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Review Article

Endoscopic Management of Colonoscopy-related Perforation

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Abstract

Colonoscopy-related perforation is a rare but serious complication. The type of perforation depends on whether it was caused by a diagnostic examination or as a sequelae to a therapeutic procedure. Although traditionally managed by surgery, endoscopic management is increasingly used. This review focuses on the currently available methods of endoscopic management following colonoscopy-related perforation, together with a brief review of their efficacy. With better development of endoscopic accessories such as through-the-scope and over-the-scope clips, and increasing experience by endoscopists, it is now recommended that endoscopic management should be the preferred initial treatment modality of colonoscopy-related perforation.

Keywords: *Colonoscopy, endoscopic clipping, endoscopic suturing, iatrogenic, perforation*

Introduction

Colorectal cancer and inflammatory bowel disease are rapidly increasing in incidence in the Asia-Pacific region and remain the most common form of lower gastrointestinal diseases worldwide.[1-3] Colonoscopy has become a vital modality in the management of these conditions, both from a diagnostic and therapeutic perspective.[4,5] Although invasive, colonoscopy is usually well tolerated and is known to have a low complication rate. Colonoscopy-associated perforation is a rare but potentially hazardous complication.

The incidence of colonoscopy-related perforation depends on the mechanism of perforation (see below). The incidence of perforation due to a diagnostic colonoscopy ranges from 0.08% to 0.11%,[6,7] while that from a therapeutic colonoscopy (for example, endoscopic submucosal dissection/endoscopic mucosal resection [ESD/EMR]) ranges from 0.9% to 4.1%.[8-10] Risk factors of iatrogenic colonic perforations include older age, comorbidity, inflammatory colonic disease, use of hot biopsy forceps, balloon dilatation, and endoscopist's experience.[11] Odagiri *et al*. demonstrated a lower rate of colonic perforation and bleeding postcolonoscopy in high compared to low colonoscopy volume Japanese hospitals.[9]

Colonoscopy-associated perforations can result in mortality and significant morbidity, with mortality rates ranging from 0% to 8.6%.[6,12,13] Colonic perforation is a medical emergency and serious complications develop if left untreated. These include abdominal compartment syndrome, tension pneumothorax, tension pneumoperitoneum, and peritonitis. The optimal management of these iatrogenic perforations is still debatable as most studies are retrospective and there is a lack of good randomized controlled studies naturally. In general, the definitive management can either be endoscopic or surgical. This review will focus solely on the endoscopic management of colonoscopy-related perforations.

Mechanism of colonoscopy perforation

As mentioned before, perforation during colonoscopy can occur during a diagnostic or a therapeutic procedure. The mechanism of injury during a diagnostic colonoscopy is blunt mechanical trauma [Figure 1]. This usually results in a larger perforation compared to that from a therapeutic procedure.[11] The size of perforation defects resulting from diagnostic colonoscopy are usually large, owing to the force of blunt trauma and maneuvering [Figure 1].[14]

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The most common site of perforation is at the sigmoid colon.[12,15,16] [Figure 2] In a study by Luning *et al*., 36 perforations occurred in a cohort of 30, 366 colonoscopies of which 26 (74%) occurred at the sigmoid colon.[12] The reason behind such an occurrence could be due to complex bowel looping while traversing the rectosigmoid and sigmoid colon.[15,16] Severe diverticular disease further increases the risk of perforation.[17]

In contrast to the above, perforation defects resulting from therapeutic colonoscopy (for example, from EMR/ESD) are usually smaller.[18] Therapeutic procedures such as polypectomy of the right side of the colon have an increased risk of perforation due to the thinner mural wall in the proximal colon. In a study that evaluated the risk factors of colonic perforations associated with EMR, features of deep mucosal injury in the resected specimen (target sign or perforation), sessile serrated polyps, and polyp size >25 mm were found to be predictors of perforation [Figure 3a and b].[19]

Other less common mechanisms of injury include balloon dilatation of a colonic stricture (for example, in Crohn's disease) and barotrauma leading to cecal perforation due to excessive air insufflation; though usage of carbon dioxide has greatly reduced the risk.[11]

Diagnosis

Abdominal pain and distension are the most common clinical symptoms and usually develop within 12 h, while peritonitis is usually a late sign.[18] Detection of perforations can be delayed (>24 h) in up to 23% of patients after completion of colonoscopy.[20] Immediate recognition is essential and is usually made by direct visualization of the colonic defect, fat, or omental tissue. A "target" sign or an actual hole seen in the resected specimen following EMR/polypectomy is usually an indication of deep muscular injury that can lead to perforation.[19]

To confirm the clinical suspicion of colonic perforation, an erect chest or abdominal radiograph demonstrating air under the diaphragm would be an initial step [Figure 4]. Computed tomography provides an alternative and more accurate imaging modality in detecting leakage of abdominal contents, free fluid, and air.[11] In some instances, the location of the perforation can be identified. Imaging modalities are useful in diagnosis, especially when no apparent defects were detected during colonoscopy and clinical signs become apparent after completion of colonoscopy.

