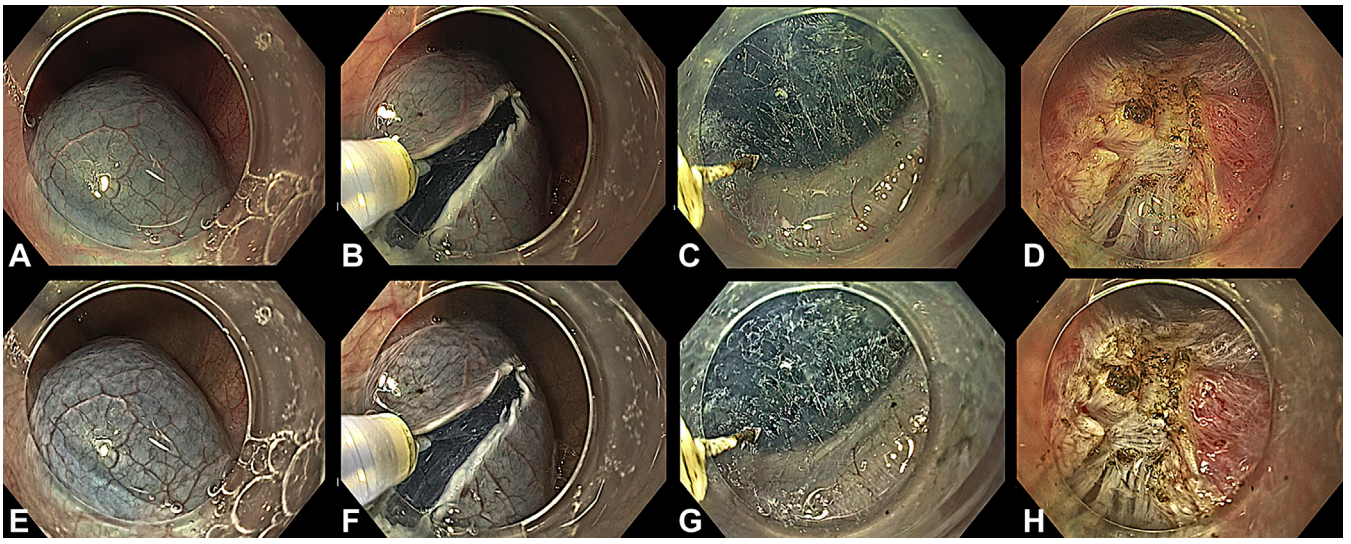

Figure 1. Comparison of conventional and texture and color enhancement imaging (TXI) modes during peroral endoscopic myotomy. **A,** Mucosal lifting injection (conventional). **B,** Mucosal incision (conventional). **C,** Submucosal tunneling (conventional). **D,** Selective circular myotomy (conventional). **E,** Mucosal lifting injection (TXI). **F,** Mucosal incision (TXI). **G,** Submucosal tunneling (TXI). **H,** Selective circular myotomy (TXI).

Definitions

Technical success was defined as successful completion of all the steps of the desired procedure. Procedure duration was defined as the time taken from mucosal lifting injection to closure of mucosal incision or defect. American Society for Gastrointestinal Endoscopy lexicon criteria were used to define adverse events.[5] Insufflation-related adverse events requiring needle decompression and mucosal injuries requiring closure were regarded as minor adverse events.

Procedural technique

All of the procedures were performed with the patient under general anesthesia after endotracheal intubation. An endoscope equipped with water jet (Olympus GIF HQ 190; Olympus Corp, Tokyo, Japan) and an electrosurgical unit (VIO300D; ERBE, Tübingen, Germany) were used for all procedures.

