Thieme

Clinical utility of a novel anchor pronged clip for mucosal defect closure after colorectal endoscopic submucosal dissection (with video)

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ABSTRACT

Background and study aims The MANTIS Clip (Boston Scientific) is a novel anchor pronged clip designed to enhance tissue grasping and facilitate the closure of defects in the gastrointestinal tract. This study evaluates the feasibility and effectiveness of the MANTIS Clip for closing mucosal defects following colorectal endoscopic submucosal dissection (C-ESD).

Patients and methods A retrospective single-center study was conducted on patients who underwent C-ESD with MANTIS Clip closure from May 2023 to April 2024. The primary outcome measured was the complete closure success rate. Secondary outcomes included defect size, sustained closure rate, closure time, number of clips used, adverse events (AEs), and hospital stay duration.

Results The MANTIS Clip was used in 52 cases. The complete closure rate was 98.1% (51/52), with a sustained closure rate of 96.1% (49/51). The median closed defect size was 32 mm, with the largest being 62 mm. The median closure time was 8 minutes. Typically, one MANTIS Clip per defect was used, with only one lesion requiring two clips. The median number of additional clips used was seven. AEs included one case of bleeding (1.9%) and one case of post-ESD coagulation syndrome (1.9%), both managed without extending hospital stays. The median C-reactive protein level on the first day post-ESD was 0.35 mg/dL and the median hospital stay was 5 days.

Conclusions The MANTIS Clip is effective and practical for mucosal defect closure post-C-ESD, demonstrating high success and sustained closure rates with minimal complications. Future multicenter randomized trials are needed to further assess its efficacy and safety.

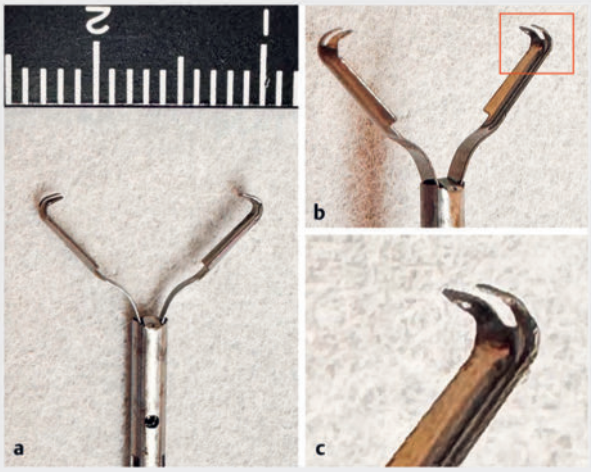
Introduction

Endoscopic submucosal dissection (ESD) has significantly advanced management of gastrointestinal lesions, enabling en bloc resection regardless of lesion size [1, 2, 3, 4, 5]. This progress is supported by improvements in procedural techniques and introduction of innovative equipment, which together have led to a decrease in the rate of intraprocedural adverse events (AEs). Despite these advances, challenges such as post-ESD bleeding, delayed perforation, and post-ESD coagulation syndrome (PECS) due to transmural electrocautery burns still

present risks in colon procedures, occasionally requiring emergency interventions and extending hospital stays [6].

Prophylactic clip closure following colorectal endoscopic resection has been effectively shown to reduce incidence of adverse AEs [7, 8, 9, 10]. Innovations in endoscopic closure techniques have significantly enhanced endoscopists' ability to manage and seal mucosal defects reliably [11, 12, 13, 14, 15, 16, 17, 18, 19, 20]. The MANTIS Clip (Boston Scientific, Marlborough, Massachusetts, United States) is a recently introduced, novel anchor-pronged clip distinguished by its strong tissue grasping capability. While the effectiveness of this novel clip in sealing gastric post-procedural defects, stent fixation in the esophagus, and closure after colorectal ESD (C-ESD) has been documented, it remains limited to a few case reports [21, 22, 23, 24, 25].

This study aimed to evaluate the effectiveness and practicality of the MANTIS Clip in closing mucosal defects following C-ESD, with a particular focus on assessing its feasibility and efficacy.



▶ **Fig. 1** Detailed views of the MANTIS Clip. **a** Image of the MANTIS Clip in the open position, with an opening width of 11 mm. **b** Oblique view of MANTIS Clip grasping arms. **c** Detailed view of the tip of the arm, highlighted in the red box in image (b), which has an anchor prong and a MANTIS-like claw designed to enhance gripping strength.