General Management

The key in managing colonoscopy-related perforations is (i) prompt diagnosis, (ii) deciding between endoscopic and surgical therapy, and (iii) treating its associated complications. The size, location, and nature of

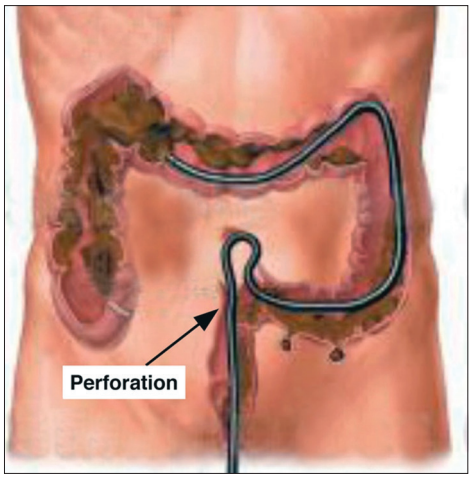

Figure 1: Diagnostic colonoscopy perforation at the sigmoid colon – adapted from trialcs.medicalillustration.com

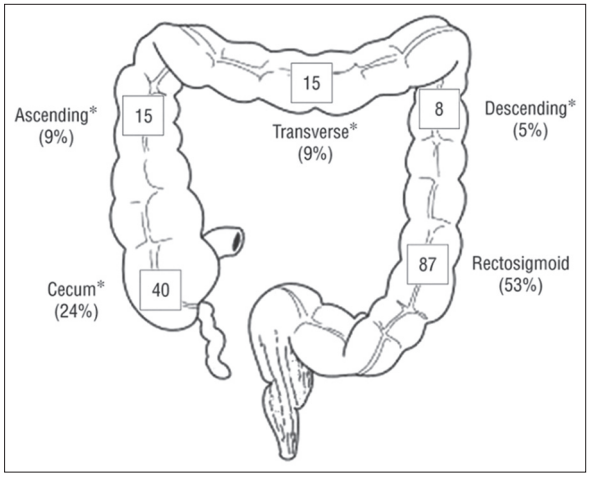

Figure 2: Common sites of colonoscopy-related perforation – reprint from Iqbal CW *et al*. Arch Surg 2008;143 (7):701-707 (with permission)

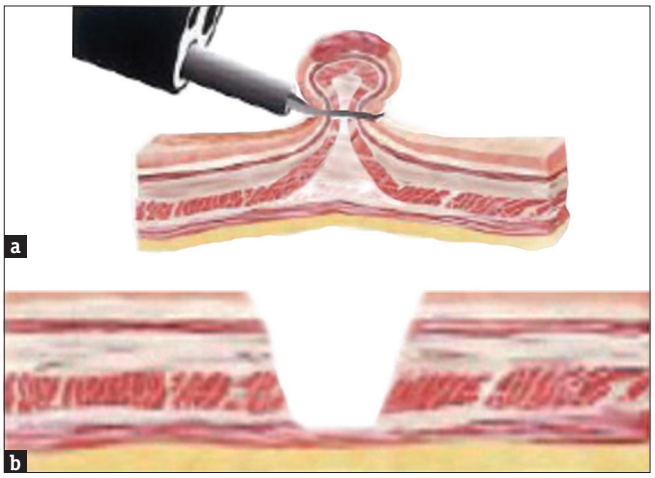

Figure 3: (a and b) Endoscopic snaring of a polyp with resultant colonic wall defect/perforation

perforation should be assessed and identified. Keeping the patient "nil by mouth," administering intravenous antibiotics, intravenous fluids, and adequate analgesia are essential supportive measures to be carried out. It is recommended that any pneumoperitoneum should be treated immediately with percutaneous aspiration using a standard large bore intravenous cannula.[11] [Figure 5a and b]

