Endoclip: closing the surgical gap

Hayashi et al.[1] in Japan first described the application of an endoclip as a therapeutic, endoscopic maneuver over 20 years ago. Initially hampered by difficulties in deployment, significant improvements in the design of the applicator device in 1988 permitted routine clinical applications in Japan and Europe for the treatment of GI bleeding.[2] Reports of non-hemostatic applications soon followed including the closure of tissue defects, perforations, and anastomotic leakage in the esophagus, stomach, and colon.[3-6] Use of the endoclip has also been described in preventing post-polypectomy bleeding,[7] placement of enteral feeding tubes,[8,9] and as a marker for surgical resection and endoscopic reexamination.[7] In this issue of *Gastrointestinal Endoscopy*, four studies reinforce the versatility of endoclips for therapeutic, endoscopic applications.

The procedural steps of endoclip application are straightforward. A stainless steel clip, each prong 6 mm in length and 1.2 mm in width, is loaded onto a clip application device and retracted into a protective Teflon sheath (HX-3L; Olympus Corp, Tokyo, Japan). The application device is inserted through the working channel of a standard endoscope. Sliding the sheath backwards using the handle extends the clip from the sheath. Retracting the clip approximately 1 mm maximally opens the prongs. When fully open, the distance between the clip prongs measures 12 mm. The orientation of the clip prongs can be adjusted by rotating the handle clockwise. The clip is closed by fully retracting the clip.

For hemostasis, the clip is used to grasp, compress, and ligate a bleeding vessel. The hemostatic effect is immediate and should be permanent if the vessel is properly ligated. The conceptual advantage over thermal and injection hemostasis is the direct mechanical method that minimizes injury to surrounding tissue. Endoclips have been effectively used in the control of GI bleeding from multiple sources. These include peptic and stomal ulcers, Mallory-Weiss tears, Dieulafoy lesions, gastric tumors, arteriovenous malformations, colonic diverticula, solitary rectal ulcers, small varices, hemorrhoids, post-sphincterotomy bleeding, and post-polypectomy bleeding from the stomach and colon.[3,10,11] Endoclip hemostasis is not necessarily competitive with standard endoscopic treatments using thermal and injection modalities. A prerequisite for endoclip hemostasis is the identification of the bleeding vessel, which may be difficult in the setting of active bleeding. The injection of diluted epinephrine may be required to reduce or stop bleeding before clip application. Patients who fail thermal or injection treatment, critically ill patients,[12] and patients with underlying coagu-

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lopathies are most likely to benefit from endoclip hemostasis.

For the closure of tissue defects, the endoclip is used to grasp the margins of the defect and approximate the tissue. Binmoeller et al.[3] described the first application of endoclips to close a 5 mm perforation after snare resection of a pedunculated stomach leiomyoma. Additional reports of clips for the closure of iatrogenic perforations have been published. Wewalka et al.[4] used hemoclips to treat an esophageal perforation after pneumatic dilatation for achalasia. Yoshikane et al.[5] used 4 clips to close a 4 mm perforation after performing endoscopic mucosal resection of an early cancer. In this issue of *Gastrointestinal Endoscopy*, Kaneko et al.[13] provide further support for the use of endoclips to close perforations complicating endoscopic mucosal resection. Perforation occurred in 2 patients after endoscopic mucosal resection of carcinoid lesions in the duodenum. The perforations were successfully closed using 4 to 5 hemoclips and complete healing was documented endoscopically at 6 months. Although it is encouraging that perforations complicating endoscopic mucosal resection or polypectomy can be managed endoscopically, we should remember that a favorable outcome depends on rapid deployment to minimize bacterial contamination. The endoscopist and assistant must be trained in the use of endoclips and prepared to apply these in a timely manner.

