INTRODUCTION

Endoclips are metallic accessory devices that are deployed via the working channel of the endoscope. Once deployed, they exert pressure, bringing two mucosal surfaces together within the gastrointestinal tract. In recent years the use of endoclips in endoscopy has increased. This is due to their proven efficacy and safety profile in hemostatic applications along with multiple emerging non-hemostatic indications. While in most instances they provide definitive management by the endoscopist, they can also aid in subsequent radiographic (radiotherapy of malignancy or vascular embolization) and surgical (tumor resection) management. In some cases their use can spare the patient from a surgical procedure (in the case of perforations and anastomotic fistulas or leaks). The purpose of this paper is to discuss endoclip features, indications, and complications.

CLIPS AVAILABLE FOR USE BY THE ENDOSCOPIST

Multiple endoclips, of varying shapes and sizes, are commercially available. Some endoclips have unique features. While most endoclips have two prongs, the TriClip (Cook Endoscopy, Winston-Salem, NC, USA) has three prongs. The re-openable jaws of the Resolution Clip (Boston Scientific, Natick, MA, USA) facilitate repositioning of the clip (if needed) and allow for additional clip applications. The Olympus QuickClip (Olympus America, Center Valley, PA, USA) is rotatable which improves maneuverability.

INDICATIONS FOR ENDOCLIP USE/PLACEMENT

Gastrointestinal Bleeding

Upper Gastrointestinal Bleeding

Acute non-variceal upper-GI bleeding (NVUGIB) remains a significant cause of morbidity and mortality. It is responsible for approximately 300,000 hospital admissions and 30,000 deaths per year in the United States. While predominantly caused by peptic ulcers...
(>80%), other sources of NVUGIB include angiodyplasias, Mallory-Weiss Syndrome (MWS), Dieulafoy lesions, mucosal inflammation and malignancy. Several endoscopic modalities can be utilized to achieve hemostasis including injection of epinephrine, thermal coagulation and mechanical devices such as band ligation and endoclips.

**Peptic Ulcer Bleeding**

Several studies have investigated the safety and efficacy of endoclips in achieving hemostasis in peptic ulcer bleeding. In 1988, Hachisu described the use of an improved endoclip in 51 patients with gastrointestinal bleeding. Permanent hemostasis was achieved in 84.3% of patients with lesions that included: esophageal ulcer (1), Mallory-Weiss tear (4), gastric ulcer (24), duodenal ulcer (7), Dieulafoy lesion (3), gastric cancer (3), and post-polypectomy sites (9).

In another study, Binmoeller et al. applied nearly 255 endoclips in 88 patients with non-variceal upper GI bleeding (78 for active spurting or oozing sources and 10 for non-bleeding visible vessel). Patients were followed for a mean duration of 397 days. Primary hemostasis was achieved in all patients. Only 5 patients had recurrent bleeding of which 4 were successfully retreated with endoclips. During follow up it was determined that there was good clip retention. There were no associated complications and clips did not impair mucosal healing of the ulcer. It was concluded that endoclips were effective and safe method of treating nonvariceal peptic ulcer disease.

In 2000, Lai et al. evaluated the efficacy of rotatable clips in bleeding peptic ulcers and demonstrated that ultimate hemostasis was achieved in 87% and 96% in spurting versus oozing vessels, respectively. Patients in shock on presentation had hemostasis rates, for the same subgroups (71% and 83%). Non-shock patients had 100% hemostasis regardless of subgroup classification. Rebleeding rates after endoclip placement were low at 8%. No immediate complications, tissue injury or impaired ulcer healing was noted during the study.

While endoclips have proven safe and effective for the treatment of bleeding peptic ulcers, several randomized controlled studies have been conducted to compare clip therapy to other endoscopic treatment modalities. Additionally, several meta-analysis have been performed comparing endoclips to thermocoagulation and injection alone. The results of these analyses demonstrated endoclipping alone or in combination with injection was superior to injection alone in definitive hemostasis, rebleeding rates or need for surgery. There was no difference, though, comparing endoclips with thermotherapy alone or in combination. Thus, endoclips have proven to be a valuable modality either alone or in combination for treating peptic ulcer bleeding.