Patients and methods

This retrospective, single-center study was conducted using prospectively collected data between May 2023 and April 2024 at Showa University Koto Toyosu Hospital, a tertiary referral center in Tokyo, Japan. All patients who underwent C-ESD with mucosal defect closure using MANTIS Clip was included. The study complied with the Declaration of Helsinki and received approval from the Institutional Review Board of Showa University (approval number 2023–297-A). Written informed consent was obtained from all participants.

C-ESD procedure

We adhered to the Japan Gastroenterological Endoscopy Society (JGES) guidelines for C-ESD indications [26]. The C-ESD procedure was conducted using a therapeutic endoscope equipped with a waterjet function (PCF-H290TI; Olympus Medical Systems, Tokyo, Japan) under carbon dioxide insufflation. A distal attachment was utilized, either the ST Hood Short-type (DH-28GR; Fujifilm, Tokyo, Japan) or a disposable distal attachment (D-201–11804; Olympus Medical Systems, Tokyo, Japan). Submucosal injection was achieved using 4% sodium hyaluronate (MucoUp; Boston Scientific, Marlborough, Massachusetts, United States) for the initial injection, supplemented as needed with normal saline mixed with indigo carmine to enhance tissue contrast. The mucosal incision and submucosal dissection were performed using a 2-mm ProKnife (Boston Scientific, Marlborough, Massachusetts, United States). Electrocautery was provided by the VIO300 D unit (Erbe Elektromedizin, Tübingen, Germany), employing an Endo cut I (effect 2) for mucosal incisions, swift coagulation (effect 2, 45 W) for submucosal dissection, or spray coagulation (effect 2, 45 W) for achieving hemostasis with the knife tip. In our C-ESD procedures, we employed three methods based on lesion characteristics: the pocket creation method [27], bridge formation method [28], and water pressure method [29]. The choice of method, or combination of methods, was decided by the endoscopist performing the ESD. In the event of a perforation during the procedure, any defects in the muscularis layer were promptly closed using conventional endoclips. C-ESD were performed by a team of endoscopists, including two experts and six trainees. Antithrombotic therapy peri-ESD treatment was managed according to the JGES guidelines [30].

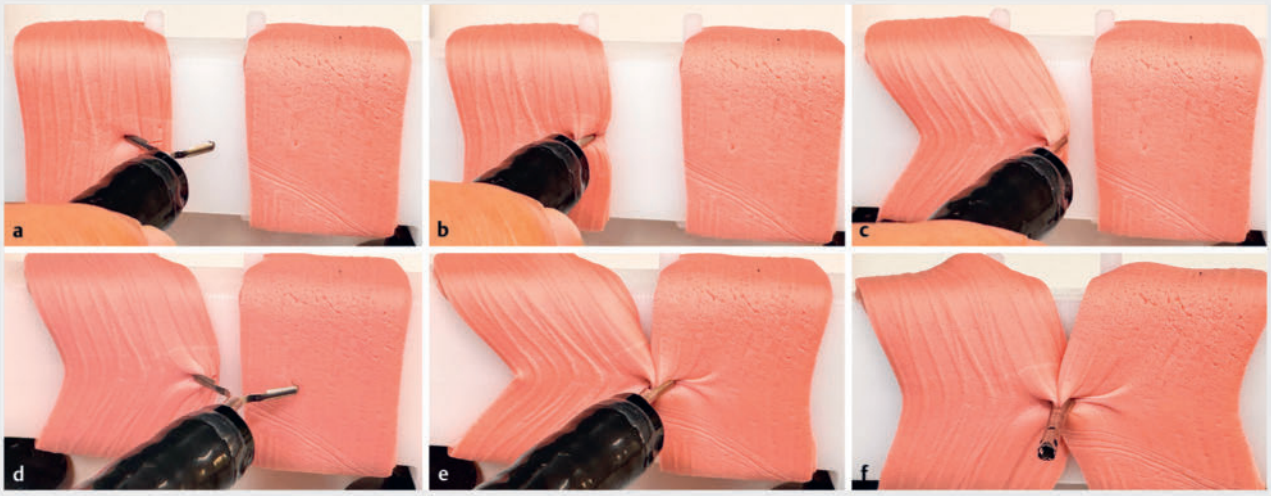
Closure method utilizing MANTIS Clip

The closure technique was implemented immediately following C-ESD, without withdrawal and reinsertion of the colonoscope. This procedure involved aligning the center of the mucosal defect along the longitudinal axis of the lumen using MANTIS clips (▶ **Fig. 1**). A MANTIS Clip was applied to grasp one edge of the defect and then drawn toward the opposite edge using endoscope manipulation. The anchor prong at the tip of the clip prevented the pulled tissue from slipping out when the clip was reopened, allowing it to close over the contralateral edge. After the defect edges were approximated, additional conventional clips (SureClip, 8-mm; MicroTech, Nanjing, China) were deployed starting from near the MANTIS Clip, gradually extending across the defect, ultimately achieving complete closure (▶ **Fig. 2**, ▶ **Fig. 3**, ▶ **Video 1**).