ESD and submucosal tunneling procedures (POEM and STER) were performed using the standard techniques described in previous studies. In brief, the steps of the POEM procedure included mucosal lifting injection, mucosal incision, submucosal tunneling to 2 to 3 cm beyond the gastroesophageal junction, myotomy, and closure of mucosal incision with endoclips (Fig. 1). The steps of the STER procedure were similar to POEM. After mucosal incision, a submucosal tunnel was made and extended for 1 to 2 cm beyond the tumor. The tumor was dissected from the surroundings and retrieved using a snare or basket. A triangle-tip knife with integrated water-jet (TriangleTipKnife J, KD-645L; Olympus Corp) was used for mucosal incision, tunneling, and myotomy during all tunneling procedures. Coagulation forceps (Coagrasper G, FD-412LR; Olympus Corp) was used to control intraprocedural bleeding.

The ESD procedure involved marking around the lesion (SOFT COAG, E4, 80 W), mucosal injection, circumferential incision, traction with 2 endoclips and rubber band if required, submucosal dissection, and retrieval of the resected lesion (Fig. 2). The insulated-tip knife (KD-611L; Olympus Corp) or DualKnife J (KD-655L, Olympus Corp) was used for ESD procedures.

Novel endoscopy processing system

A novel endoscopy processing system (EVIS X1, Olympus Corp) was used for all of the procedures. TXI mode was used for delineating the boundaries and marking the lesion during ESD and mucosal incision during ESD as well as tunneling procedures. In addition, TXI mode was used during submucosal dissection to clearly distinguish between the submucosa and the muscle layer. The mode was switched intermittently to conventional white-light mode for comparison (Fig. 3). The RDI mode was used either preemptively to detect deeper blood vessels, especially during POEM while performing myotomy toward the gastric side, or during active bleeding to locate the source of bleed (Figs. 3C and 4). The RDI mode was also used to choose an avascular area for mucosal incision during submucosal tunneling procedures.

The procedures (POEM and ESD) using the TXI and RDI imaging modes have been demonstrated in the video (Video 1, available online at www.giejournal.org).

RESULTS

A total of 25 procedures (13 male; age 43 ± 15.69 years) were performed using the new endoscopy imaging system