An additional use of endoclips in the setting of peptic ulcers is the displacement of an adherent clot that obscures the source of bleeding (Figures 1A and 1B). It is therefore, readily accessible if the bleeding vessel is suddenly revealed eliminating the need to prepare and exchange instruments through the channel.

There have been some limitations to endoclip use in bleeding peptic ulcers, however. Ulcers in the posterior duodenal bulb, posterior wall of the stomach and along the lesser curvature have had multiple reports of failed deployment.

**Dieulafoy Lesions**

Dieulafoy lesions produce massive bleeding from a caliber-persistent arteriole that protrudes through normal mucosa. They are typically found in the proximal stomach along the lesser curvature. While only accounting for 1–2% of bleeding from an upper gastrointestinal source, their effects can be catastrophic and the need for diagnosis and effective therapy is crucial. In 2000, Chung et al. compared the efficacy of endoclips, banding and injection therapy in 24 patients presenting with bleeding from Dieulafoy lesions. Nine patients had endoclips placed, bands were used in three and the remaining 12 cases received injection therapy. Initial hemostasis between mechanical versus injection therapy was 91% and 75%, respectively. Recurrence in bleeding was 8.3% and 33.3%, respectively. While none of the patients in the mechanical therapy group required surgical intervention, 17% of the injection therapy group did. Park et al. studied endoclip therapy alone with epinephrine injections in 32 patients presenting with bleeding from Dieulafoy lesions. Primary hemostasis between endoclips and injections was 93.8% and 87.5% respectively. Endo-
clipping proved more effective in preventing recurrent bleeding than injection, (0% v. 33 %, p < 0.05). Additional studies have been performed comparing endoclips to other endoscopic modalities for controlling bleeding from Dieulafoy lesions. All have demonstrated efficacy in providing initial hemostasis and reduction in rebleeding rates.7,12–13 Figure 2A shows an actively bleeding Dieulafoy lesion. Figure 2B shows the same lesion with complete hemostasis after deployment of endoclips.

**Mallory-Weiss Syndrome**

While bleeding from a Mallory-Weiss tear is usually self-limited, there are occasions when endoscopic therapy is required due to active bleeding from a spurting or oozing blood vessel. Endoclips used to achieve hemostasis in this setting have been described. In one study by Huang et al. in 2002, endoclipping and epinephrine injections were compared.14 Another study in 2008, by Cho et al., compared endoclips to band ligation.15 Both studies demonstrated equal efficacy in primary hemostasis and reduction in bleeding recurrence between endoclips and their respective comparisons, epinephrine injection or band ligation.

**Lower Gastrointestinal Bleeding**

Diverticular bleeding is one of the most common types of lower gastrointestinal bleeding. While surgical resection has traditionally been indicated for recurrent bleeding, endoscopic hemostatic approaches appear to be a viable alternative. Multiple case reports have described the effective use of endoclips to control diverticular bleeding.16–18 Endoclip application can be to the culprit vessel within the dome16 or to close the margins of the diverticulum.18 While no head-to-head comparisons have been made with other endoscopic therapeutic modalities, there is theoretical decreased risk of perforation. In addition, they can serve as a marker for either angiographic therapy or surgical approach if needed.19

Post-polypectomy bleeding is another cause of clinically significant hematochezia. It can manifest immediately following removal of the polyp or occur days to weeks later. Factors associated with higher bleeding risks include polyp location, number, size and morphology (sessile or thick stalk).20 Early endoscopic intervention can minimize blood loss from such bleeds. Endoclips have proven to be efficacious in providing hemostasis to immediate and delayed post-polypectomy hemorrhage. Parra-Blanco et al. reported 72 cases where endoclips were utilized in post-polypectomy bleeds.21 In cases involving pedunculated polyps, the clips were applied to the transected

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Endoclips were first applied to any visible vessel, and then used to close the margins of the ulcerated site. In 2010, Chou et al. reported a case involving a large post-polypectomy bleeding site that they were unable to primarily close using a single endoclip. They described a novel approach whereby 4 clips were applied to the margin of the ulcer site, followed by the deployment of a detachable Endoloop in a purse-string fashion around the clips to achieve hemostasis.