The application of clips for the closure of anastomotic leaks was first reported by Rodella et al.[6] in 7 patients. Leaks measuring 10 to 20 mm in diameter could be closed with 2 to 3 clips, which is surprising considering the maximal span of 12 mm between clip prongs. Two of the seven patients required more than one clip session, indicating problems with maintaining tissue approximation after clip application. The case report by Van Bodegraven et al.[14] offers a strategy that may improve results. Speculating that mucosal inflammation would improve the contact and adherence of the opposing walls in the fistula tract, the authors primed an esophagopleural fistula tract before clip application using fulguration by argon plasma coagulation. Argon plasma coagulation[15] was selected to fulgurate the tract due to its shallow depth of thermal injury. The authors successfully closed the fistula measuring 12 mm with this combined approach. It is noteworthy that before clipping the authors had attempted to seal the fistula using injection of the cyanoacrylate glue into the tract. Possibly a combination of cyanoacrylate glue application and endoclips may have achieved the desired result.

The application of an endoclip to the stalk of a polyp to prevent post-polypectomy bleeding has been previously described. In this issue of *Gastrointestinal Endoscopy* Cippolletta et al.[16] extend this application to enable the resection of polyps with a needle-knife. The authors used endoclips to ligate the stalk of large polyps (3 to 6 cm range) that were not amenable to standard snare application. Because the large size of the polyps did not permit snare deployment, an endo-loop could not be used in this role. The authors placed clips at two levels—close to the bowel wall and near the head of the polyp—to prevent bleeding. To ligate the full stalk thickness, two opposing clips were used. After placing clips, the stalk was transected between the two sets of clips with a needle knife. The authors noted that the entire procedure was "rather time consuming." The advantage over standard piecemeal resection remains to be defined.

The final study published in this issue of *Gastrointestinal Endoscopy* by Scotiniotis et al.[17] describes the novel use of endoclips to improve anatomic orientation for biliary duct cannulation. We have similarly used clips to elevate and affix a fold that hindered cannulation of the bile duct. Several caveats deserve mention. Misguided endoclip placement can obstruct the outflow of the pancreatic and/or biliary ducts. The traction applied can alter anatomy and make interpretation of the distal ductal cholangiogram difficult. The concept of using endoclips to modify the anatomy for interventional maneuvers has merit and deserves to be explored further.

What about the safety of endoclips? No serious complications have been reported. The potential for significant tissue injury is small, as clips have been found to grasp only the mucosal and submucosal layers.[18] Clips are made out of metal and hence may conduct current if diathermy is applied after clip application. For hemostatic indications, clips have been observed to dislodge spontaneously 1 to 3 weeks after placement with re-epithelization of the lesion.[3] There have been isolated reports of clips remaining in situ up to 26 months after deployment when used for marking.[7] There has been no evidence of clip-induced tissue injury or impairment of healing. Concerns that clips could impact (e.g., at the ileocecal valve) and perforate have not been validated.

Future developments are necessary before endoclips gain more widespread popularity. First, the ease and rapidity of loading the clips onto the applicator device must be markedly improved. This poses a problem in the setting of active bleeding where clips may need to be applied in rapid sequence. In a large series of patients treated for various causes of non-variceal GI bleeding, Binmoeller et al.[2] found an average of 2.9 clips were required per patient.

Having two applicator devices for loading is helpful in this situation but also requires two assistants. Development of a multiple-firing device enabling the deployment of multiple clips in sequence is desirable, analogous to the current multiple band-ligation devices. Second, better deployment maneuverability of the endoclip is required. The "rotatability" of the new clip design (Olympus HX5U) to adjust its orientation has not lived up to expectations. Areas that are difficult to access endoscopically such as the bulb of the duodenum, along the high lesser curvature, and at the cardia are particularly problematic using the endoclip. Deployment of the clip is often blind where lesions are approached tangentially. Third, clips with stronger grasping and ligating force are needed. Clips often do not hold when applied to chronic ulcers with fibrotic bases. They need greater strength to manipulate anatomy. Finally, the size of the defect that can be treated is limited by the size of the clip. Larger clips are needed to close larger defects. Larger clips may also enable the endoscopist to approximate the edges of a bleeding ulcer, analogous to a surgical oversew, to achieve hemostasis.

Endoscopists are able to cut, inject, burn, dilate, and stent, but we still cannot suture. With endoclips, the endoscopist has a tool with virtues similar to the surgeon's suture. The repertoire of potential uses of clips continues to expand. Until an endoscopic sewing machine is marketed, this is the best thing the endoscopist has for closing the surgical gap.

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