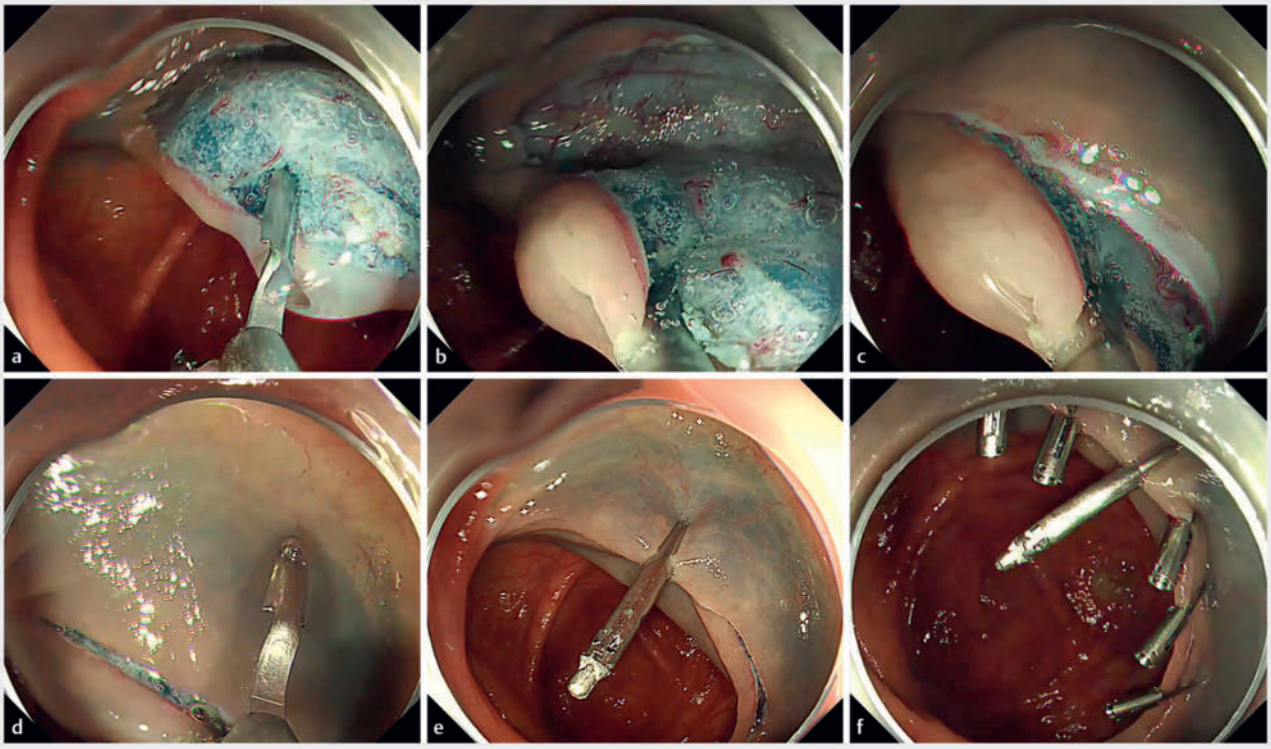
Outcome measures and definitions

The primary outcome measured was the success rate for complete closure, with secondary outcomes including the size of the closed defect, sustained closure rate, time taken for complete closure, number of clips used, incidence of AEs, C-reactive protein levels on the first day post-ESD, and duration of hospital stays post-ESD.