Endoclips, when applied prophylactically immediately after polypectomy, have also shown benefit in preventing post-polypectomy bleeding, even in anticoagulated patients. Figure 3A shows a 1.5 centimeter cecal polyp. Figure 3B shows the post-polypectomy site. Figure 3C shows the post polypectomy site after deployment of two endoclips.

**Post-Operative Complications**

When fistulas and anastomotic leaks occur, the mainstay of closure is surgical. However, an initial attempt at closure with endoscopic clips may prove successful and save the patient from another extensive surgery. Rodella et al. first described the successful use of endoclips to close esophagogastric anastomotic leaks in seven patients. The median time to complete closure following clip placement, verified by radiography, was 2.3 days. Two of the seven patients required more than one session to achieve complete closure of the leak. Figure 4A shows the site of anastomotic leak after gastric pull-up surgery. Figure 4B shows multiple endoclips deployed at the anastomotic leak site.

Endoclips have also been utilized to close chronic fistulas. Hameed et al. detailed such a case of non-healing gastrocutaneous fistula from a gastrostomy tube. They first used argon plasma coagulation to denude the fistulous tract, and then applied 4 endoclips to approximate the mucosal wall. This combination resulted in successful permanent closure of the tract on day two post-procedure.

**Perforations**

Perforations in the gastrointestinal tract currently represent an important indication for endoclip use. Most perforations are iatrogenic and are recognized complications of diagnostic and therapeutic procedures [e.g., dilation of strictures and achalasia, endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD), excision of tumors, polypectomy,
endoscopic sphincterotomy, and endoscopic retrograde cholangiopancreatography (ERCP) with stent placement, etc.). Ideally, the defect should be closed as early as possible to minimize peritoneal contamination with digestive enzymes and fecal material.\(^{26-27}\)

Surgical closure has traditionally been the standard of treatment for perforations but immediate closure of the defect with endoclips has been successfully reported. Binmoeller et al. described the first successful closure of an iatrogenic perforation using an endoclip in 1993.\(^{28}\) In high risk patients, small localized perforations can be managed non-surgically with endoclips.\(^{29}\)

Defects as large as 10 cm have been successfully treated by endoclips.\(^{30}\)

The endoclip is used by grasping the margins of the defect and approximating the tissue.\(^{31}\) Small perforations can be closed by placing clips across the center of the gap whereas larger perforations require end to end placement of multiple clips.\(^{29}\) With closure of large defects, the endoscopist should start at one end of the defect and proceed across to the opposite end until the defect is closed. Endoclip deployment can sometimes be difficult depending on the size and location (e.g., posterior wall of the duodenal bulb) of the defect. A varix ligation cap device can be used to create suction to facilitate endoclip deployment in cases where alignment of the edges is difficult or the perforation is larger than the opened diameter of the endoclip.\(^{32}\) Elastic bands, endoloops and fibrin glue can all be used along with endoclips to seal such difficult defects.\(^{33-36}\)

Figure 5A shows a colonic perforation site. Figure 5B shows complete resolution of the colonic mucosal defect following endoclip application.
Diagnostic Procedures

Diagnostic EGDs rarely result in perforations but have been reported. Esophageal perforations secondary to diagnostic upper endoscopies have been successfully closed with endoclips. When esophageal perforations are either too high or too low, they are not amenable to stent placement to cover the defect. Consequently, endoclips are the ideal choice in these situations. The risk of esophageal perforation with esophagogastroduodenoscopy (EGD) alone is only 0.03% but increases to 17% with therapeutic interventions. 33–75% of the esophageal perforations are iatrogenic.

There is almost no risk for duodenal perforation during a diagnostic EGD. However, this has been reported with diagnostic endoscopic ultrasound (EUS). Siebert and Sanders reported duodenal perforations occurring during diagnostic EUS that were successfully treated with multiple endoclips and endoloops.