Endoscopic Therapy for Colonic Perforation

Endoscopic clipping can be attempted and surgical intervention is needed if there is failure of closure. Conventionally, colonic perforations have been managed surgically. However, with recent advances and increasing usage of endoscopic clips, this has been the management of choice before one decides for surgical therapy. The decision for endoscopic therapy depends on the cause of injury, endoscopist's experience, size of the defect, and the availability of accessories needed. Closure of the mucosal and submucosal layers by endoscopic clips appears to be sufficient to avoid spillage of colonic content and subsequent need for surgery.[21] Several case series have now been published globally of individual centers experience with endoscopic clipping for colonic perforation – this has been summarized in Table 1. The average success rate of endoscopic clipping for colonoscopy-related perforation appears to be between 70% and 80%. However, this depends generally on the type of colonic perforation – namely whether it is a diagnostic versus therapeutic procedure-related perforation. In one case series, the success rate of endoscopic clipping in diagnostic colonoscopy-related perforation is only between 17% and 48%, in contrast to a 75% and 80% success rate in therapeutic colonoscopy-related perforations.[14]

At present, there are two main types of clips used in closing colonoscopy-related perforations – through-the-scope clips (TTS) and over-the-scope clips (OTSC).

Through-the-Scope Clips

TTS clips [Figures 6 and 7a, b] are most effective for defects of <1 cm. For defects between 1 cm and 2 cm, multiple clips may be needed. At present, there are several commercially available clips in the market, all of which are suitable for TTS clipping: Quick clip (Olympus, Tokyo, Japan), Instinct clip (Cook Medical, USA),and the Resolution Clip (Boston Scientific, USA).[33] Regardless of the brand of TTS clips, several practical tips have been shown by experts to improve the success rates of clipping following colonic perforation as follows:

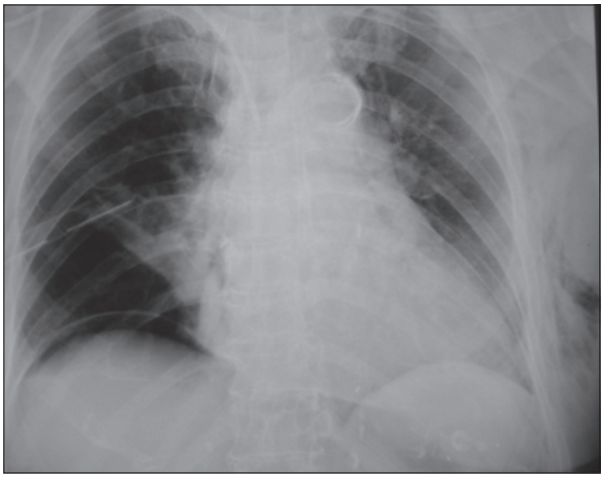

Figure 4: Gas under the diaphragm and pneumothorax identified by chest X-ray following colonoscopy-related perforation

Figure 5: (a and b) Pneumoperitoneum in a patient following colonoscopy-related perforation and percutaneous aspiration with a standard large-bore intravenous cannula

Table 1: Summary of case series' reporting endoscopic clipping for colonoscopy-related perforation

Studies	Study type	Colonic perforations (*n*)	Attempted endoscopic clips	Failure of closure	Overall success rate (%)
Voermans *et al*., 2012[22]	Prospective	13	13× OTSC	1	92.3
Magdeburg *et al*., 2013[4]	Retrospective	105	71	12	83.1
Chan *et al*., 2013[16]	Retrospective	12	5	1	71.4
Cho *et al*., 2012[23]	Retrospective	32	29	7	76
Kim *et al*., 2013[24]	Retrospective	27	16	3	81
An *et al*., 2016[25]	Retrospective	109	31	10	70
Shin *et al*., 2016[5]	Retrospective	41	9	3	78
Honegger *et al*., 2017[26]	Retrospective	56	56× OTSC	6	90.3

OTSC=Over-the-scope clips

- Use of rotatable clips
- Clips which allow to open and close several times
- Use of transparent hood (cap) on the tip of the scope (for better visualization)
- Use of multiple clips

Most of the case series published have used TTS clips, as it is readily available, simple to use, and relatively inexpensive. Nevertheless, as mentioned above, the efficacy of TTS clips is reduced when the perforation defect is large.[14,21]

Over-the-scope clips

The OTSC [Figure 8] consists of a large clip mounted on a cap/transparent hood that is friction attached over the tip of the endoscope. It has a clip releasing mechanism through a string to close the tissue defect. It is able to grasp a deeper layer of tissue compared to TTS clips and close larger perforation defects between 2 and 3 cm.[21,27] However, the reported efficacy of the OTSC in colonic perforations is relatively small. In a series of 56 colonic perforations, the OTSC was reported to have a 90% success rate.[21] In a study by Honegger *et al*., 262 OTSC were used in 233 endoscopic procedures for various indications, of which 72 were for gastrointestinal perforations. The overall success rate was 90.3%.[26] A systemic review on the usage of OTSC for GI perforations reported a success rate of 57% to 100%.[28] Although the OTSC may be superior to TTS clipping for larger perforation defects, it has several disadvantages. It is cumbersome to use, not readily available in most endoscopy units and is expensive.