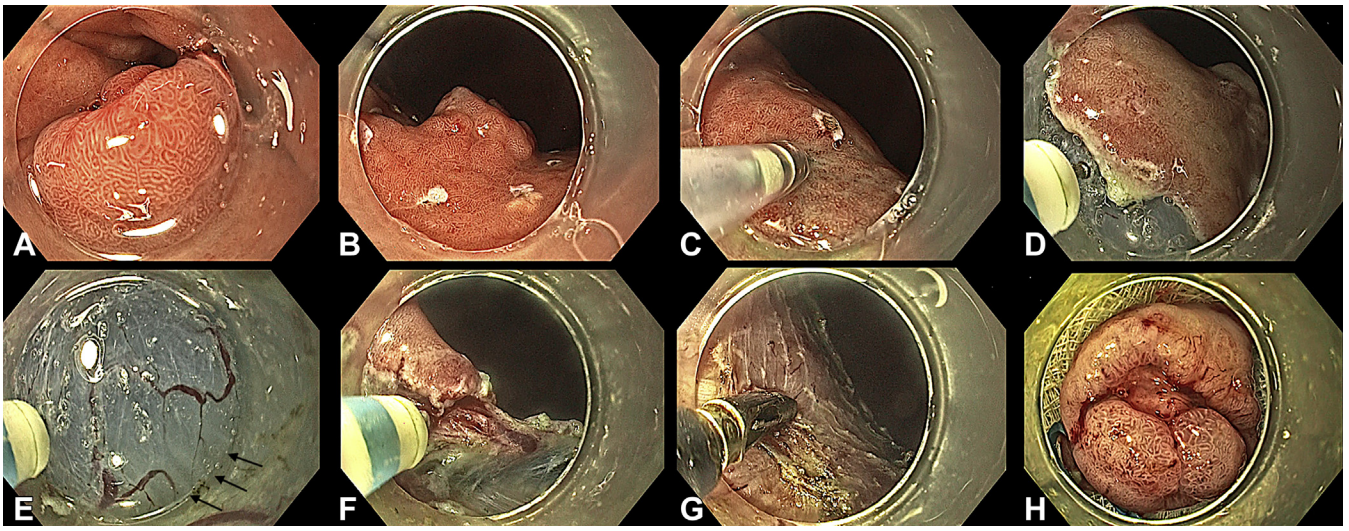

Figure 2. Endoscopic submucosal dissection in a case with gastric neuroendocrine tumor using texture and color enhancement mode. **A,** Gastric neuroendocrine tumor. **B,** Circumferential marking around the lesion. **C,** Submucosal lifting injection. **D,** Circumferential mucosal incision. **E,** Submucosal fibers, small vessels, and underlying muscle fibers distinctly visible during submucosal dissection. **F,** Completion of submucosal dissection. **G,** Prophylactic coagulation of vessels at base (greater color separation with texture and color enhancement allows easy identification and targeting of remnant vessels at the base). **H,** Resected specimen.

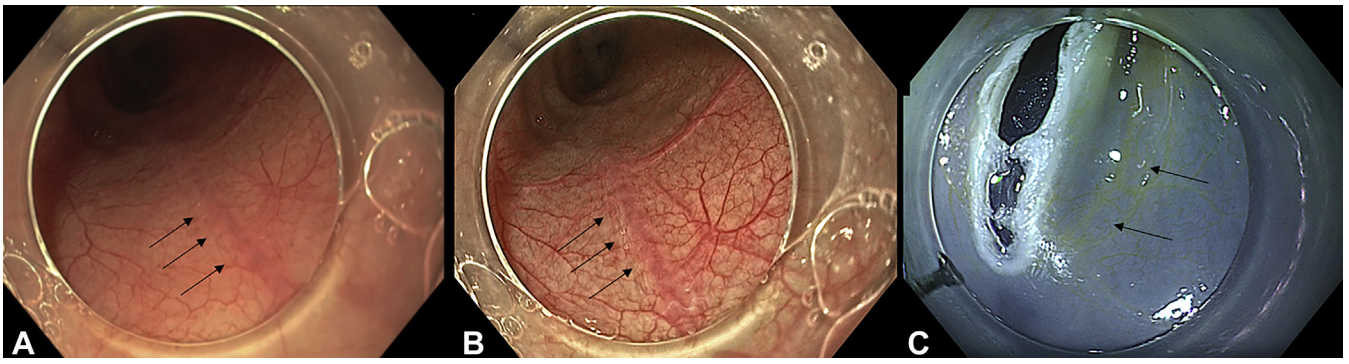

Figure 3. Esophageal mucosa visualized with and without texture and color enhancement and red dichromatic imaging mode. **A,** Faintly visible blood vessel on conventional white-light mode. **B,** Distinctly visible large vessel on texture and color enhancement mode. **C,** Mucosal incision case using red dichromatic imaging mode. Note the amber colored vessels toward the right of the mucosal incision.

during the study period. The indications included achalasia cardia (n = 20), subepithelial lesions involving the lower esophagus and gastroesophageal junction (n = 3), and gastric neuroendocrine tumors (n = 2). The subtypes of achalasia included type I (n = 2), type II (n = 12), type III (n = 4), and unspecified (n = 2). The mean length of total myotomy was 9.70 ± 3.39 cm, and the average myotomy toward the gastric side during POEM was 2.95 ± 0.22 cm.

All of the cases were successfully performed (100% technical success rate). The TXI mode was used in all cases. The site of mucosal incision during POEM was revised in 3 cases based on the information provided by TXI and RDI modes (Figs. 3 and 5). In 2 cases, the site of mucosal incision was changed after detection of a vessel with RDI mode. In the third case, the site of incision was revised because of thickened mucosa as a result of stasis esophagitis, as apparent on TXI mode. In all 3 cases, the corresponding findings on TXI and RDI mode leading to a change in the site of mucosal incision were not readily apparent on white-light mode. Intraoperative switching to conventional white-light mode was required in the initial 4 cases (3 POEM and 1 ESD) because of unfamiliarity with the modes.

The RDI mode was used on 15 occasions to identify the site of active bleeding (Fig. 4). The site of bleeding was correctly identified in 1 attempt in 12 (80.0%) cases while using the RDI mode. The median number of attempts to identify the site of active bleeding using the RDI mode was 1 (range, 1-3) (Table 1).