For EUS guided fine needle aspiration biopsy, the risk of duodenal perforation is reported to be 0.44%. Von Renteln et al. described the use of over-the-scope clips to close duodenal perforations in a swine model.

Perforation Due to Retroflexion

Rectal and colonic perforations have been reported during colonoscopic retroflexion. These occur with a frequency of 0.1 per 1000 colonoscopies, even in the hands of experienced endoscopists. Prompt endoclipping of these perforations has been reported. Tribonias et al. reported the use of endoclips to assist surgeons in performing full thickness suturing intraoperatively. Ahlawat et al. described a case of rectal perforation during routine screening colonoscopy which was immediately closed with multiple endoclips. Several other cases of iatrogenic rectal perforations that were treated with endoclips (with or without endoloops) have been described recently.

Colon Perforations

Colonic perforations during diagnostic and therapeutic colonoscopies (EMR 58%, ESD 21%, polypectomy 18%, hot biopsy 1.5%, argon plasma coagulation 1.5%) were reported to be between 0.01% and 3%. Surgical treatment is recommended if signs and symptoms of sepsis are present. Using endoclips to close these perforations has been successfully reported even when they are >10 mm and in all segments of the colon and rectum. Yoshikane reported the first successful case of colonic perforation repair with clips followed by Mana et al. and several others. Raju et al. used a porcine model to demonstrate the use of endoclips to close colon perforations. Endoclips may fall off...
spontaneously and get eliminated in 4 weeks to 4
months.49

In a large case series of 7859 colonoscopies in
2007, Madgeburg et al. reported that most colonic per-
forations occurred during therapeutic colonoscopies,
especially with EMR, but in most cases were amenable
to endoclipping.51

EMR and ESD
EMR is a popular therapeutic technique used for high
grade dysplasia and early stage cancer within the gas-
trointestinal tract. It is an alternative to surgery for the
removal of superficial gastrointestinal neoplasms.52
Reported perforation rates for EMR are 0.3–0.5% and
for ESD, 4–10%. Small perforations recognized during
the procedure can be successfully sealed with
endoscopic clips.53

Shimizu et al. reported three perforations in 185
patients who underwent EMR between 1994 and
2003.54 All 3 defects were closed using the clipping
technique. In 2003, Tsunada et al. reported 7 cases of
gastric perforation secondary to EMR for early gastric
cancer, one of the first reported case series using endo-
clips for EMR induced perforations.55 The largest per-
foration was 25 mm and the maximum number of clips
used was 11. Several other case reports and series have
been published about EMR induced perforations
treated with endoclips.56–60

Endoclips can also be used to close large defects
secondary to EMR to prevent bleeding or perforation.
Fuju et al. described a unique technique using a spe-
cially designed 8-ring to connect two endoclips to
close the defect.61 Another technique using endoloops
and endoclips was proposed by Hurlstone et al. in
2002.62

EMR can also be performed through a retroflexed
colonoscope. Coumaros and Tsesmeli described a case
of such a procedure resulting in perforation which was
immediately closed with endoclips.63 ESD allows en-
bloc resection of lesions >2 cm which makes it more
desirable than EMR for large lesions. However, it is
also associated with a higher rate and size of perfora-
tions.54,64 Nonetheless, a good number of these perfo-
rations can be managed endoscopically. Minami et al.
reported the first case series of gastric perforations
post ESD managed endoscopically with clips with a
98.3% success rate.56 The immediate endoscopic man-
gement of such iatrogenic perforations is a key factor
in the success of endoscopic resection of early gastric
cancer by ESD.64 According to Chung et al., perfora-
tion related to ESD can no longer be regarded as an

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obstacle to performing ESD, because this can be completely managed by endoscopic clipping in most cases, with favorable outcomes. Several other reports of ESD related perforations have been reported to be treated by endoclipping.