In this study, complete closure rate was defined as complete coverage of the defect ulcer base by mucosa using the MANTIS

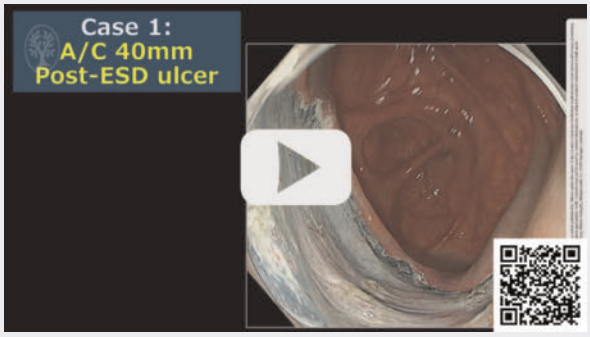


▶ **Fig. 2** Demonstration of mucosal defect closure using the MANTIS Clip in an ex-vivo model. **a** Overview of an ex-vivo setup showing a mucosal defect model, an endoscopic scope, and the MANTIS Clip, illustrating the initial setup for defect closure. **b** Application of the MANTIS Clip to grasp one side of the mucosal defect securely. **c** The endoscope is carefully dragged to the opposite side while maintaining a firm grasp on the mucosa with the clip. **d** Reopening of the MANTIS Clip; the mucosa remains securely held by the hook of the clip's arm. **e** Closure of the clip, capturing the mucosa from the opposite side to ensure comprehensive closure of the defect. **f** Effective approximation of the defect's center by the MANTIS Clip, demonstrating the clip's capability in facilitating mucosal defect closure.



▶ **Fig. 3** Closure of a colonic mucosal defect after ESD. **a** A 30-mm post-ESD defect in the ascending colon. **b** The mucosal edge on the anal side of the defect is grasped with the MANTIS Clip. **c** The lumen is suctioned and the mucosa on the anal side is dragged toward the opposite side while holding it with the MANTIS Clip. **d** Upon opening the MANTIS Clip, the mucosa on the anal side is securely hooked onto the MANTIS Clip. **e** After suturing, the wound is tightly closed in the center of the defect. f Conventional clips were added to achieve complete closure.

VIDEO



▶ **Video 1** Closure of 40-mm post-ESD mucosal defects in the ascending and transverse colon. This video presents the closure techniques for two 40-mm mucosal defects following ESD, one in the ascending colon and the other in the transverse colon. It illustrates step-by-step procedural strategies, deployment of the closure device, and final outcomes for each case. The video highlights the adaptability and effectiveness of the closure method across different anatomical locations within the colon.

Clip alongside additional conventional clips. The sustained closure rate was assessed by absence of a visible ulcer base during follow-up colonoscopy 4 to 5 days after C-ESD. Closure time was measured from insertion of the first MANTIS Clip until full closure of the defect was achieved. Delayed bleeding was identified as hematochezia that necessitated endoscopic hemostasis post-ESD. Delayed perforation was characterized by sudden onset of severe abdominal pain accompanied by peritoneal or retroperitoneal free air on a computed tomography scan post-C-ESD, without evidence of perforation during the procedure. PECS was defined as localized abdominal pain and fever (> 37.6°C, leukocytosis (> 10,000/μL), or elevated CRP levels (> 0.5 mg/dL) occurring post-procedure without clear evidence of perforation [31].

Statistical analysis

Statistical analyses were performed using JMP Pro 16 (SAS Institute Inc., Cary, North Carolina, United States). Categorical data were represented as frequencies and percentages, while continuous and nonparametric variables were presented as medians with interquartile ranges or overall ranges.

▶ **Table 1** Patient and lesion characteristics. (N = 52)

Characteristics	Values
Age, median (IQR, range), years	68 (57.75–75, 28–88)
Gender, male/female	27 / 25
Use of oral antithrombotic agent, n (%)	5 (9.6%)
▪ Aspirin	2 (3.8%)
▪ Thienopyridines	0 (0%)
▪ Other antiplatelet drugs	1 (1.9%)
– Warfarin	1 (1.9%)
– DOACs	2 (3.8%)
Location, n (%)	
▪ Cecum	4 (7.7%)
▪ Ascending colon	20 (38.5%)
▪ Transverse colon	13 (25.0%)
▪ Descending colon	2 (3.8%)
▪ Sigmoid colon	10 (19.2%)
▪ Rectum	3 (5.8%)
– Rectosigmoid	1 (1.9%)
– Ra	0 (0%)
– Rb	2 (3.8%)
Size of the lesion, median (IQR, range), mm	24 (17.75–29.25, 13–53)
Histology, n (%)	
▪ Serrated lesion	9 (17.3%)
▪ Low-grade tubular adenoma	8 (15.4%)
– High-grade tubular adenoma ~ intramucosal cancer	31 (59.6%)
– Submucosal cancer	4 (7.7%)
Complication during ESD (injury to the muscle layer)	5 (9.6%)

IQR, interquartile range; DOAC, direct oral anticoagulant; Ra, rectum above the peritoneal reflection; Rb, rectum below the peritoneal reflection; ESD, endoscopic submucosal dissection.