Adverse events

No severe adverse events occurred. Minor adverse events included capnoperitoneum requiring needle

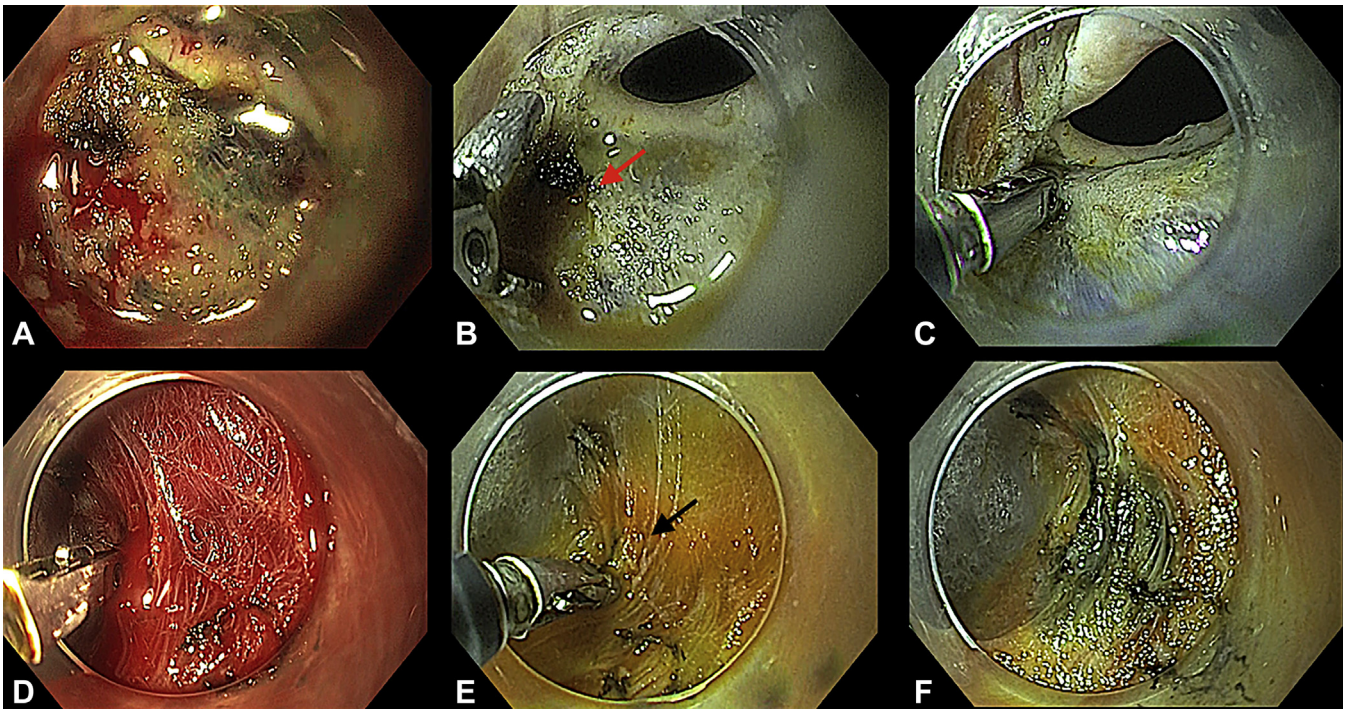

Figure 4. Hemostasis using red dichromatic imaging (RDI) mode during endoscopic submucosal dissection **(A-C)** and peroral endoscopic myotomy **(D-F)**. **A,** Active bleeding during endoscopic dissection in a case with gastric neuroendocrine tumor. **B,** Localization of the bleeding source using RDI mode. **C,** Hemostasis achieved using coagulation forceps. **D,** Failed attempt at hemostasis during POEM. **E,** Localization of the bleeding source in the same case using RDI mode. **F,** Successful hemostasis using coagulation forceps.