**ERCP**

ERCP-related duodenal perforation is a well-recognized albeit rare complication. Lateral and medial wall perforations can occur due to the introduction of the duodenoscope (0.1%), endoscopic sphincterotomy (<1%) or guidewire trauma. These perforations are severe and usually require immediate surgical repair. However, endoscopic closure with endoclips (with or without endoloops) can be attempted during the procedure. The endoclip is designed to be used through the forward-viewing endoscope. Consequently, endoclip deployment is more difficult when a side-viewing endoscope is used and therefore requires a higher level of skill and expertise by the endoscopist.

**Stent Perforations**

Duodenal perforation caused by biliary stents is very rare (1%) and is usually secondary to migration of the stent, leading to impaction and puncturing of the duodenal wall. This can happen with both plastic and metal stents and can occur after either endoscopic or percutaneous placement. Migration of the stent to the ileum and colon causing perforation has also been reported. Most stent related perforations are retroperitoneal.

**Polypectomy**

Perforations can also occur during endoscopic polypectomy. The Munich Polypectomy Study (MUPS) in 2005 reported a 1.1% perforation rate for 3976 snare polypectomies, 5 of which were treated with endoscopic clipping. Katsinelos et al. reported a case of gastric polypectomy induced perforation in the gastric antrum that was treated with endoclipping. Chuan-San Fan et al. described a case of perforation on the posterior wall of the duodenal bulb after snare resection of a 2.5-cm polyp. In this particular case, a band ligator device and elastic band was used to close the gap due to limited space and tangential angle of the location.

**Dilation**

Endoscopic dilation, as necessitated by benign and malignant etiologies, also raises the risk of perforation. Mucosal perforation is a major complication of endoscopic balloon dilation in the esophagus. Fischer et al. reported a case of esophageal perforation due to esophageal dilation in a patient with achalasia which was immediately closed with endoclips.

Strictures form occasionally at the gastrojejunal stomal site after Roux-en-Y gastric bypass. Iatrogenic perforation during dilation of such strictures ranges from 3–12%. Tang et al. reported a case of gastrojejunal anastomosis perforation during dilation and immediate closure with endoclips. Cipolletta et al. described two patients with esophagojejunal anastomotic strictures post Roux-en-Y esophagojjeunostomy which were treated conservatively with metal endoclips in a single session. Qadeer et al. compiled a pooled analysis of several reports of esophageal perforations caused spontaneously and iatrogenically (including dilation), all treated with clips.

**NOTES**

In Natural Orifice Transluminal Endoscopic Surgery (NOTES), safe closure of gastrostomy is essential if the transgastric route is used. Experimental NOTES done on pig models in multiple studies showed that endoscopic clips provide a superior histopathological outcome. In 2009, an over-the-scope clip was used for gastric closure in NOTES and was shown to be easy, reliable and comparable to surgical sutures.

**Non-iatrogenic Perforations Treated by Endoclipping**

Non-iatrogenic spontaneous perforations have also been successfully treated with clips. Addley et al. reported a case of anterior gastric perforation sustained during a stab injury to the anterior wall that was treated with endoclips. Fish bone impaction is a common cause of GI perforation in the Far East. Sung and Shimamoto reported two cases of fish bone induced esophageal perforations that were closed with endoclips. Successful closure of a spontaneous esophageal perforation caused by Boerhaave’s syndrome has also been reported.
Other Endoclip Applications

Preoperative Endoclipping (Including Localization of Malignancy)

Preoperative endoclip deployment can assist surgeons in performing full thickness suturing intraoperatively. Matsui and Kikuchi et al. reported the use of endoclips to delineate the line of resection in laparoscopic gastrectomy. A novel magnetic marking clip-detection system was proposed by Ohdaira and Nagai for tumor detection during surgery. Tabibian et al. advocate the placement of an endoclip into the mucosa around small colonic malignancies prior to surgery as this aids the surgeon in localizing them when they might otherwise be difficult to find by palpation.