Results

Patient and lesion characteristics

The MANTIS Clip was utilized in 52 cases for the closure of mucosal defects after C-ESD during this study period. ▶ **Table 1** provides detailed patient demographics and lesion characteristics. The median age of the patients was 68 years (IQR 57.75–75; range 28–88 years), consisting of 27 males (51.9%) and 25 females (48.1%). Regarding antithrombotic therapy, five patients (9.6%) were receiving treatment: two patients (3.8%) were on Aspirin, one patient (1.9%) on other antiplatelet drugs, one patient (1.9%) on warfarin, and two patients (3.8%) on direct oral anticoagulants. Lesion locations included the cecum (4; 7.7%), ascending colon (20; 38.5%), transverse colon (13; 25.0%), descending colon (2; 3.8%), sigmoid colon (10; 19.2%), and rectum (3; 5.8%). The median lesion size was 24 mm (IQR 17.75–29.25; range 13–53 mm). Histological classifications were serrated lesions (9; 17.3%), low-grade tubular adenoma (8; 15.4%), high-grade tubular adenoma to intramucosal cancer (31; 59.6%), and submucosal cancer (4; 7.7%). Complications during ESD, such as injury to the muscle layer, occurred in five cases (9.6%).

Closure technique results

The results of the closure techniques are summarized in ▶**Table 2**. The complete closure rate was 98.1% (51/52), and the sustained closure rate was 96.1% (49/51). The median size of the closed defect was 32 mm (IQR 27.75–39.25 mm; range 16–62 mm), and the median time for complete closure was 8 minutes (IQR 6–10.25 minutes). The median number of MANTIS clips used per defect was 1 (range 1–2). Only one lesion, a 40-mm defect in the transverse colon, required the use of 2 MANTIS clips (). Notably, a dead space formed under the mucosa in one case (1.9%), necessitating the removal of the MANTIS Clip and subsequent closure with conventional clips. In a separate instance involving the sigmoid colon, the arm of the MANTIS Clip broke during the procedure; however, successful defect closure was achieved using a second MANTIS Clip. The median number of additional clips used was seven (IQR 5–8.25). Post-procedural AEs included one case of bleeding (1.9%) in a patient on dual anticoagulation therapy (edoxaban and prasugrel), which was successfully managed with endoscopic clipping. There was also one case of PECS (1.9%) in the cecum, which resolved with antibiotics by the third postoperative day without extending the hospital stay. Both patients recovered without further complications. The median C-reactive protein (CRP) level on the first day post-ESD was 0.35 mg/dL (IQR 0.1–1.51 mg/dL), and the median duration of hospital stay post-ESD was 5 days (IQR 4–5 days).

▶**Table 2** Patient and lesion characteristics. (N = 52)

Closure technique results	Values
Size of the closed defect, median (IQR, range), mm	32 (27.75–39.25, 16–62)
Complete closure success rate, n (%)	51/52 (98.1%)
Sustained closure rate, n (%)	49/51 (96.1%)
Time for complete closure, median (IQR), min	8 (6–10.25)
Number of MANTIS clips used, median (IQR, range)	1 (1–1, 1–2)
Number of additional clips used, median (IQR)	7 (5–8.25)
Post-procedural adverse events	
▪ Delayed perforation, n (%)	0 (0%)
▪ Bleeding, n (%)	1 (1.9%)
▪ Post-ESD electrocoagulation syndrome, n (%)	1 (1.9%)
▪ Stenosis, n (%)	0 (0%)
CRP level (mg/dL) on the first day post-ESD, median (IQR)	0.35 (0.1–1.51)
Duration of hospital stays after ESD, days, median (IQR)	5 (4–5)

IQR, interquartile range; ESD, endoscopic submucosal dissection; CRP, C-reactive protein.

Discussion

This study demonstrated that the MANTIS Clip achieves a high success rate of complete closure and a sustained closure rate for mucosal defects after C-ESD. The procedure is simple and requires a short closure time, making it a useful method for defect closure post-C-ESD. To the best of our knowledge, this study represents one of the more extensive case series to date, examining 52 instances of mucosal defect closures using the MANTIS Clip following C-ESD.