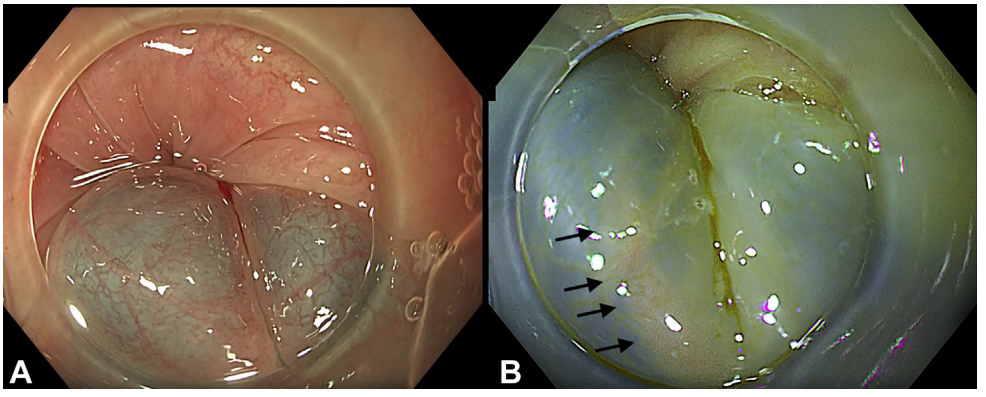

Figure 5. Mucosal incision during peroral endoscopic myotomy under the guidance of red dichromatic imaging mode. **A,** Appearance of mucosal vessels under white-light mode after submucosal injection. **B,** Appearance of mucosal vessels under red dichromatic imaging mode (identification of deep blood vessel).

decompression in 3 cases during POEM and muscle injury requiring closure with clips in 1 case during ESD for a gastric lesion.

DISCUSSION

In this study, we evaluated the feasibility and utility of endoscopic dissection and tunneling procedures using a novel endoscopy processing system. The imaging modes (TXI and RDI) improved the visualization of mucosal texture and the actively bleeding points.

With recent innovations in devices and techniques, the use and indications for therapeutic endoscopy have expanded considerably. High-definition endoscopes permit better visualization of subtle lesions. In addition, integrated water jet facility enables recognition of the source of bleeding, thereby facilitating hemostasis. Nevertheless, expertise is required for both of these tasks. Recently, a novel endoscopy processing system has been introduced

TABLE 1. Baseline characteristics of study patients

Characteristics	Value
Total patients, n	25
Age, mean ± SD (range), y	43 ± 15.69 (14-79)
Male:female	13:12
Indications, n	
Achalasia	20
Subepithelial lesions	3
Gastric neuroendocrine tumor	2
Procedures, n	
POEM	20
STER	3
ESD	2
Procedure duration, min	
All procedures	55.52 ± 21.61
POEM	50.15 ± 16.13
STER	108.33 ± 43.68
ESD	80.00 ± 14.14
RDI use, no. of occasions	
Total	15
POEM	9*
ESD	1
STER	3
Median (range) attempts for hemostasis, n	1 (1-3)
Hemostasis in single attempt, n (%)	12 (80%)
Technical success, %	100%

ESD, Endoscopic submucosal dissection; *POEM*, peroral endoscopic myotomy; *SD*, standard deviation; *STER*, submucosal tunneling endoscopic resection.
*Used twice in 2 POEM procedures.

TABLE 2. Potential utility of new imaging modes during endoscopic dissection and tunneling procedures

	TXI mode	RDI mode
Endoscopic submucosal dissection		
Demarcation of lesion	Yes	No
Mucosal incision	No	No
Submucosal dissection	No	No
Hemostasis assistance	No	Yes
Submucosal tunneling procedures		
Mucosal incision	Yes	Yes
Submucosal tunneling	No	No
Hemostasis assistance	No	Yes
Myotomy	No	No
Gastric extension of myotomy	Yes	No
Closure of incision	No	No

RDI, Red dichromatic imaging; *TXI*, texture and color enhancement imaging.

that is equipped with modes that enable texture enhancement and improved localization of bleeding sites.