Radiographic Localization of Colonic Tumors

When an obstructing tumor proximal to the recto-sigmoid colon prevents completion of the endoscopic exam, accurate localization becomes challenging. This has important surgical management implications in that the anatomical location of the lesion is not well-defined. Knopp et al. described placement of an endoclip on the first haustral fold (just distal to the lesion) for radiographic purposes. Subsequent flat plate of the abdomen revealed the endoclip in the area of the distal transverse colon in close proximity to the splenic flexure. This approach appears to be useful when endoscopic localization of a colorectal lesion is unclear.

Endoclip-assisted Biliary Cannulation

The presence of an intradiverticular papilla (IDP) during ERCP can present a challenge to the endoscopist with respect to cannulation of the common bile duct. Scotiniotis and Ginsberg reported the first case of endoclip-assisted biliary cannulation. This technique uses one or more endoclips to facilitate a temporary and favorable change in the anatomical position of the major papilla, thus enabling successful cannulation. Huang et al. recently described two additional cases that confirmed the utility of this technique in cases of IDP.

Prevention of Luminal Stent Migration

With the increasing use of endoluminal stents, we are also more frequently encountering one of its most common complications, stent migration. This is especially true in the case of covered stents, which were designed to overcome tumor in-growth associated with uncovered stents. Stent migration can lead to increased morbidity (obstructive symptoms or perforation). It also may result in repeat endoscopic examinations which can inflate healthcare costs and lead to a decreased quality of life, especially in the palliative care setting.

Kim et al. prospectively evaluated the clinical efficacy of endoscopic clipping for the prevention of covered stent migration in the treatment of malignant gastric outlet obstruction (GOO). The site of obstruction was at the pylorus and antrum (n = 18), duodenal bulb (n = 1), and in the second portion of the duodenum (n = 6). Immediately following stent deployment, endoclips were applied at the proximal end of the enteral stent to fix the gastrointestinal mucosa. The stent was a double-layered combination stent (comprising an outer uncovered and an inner covered stent). Three clips were used for each stent and the endoscopist clipped the wire mesh of the stent and the normal mucosa together at three different points. Technical success (defined as satisfactory deployment and precise positioning at the location of the stenosis) and clinical success (defined as the ability to tolerate oral intake without vomiting) were 100% and 88%, respectively. Subsequent stent migration did not occur in any of the patients. Anchoring the stent to normal tissue with endoclips allows enough time for tissue or tumor to grow into mesh struts and provide adequate anchorage for the self-expanding metal stents (SEMS). It also avoided the patient inconvenience of having a catheter or silk thread protruding from the nasal cavity, thus improving patient tolerance.

Park et al. also reported no early stent migration in their clipping group (0/19 patients) in contrast to their non-clipping group (5/19 patients). This study was notable in that it included nine cases of malignant colonic obstruction.

Kato et al. reported on the utility of endoclips in preventing esophageal stent migration. Nine patients underwent SEMS implantation. After deployment of the SEMS, endoscopic clips were used to fix the upper end of the stent to the esophageal mucosa. No stent migration was observed in any of the patients.
Sebastian and Buckley applied endoclips at the cranial and caudal ends of SEMS in three patients with rectal cancer. Subsequent stent migration did not occur in any of these patients.

**Fluoroscopic Markers in Luminal Stent Deployment**

Given their metallic composition, endoclips have also demonstrated utility as fluoroscopic markers prior to stent deployment.

**Ambulatory Colonic Manometry**

While ambulatory colonic manometry can provide useful pathophysiologic information regarding colonic motor function, probe displacement during prolonged recording can prove problematic. Such displacement likely occurs because of propulsive forces which cause the catheter to move distally. Rao et al. compared two study groups [one group whose probes were anchored to the colonic mucosa using endoclips (n = 14) and another group whose probes were left unattached in the colon (n = 16)]. The magnitude of transducer displacement was subsequently assessed by fluoroscopic localization and a displacement score was calculated. In patients without clipping, the mean displacement score was 1.6, implying displacement of transducers by 1.6 colonic segments relative to their initial location. In contrast, there was no displacement of transducers in those who received endoclipping. The authors concluded that endoscopic mucosal clipping was safe and effective for prevention of probe displacement and ensures more accurate temporospatial resolution of data for prolonged colonic manometry recording. Other authors have reported similar efficacy of colonic manometric endoclipping.