C-ESD poses unique challenges, primarily due to a higher frequency of perforation compared with other organs [32]. This elevated risk highlights the critical need for reliable closure methods that can effectively manage or prevent perforations. Effective colonic closure devices must meet specific technical requirements: In the colon, particularly on the right side, scope reinsertion can be troublesome and time-consuming, emphasizing the importance of devices that can be easily inserted through the endoscopy channel. In addition, these devices should be straightforward and quick to operate, reducing reliance on scope maneuverability. Although delayed perforation after C-ESD is relatively rare, its occurrence can be severe, often necessitating surgical intervention. Thus, the ability of a closure device to perform prophylactic closures in high-risk scenarios is particularly valuable, enhancing both safety and outcomes in C-ESD procedure.

The MANTIS Clip is a specialized device designed for the hold-and-drag closure technique [13], which originally utilized only conventional reopenable clips. Conventional reopenable clips often have blades that do not catch well, causing tissue to slip easily after dragging and reopening. In contrast, the MANTIS Clip, with its mantis-like claw, ensures strong tissue grasping and facilitates the hold-and-drag process. The median closure time in this study was 8 minutes, which is comparable to the 8 to 18.2 minutes reported in past studies of endoscopic closure methods utilizing endoclips, including the hold-and-drag technique [11, 13, 15, 16, 18, 19, 20]. In addition, a unique aspect of this study is that all patients underwent second-look endoscopy, revealing a sustained closure rate of 96.1% (49/51) among those who achieved immediate closure post-ESD. Reports about sustained closure rates are limited, but it has been reported as 64% (7/11) with the endoscopic hand-suturing technique [17] and 75% (3/4) with the Loop9 technique [18]. These findings demonstrate the robust closure force and durability of the MANTIS Clip. This is particularly important in C-ESD, where the risk of delayed complications such as perforation and bleeding could have serious consequences if closures are not maintained. Ensuring durability of closure not only enhances patient safety but also has the potential to reduce hospital stays, further emphasizing the clinical benefits of a secure and reliable closure technique.

In the colon, closure should generally be performed along the longitudinal axis. Closing along the short axis can reduce the working space, making subsequent clip placement more challenging and increasing risk of stenosis in cases of large lesions. In the application of the MANTIS Clip after C-ESD, we

propose several best practices based on our experiences, ensuring optimal outcomes through meticulous adherence to three critical stages: anchoring, mobilization, and closure. First, it is essential to simulate the hold-and-drag process to identify the optimal points for anchoring and closure. We believe that for defects oriented along the axis of the colon, it is effective to grasp the anal side of the edge and push toward the oral side. For a defect directly facing the front, anchoring can be effectively performed from either the left or right sides. During the anchoring phase, it is essential to capture as much tissue as possible, aiming to grasp the mucosa, submucosa, and muscularis layers from above. This ensures a stable base for manipulation and minimizes risk of tissue damage from the clip's sharp blades. In the mobilization phase, carefully deflate the lumen to reduce tension on the tissue and the clip. This step is crucial for minimizing risk of mechanical stress and potential blade failure. Drag the clip with the endoscope toward the intended optimal opposite target point to close. The clip should be slowly reopened after mobilization to ensure the anchor does not slip, maintaining the integrity of the initial grasp. Finally, during the closure phase, apply appropriate force to secure the tissue and close the clip. The clip's release must be controlled to maintain proper alignment and integrity of the tissue. This requires precision and a thorough understanding of the device's mechanics to avoid premature closure or displacement of the clip. By rigorously adhering to these practices, use of the MANTIS Clip can be optimized, enhancing the safety and efficacy of C-ESD procedures and significantly reducing the likelihood of complications.

Despite its benefits, the MANTIS Clip presents some challenges. Notably, excessive tension can cause the arm to break when pressing the clip after reopening, a complication we have encountered in our own experience. In addition, the sharpness of the clip's claw poses a risk of accidentally damaging the exposed muscle layer, potentially leading to perforation, necessitating careful handling, especially in narrow spaces. Furthermore, the economic cost of the MANTIS Clip is a consideration. As of 2024, the retail price is 15,000 JPY in Japan and $350 US dollars. In most C-ESD cases, a single MANTIS Clip has been sufficient to approximate the center of the defect. Although SureClips were used for additional clips in this study, non-reopenable conventional clips, which are cheaper, can certainly serve as adequate substitutes, offering a more cost-effective solution. Regardless, the MANTIS Clip is considered a clinically useful tool that facilitates efficient and effective closure.