In this study, we performed submucosal tunneling and ESD procedures while using the new endoscopy processing system. The adaptation to the new modes was swift, and the entire procedure could be performed using the TXI mode after the initial 4 cases.

TXI mode has been designed for improved detection of subtle lesions by increasing texture and brightness and enhancing color tone.[1,2] In this study, we found improved visualization of mucosal texture and superficial mucosal blood vessels (Fig. 3). Therefore, this mode is potentially useful in demarcation of neoplastic lesions from normal mucosa and selecting a relatively avascular area for mucosal incision during POEM procedures.[2] In addition, the demarcation between submucosa and muscle layer is more distinct (Figs. 1 and 2).

The RDI mode has been developed for identification of sites of bleeding. The utility of RDI for the identification and management of GI bleeding has been demonstrated in several case reports.[6-9] In the present study, RDI helped in identification of the bleeding site, enabling prompt hemostasis in 1 attempt in the majority of cases (Fig. 4). In our opinion, RDI may be especially useful in several scenarios. First, it would be useful in cases where visualization of the source of bleeding is hampered because of gravitational pooling, such as in posterior POEM or dissection along the posterior gastric wall. Repeated attempts at coagulation in such cases produce charring and inadvertent thermal injury to the surrounding tissues. Second, it improves pre-emptive identification of deeper blood vessels during submucosal dissection in areas with increased vascularity (eg, rectal polyps) and beyond the gastroesophageal junction during POEM.

CONCLUSIONS

The novel endoscopy processing system improved visualization of mucosal details and assisted in hemostasis during endoscopic dissection (Table 2). Improvised information provided by new modes may be especially beneficial during the learning curve when appreciation of lesions and hemostasis ability may be suboptimal. This is the first study analyzing the utility of new imaging techniques for submucosal tunneling procedures. We acknowledge several drawbacks of this study, including small sample size and lack of a control arm. The ability to quickly control bleeding is subjective and dependent on the operator's experience as well as the use of a new mode. Therefore, randomized trials are required to confirm their utility over and above currently available image-enhanced techniques such as narrow-band imaging.

DISCLOSURE

All authors disclosed no financial relationships.

Abbreviations: ESD, endoscopic submucosal dissection; POEM, peroral endoscopic myotomy; RDI, red dichromatic imaging; STER, submucosal tunneling endoscopic resection; TXI, texture and color enhancement imaging.

REFERENCES

1. Sato T. TXI: texture and color enhancement imaging for endoscopic image enhancement. J Healthc Eng 2021;2021:5518948.
2. Ishikawa T, Matsumura T, Okimoto K, et al. Efficacy of texture and color enhancement imaging in visualizing gastric mucosal atrophy and gastric neoplasms. Sci Rep 2021;11:6910.
3. Tanaka H, Oka S, Tanaka S, et al. Dual red imaging maintains clear visibility during colorectal endoscopic submucosal dissection. Dig Dis Sci 2019;64:224-31.
4. Maehata T, Fujimoto A, Uraoka T, et al. Efficacy of a new image-enhancement technique for achieving hemostasis in endoscopic submucosal dissection. Gastrointest Endosc 2020;92:667-74.
5. Cotton PB, Eisen GM, Aabakken L, et al. A lexicon for endoscopic adverse events: report of an ASGE workshop. Gastrointest Endosc 2010;71:446-54.
6. Kubosawa Y, Mori H, Fujimoto A. Utility of dual red imaging for endoscopic hemostasis of gastric ulcer bleeding. Dig Dis 2020;38:352-4.
7. Miyamoto S, Sugiura R, Abiko S, et al. Red dichromatic imaging helps in detecting exposed blood vessels in gastric ulcer induced by endoscopic submucosal dissection. Endoscopy 2021;53:E403-4.
8. Miyamoto S, Ohya TR, Nishi K, et al. Effectiveness of red dichromatic imaging for dissection of the submucosal layer when hematoma is encountered. Endoscopy 2021;53:E413-4.
9. Saino M, Aoyama T, Fukumoto A, et al. Tracking the target in colonic diverticular bleeding using red dichromatic imaging. Endoscopy 2021;53:E425-6.

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