**24-hour Ambulatory Esophageal pH Monitoring**

Endoclips have also been utilized in 24-hour ambulatory esophageal pH monitoring to anchor the electrode to the mucosa.

**Placement of Jejunal Feeding Tubes**

Endoscopic placement of jejunal feeding tubes can be challenging given the high rate of proximal migration which can occur even during endoscope withdrawal.

Frizzell and Darwin describe a technique where a Resolution Clip was used to ensure proper placement of nasojejunal feeding tube and jejunal extension through a percutaneous endoscopic gastrostomy (PEG-J). This technique takes advantage of the ability of the Resolution Clip to be open and closed, like biopsy forceps, without inadvertent deployment. After the jejunal feeding tube is passed into the gastric body, a Resolution Clip is passed through a pediatric colonoscope and is used to grasp a suture attached to the feeding tube. After the clip is closed on the suture, the clip is withdrawn back into the endoscope. The endoscope is then passed to the ligament of Treitz, where the clip is advanced, opened, and deployed on the jejunal mucosa. The authors noted good long-term results, with no migration up to 46 days after tube placement. Ginsberg et al. describe a similar technique of endoclip assisted placement of enteral feeding tubes. Figure 6 shows a jejunostomy tube anchored to the jejunal mucosa via a Resolution Clip.

**Incomplete Colonoscopic Examinations**

When anatomic landmarks such as the ileocecal valve or appendiceal orifice are not visualized during colonoscopy, the endoscopist cannot say with confidence that the entire colon has been examined. Tabbian et al. described the use of endoclips in such cases.
Following the procedure, the location of the endoclip was established radiographically. This facilitates correlation of endoscopic and radiographic impression and helps determine whether further evaluation is needed (e.g. repeat colonoscopy or barium enema).

**Delineation of Gastrointestinal Malignancies Prior to Radiotherapy**

Endoclips can also be used to delineate gastrointestinal malignancies prior to radiotherapy. Weyman and Rao describe a case where the esophageal tumor margins were readily identified on upper endoscopy after barium esophagram failed to localize the full extent of the tumor. One endoclip was placed at the proximal margin and another at the distal margin of the tumor.

**Clip-assisted Zenker’s Diverticulotomy**

Tang and Lara describe a case of a patient with a symptomatic residual Zenker’s diverticulum (ZD) who underwent flexible endoscopic clip-assisted diverticulectomy (ECD). This resulted in complete septum dissection with resolution of all esophageal symptoms and no complications. The authors also propose the use of ECD for small ZD (less than 2 cm), for patients with a larger ZD who prefer stepwise dissection, and for ECD of lower parts or bottom of the septum (bottom ECD).

**Foreign Body Management**

Ingestion of sharp foreign bodies can pose a management challenge to the endoscopist. At times multiple attempts at retrieving the foreign bodies using multiple retrieval modalities (snares, nets, baskets, and forceps) will fail. Thornton et al. describe a case where a Resolution Clip was used to grasp a razor blade fragment. The clip was opened and repositioned several times until the hole in the razor blade was clapsed and secured. The clip was placed in the closed and locked position but not deployed. Once the razor blade was brought back into the esophagus, the endoscope, overtube, clip, and blade were all removed as a system.

**Localization of Suspicious Vascular Lesions Prior to Embolization**

Endoclips placed at the site of a suspicious vascular lesion have proven useful for localization on subsequent angiography. This has potential therapeutic implications with respect to guiding embolization.

**Modification of Obstructive Post-surgical Anatomy**

Zanati et al. describe a case where post-surgical anatomy was successfully modified by the deployment of endoclips. The patient they describe developed gastric outlet obstruction shortly after Billroth II gastrojejunostomy for gastric adenocarcinoma. On upper endoscopy, a redundant jejunal fold was noted to be obstructing the inlet to the efferent limb. Given poor nutritional status, the risk of re-operation was substantial and a decision was made to attempt endoscopic revision of the anastomosis using endoclips. Multiple endoclips were deployed with resultant fixation of redundant jejunal folds to open lumen of the efferent limb. While the patient died six months after surgery from metastatic disease, he was able to tolerate a full diet without recurrence of vomiting following endoclip placement.