This study has several limitations including a small sample size and single-center, retrospective design, which may affect generalizability of the results. The absence of a control group limits comparative analyses with conventional closure methods, and the observational nature of the study could introduce bias. In addition, variability in operator skill with the MANTIS Clip could influence efficacy and safety results. Because of these limitations, the results of our study should be interpreted with caution. Future research should focus on larger, multicenter trials with randomized controls to comprehensively evaluate clip effectiveness and safety across a broader spectrum of lesion sizes and diverse clinical settings.

Conclusions

In conclusion, this study demonstrates the feasibility and efficacy of the MANTIS Clip for mucosal defect closure following C-ESD. The results indicate a high success rate and sustained effectiveness of closure, with minimal complications and brief closure times. These findings suggest that the MANTIS Clip is a promising and efficient tool for endoscopic closures after C-ESD. However, further studies are needed to confirm these results and establish standardized protocols for its use in diverse clinical environments.

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Conflict of Interest

Author H.I. serves as an advisor for Olympus Corporation and Top Corporation. In addition, he has received educational grants from Olympus Corporation and Takeda Pharmaceutical Company. All other authors have no conflicts of interest to disclose.

References

[1] Gotoda T, Kondo H, Ono H et al. A new endoscopic mucosal resection procedure using an insulation-tipped electrosurgical knife for rectal flat lesions: report of two cases. Gastrointest Endosc 1999; 50: 560–563 doi:10.1016/s0016-5107(99)70084-2

[2] Fujishiro M, Yahagi N, Kakushima N et al. Outcomes of endoscopic submucosal dissection for colorectal epithelial neoplasms in 200 consecutive cases. Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association 2007; 5: 678–683 doi:10.1016/j.cgh.2007.01.006

[3] Saito Y, Uraoka T, Matsuda T et al. Endoscopic treatment of large superficial colorectal tumors: a case series of 200 endoscopic submucosal dissections (with video). Gastrointest Endosc 2007; 66: 966–973

[4] Saito Y, Uraoka T, Yamaguchi Y et al. A prospective, multicenter study of 1111 colorectal endoscopic submucosal dissections (with video). Gastrointest Endosc 2010; 72: 1217–1225

[5] Fuccio L, Hassan C, Ponchon T et al. Clinical outcomes after endoscopic submucosal dissection for colorectal neoplasia: a systematic review and meta-analysis. Gastrointest Endosc 2017; 86: 74–86.e17

[6] Hirasawa K, Sato C, Makazu M et al. Coagulation syndrome: Delayed perforation after colorectal endoscopic treatments. World J Gastrointest Endosc 2015; 7: 1055–1061 doi:10.4253/wjge.v7.i12.1055

[7] Zhang QS, Han B, Xu JH et al. Clip closure of defect after endoscopic resection in patients with larger colorectal tumors decreased the adverse events. Gastrointest Endosc 2015; 82: 904–909

[8] Pohl H, Grimm IS, Moyer MT et al. Clip closure prevents bleeding after endoscopic resection of large colon polyps in a randomized trial. Gastroenterology 2019; 157: 977–984.e973

[9] Liu M, Zhang Y, Wang Y et al. Effect of prophylactic closure on adverse events after colorectal endoscopic submucosal dissection: A meta-analysis. J Gastroenterol Hepatol 2020; 35: 1869–1877 doi:10.1111/jgh.15148

[10] Omori J, Goto O, Habu T et al. Prophylactic clip closure for mucosal defects is associated with reduced adverse events after colorectal endoscopic submucosal dissection: a propensity-score matching analysis. BMC Gastroenterol 2022; 22: 139

[11] Otake Y, Saito Y, Sakamoto T et al. New closure technique for large mucosal defects after endoscopic submucosal dissection of colorectal tumors (with video). Gastrointest Endosc 2012; 75: 663–667

[12] Kantsevoy SV, Bitner M, Mitrakov AA et al. Endoscopic suturing closure of large mucosal defects after endoscopic submucosal dissection is technically feasible, fast, and eliminates the need for hospitalization (with videos). Gastrointest Endosc 2014; 79: 503–507

[13] Akimoto T, Goto O, Sasaki M et al. "Hold-and-drag" closure technique using repositionable clips for large mucosal defects after colonic endoscopic submucosal dissection. Endosc Int Open 2016; 4: E1068–E1072 doi:10.1055/s-0042-112126

[14] Akimoto T, Goto O, Nishizawa T et al. Endoscopic closure after intraluminal surgery. Dig Endosc 2017; 29: 547–558 doi:10.1111/den.12839