**Complications of Endoclip Placement**

Endoclip placement has proven to be safe in a variety of clinical settings and potential complications are minimal. Since endoclips only adhere to the mucosa and submucosa, the risk of perforation is low. One should use caution when utilizing cautery in close proximity to endoclips. This is especially important in hemostasis when electrocautery may be used in combination with endoclips.

Gill et al. looked at the compatibility of endoclips in magnetic resonance imaging. They studied the physical deflection and strength of attraction of various endoclips (Resolution Clip, TriClip, QuickClip, and Ethicon Endo-Surgery Clip (Ethicon Endo-Surgery, Cincinnati, OH, USA)) in an MRI using a pig model. They found that the Ethicon Endo-Surgery clip was compatible with MRI. They also showed that all other clips showed deflection in a magnetic field. The TriClip demonstrated detachment from gastric tissue, and it was thus felt by the authors to be considered MRI incompatible. This is an important consideration, especially in light of the fact that in
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Table 1. Indications for Endoclip Use/Placement.

- **Gastrointestinal bleeding**
  - Movement of clot to reveal bleeding source (in position for rapid endoclipping if active re-bleeding occurs)
  - Non-variceal upper gastrointestinal bleeding
    - Peptic ulcer disease
    - Dieulafoy lesions
    - Mallory-Weiss tear
  - Lower gastrointestinal bleeding
    - Diverticular bleeding
    - Post-polypectomy bleeding
- **Post-operative complications**
  - Anastomotic leaks
  - Fistulas
- **Perforations**
  - Diagnostic endoscopy
  - Therapeutic endoscopy
    - Dilatation
    - EMR/ESD
    - Polypectomy
  - Secondary to stent migration
  - NOTES
  - Trauma
  - Fish bone impaction
  - Boerhaave’s syndrome
- **Other endoclip applications**
  - Preoperative endoclipping (including localization of malignancy)
  - Radiographic localization of colonic tumors
  - Endoclip-assisted biliary cannulation
  - Prevention of luminal stent migration
  - Fluoroscopic markers in luminal stent deployment
  - Ambulatory colonic manometry
  - 24-hour ambulatory esophageal pH monitoring
  - Placement of jejunal feeding tubes
  - Incomplete colonoscopic examinations
  - Delineation of gastrointestinal malignancies prior to radiotherapy
  - Clip-assisted Zenker’s diverticulotomy
  - Foreign body management
  - Localization of suspicious vascular lesions prior to embolization
  - Modification of obstructive post-surgical anatomy

some instances endoclips can remain attached to the mucosa for protracted periods of time (up to 26 months has been reported).31

**CONCLUSION**

Endoclips have proven to be one of the most valuable accessories available to the endoscopist. Their utility has transcended initial hemostatic indications, evolving over time to encompass numerous other luminal and biliary applications (Table 1). These applications, while at times prove definitive, often guide further management by our radiological and surgical colleagues. We must strive to refine existing clipping techniques and continue to develop new and beneficial endoclip indications.

**Acknowledgment**

The authors would like to acknowledge Max Miranda, M.D. for his valuable input in the preparation of this manuscript.

**References**

Practical Points

- Multiple hemostatic and non-hemostatic indications exist for endoclips. A few of which do not require clip deployment.

- Endoclips have proven utility in both the prophylaxis and treatment of gastrointestinal bleeding.

- While emergent surgery has traditionally been the standard of care for iatrogenic endoscopic perforations, immediate endoclips closure is currently the treatment of choice in most patients.

- Endoclips serve as excellent markers in many clinical scenarios and guide subsequent radiographic or surgical management.

- Endoclips have a favorable safety profile and are associated with minimal complications.


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65. Chung IK, Lee JH, Lee SH, et al. Therapeutic outcomes in 1000 cases of endoscopic submucosal dissection for early gastric neo-


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