[15] Nishizawa T, Ochiai Y, Uraoka T et al. Endoscopic slip-knot clip suturing method: prospective pilot study (with video). Gastrointest Endosc 2017; 85: 433–437

[16] Nomura T, Matsuzaki I, Sugimoto S et al. Clip-on-clip closure method for a mucosal defect after colorectal endoscopic submucosal dissection: a prospective feasibility study. Surg Endosc 2020; 34: 1412–1416 doi:10.1007/s00464-019-07195-x

[17] Abe S, Saito Y, Tanaka Y et al. A novel endoscopic hand-suturing technique for defect closure after colorectal endoscopic submucosal dissection: a pilot study. Endoscopy 2020; 52: 780–785 doi:10.1055/a-1120-8533

[18] Inoue H, Tanabe M, Shimamura Y et al. A novel endoscopic purse-string suture technique, "loop 9", for gastrointestinal defect closure: a pilot study. Endoscopy 2022; 54: 158–162 doi:10.1055/a-1364-4160

[19] Masunaga T, Kato M, Sasaki M et al. Modified double-layered suturing for a mucosal defect after colorectal endoscopic submucosal dissection (Origami method) (with video). Gastrointest Endosc 2023; 97: 962–969

[20] Yamasaki Y, Harada K, Oka S et al. Feasibility of underwater clip closure for large mucosal defects after colorectal endoscopic submucosal dissection. Digestion 2019; 99: 327–332 doi:10.1159/000492815

[21] Mizutani H, Tsuji Y, Hisada H et al. Successful closure of gastric wall defect after endoscopic full-thickness resection using novel anchor pronged clips: a case report. Endoscopy 2023; 55: E1234–E1235 doi:10.1055/a-2209-0076

[22] Nishiyama N, Matsui T, Nakatani K et al. Novel strategy of hold-and-drag clip closure with mantis-like claw for post-gastric endoscopic submucosal dissection defect of <30 mm. Endoscopy 2023; 55: E1244–E1245

[23] Kitagawa D, Shichijo S, Li JW et al. Use of a novel re-openable endoclip for the closure of a large mucosal defect after endoscopic submucosal dissection. Endoscopy 2023; 55: E883–E884 doi:10.1055/a-2109-0883

[24] Kubota Y, Nishiyama R, Sasaki M et al. Fixation of an esophageal stent using a novel re-openable endoclip for a tracheoesophageal fistula. DEN Open 2024; 4: e342 doi:10.1002/deo2.342

[25] Motomura D, Toyonaga T, Takayama H et al. Endoscopic double-layered suturing: an updated technique for clip closure of large mucosal defects after endoscopic submucosal dissection. VideoGIE 2024; 9: 95–98 doi:10.1016/j.vgie.2023.09.020

[26] Tanaka S, Kashida H, Saito Y et al. Japan Gastroenterological Endoscopy Society guidelines for colorectal endoscopic submucosal dissection/endoscopic mucosal resection. Dig Endosc 2020; 32: 219–239 doi:10.1111/den.13545

[27] Sakamoto H, Hayashi Y, Miura Y et al. Pocket-creation method facilitates endoscopic submucosal dissection of colorectal laterally spreading tumors, non-granular type. Endosc Int Open 2017; 5: E123–E129 doi:10.1055/s-0042-122778

[28] Abe M, Hayashi T, Kudo SE. Bridge formation method in colorectal endoscopic submucosal dissection. Dig Endosc 2023; 35: e11–e12 doi:10.1111/den.14453

[29] Yahagi N, Nishizawa T, Sasaki M et al. Water pressure method for duodenal endoscopic submucosal dissection. Endoscopy 2017; 49: E227–E228 doi:10.1055/s-0043-113556

[30] Kato M, Uedo N, Hokimoto S et al. Guidelines for gastroenterological endoscopy in patients undergoing antithrombotic treatment: 2017 appendix on anticoagulants including direct oral anticoagulants. Dig Endosc 2018; 30: 433–440 doi:10.1111/den.13184

[31] Yamashina T, Takeuchi Y, Uedo N et al. Features of electrocoagulation syndrome after endoscopic submucosal dissection for colorectal neoplasm. J Gastroenterol Hepatol 2016; 31: 615–620 doi:10.1111/jgh.13052

[32] Libânio D, Pimentel-Nunes P, Bastiaansen B et al. Endoscopic submucosal dissection techniques and technology: European Society of Gastrointestinal Endoscopy (ESGE) Technical Review. Endoscopy 2023; 55: 361–389 doi:10.1055/a-2031-0874