Stenting

Endoluminal self-expandable metal stents (SEMS) have been frequently used for upper gastrointestinal perforations, particularly in the esophagus. In a systemic review of 25 evaluated studies, endoluminal stent placement was shown to be effective, with a clinical success rate of 85%.[29] There is a lack of data about use for colonic perforations. In a case report of an iatrogenic colonic perforation from stricture dilatation in an 82-year old male, placement of a fully covered SEMS stent was able to seal the perforation successfully.[30] Clinical evidence of SEMS usage in colonic perforation is otherwise limited. However, the utility of SEMS for managing colonic perforations would be limited in a nonstricture situation, as the possibility of covered stent migration would be high. At present, all approved colon SEMS are uncovered (in the USA) and hence usually not used for perforations. Covered esophageal SEMS used for colon perforation on an off-label use, if needed.

Endoscopic Suturing

Endoscopic suturing has emerged as a promising modality in closing colonic mucosal and submucosal defects. The Overstitch™ Endoscopic Suturing System by Apollo Endosurgery Inc. is currently the only commercially available device for this purpose. At present, there is limited evidence pertaining its use in colonoscopy-associated perforations. A retrospective, single-centered study was able to show successful closure using the Overstitch™ in 14 of 16 patients (87.5%)

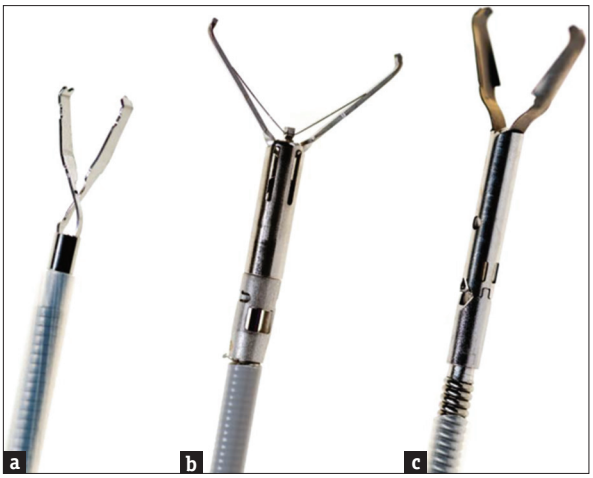

Figure 6: Different types of through the scope clips. (a) Quick clip (Olympus, Hamburg, Deutschland); (b) Instinct clip (Cook Medical, Limerick, Ireland); (c) Resolution clip (Boston Scientific Germany, Ratingen, Germany) Reprint from Goelder *et al*

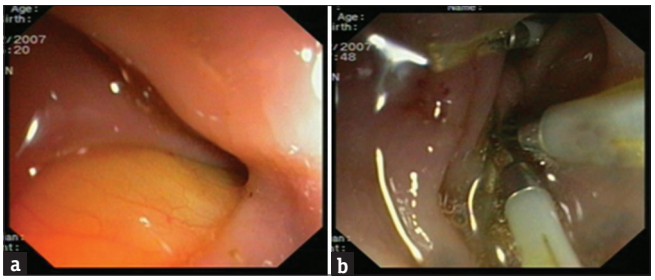

Figure 7: (a) Colonic perforation defect with visualization of intraperitoneal fat tissue. (b) Closure of defect using through-the-scope clips

Figure 8: Over-the-scope clip (Oversco, Tübingen, Germany)

with colonoscopy-associated perforations and avoiding the need for rescue surgery. Majority of these patients, however, underwent ESD/EMR with a mean perforation size of 5.6 mm.[31] Nonetheless, it appears that endoscopic suturing provides a feasible alternative and equally effective treatment compared to endoscopic clipping. Similar to the OTSC, the level of expertise, availability of the device, and cost may limit its usage.

When endoscopic clipping fails

As mentioned before, this review does not aim to provide an exhaustive review of surgical techniques in the management of colonoscopy-related perforation. However, surgery is still the main salvage option when endoscopic clipping fails to seal a colonic perforation. Previous reviews and experts have indicated that surgical therapy for colonoscopy-related perforation is more likely to be needed in the following situations:

- Failure of endoscopic closure
- Suspicious of peritoneal contamination of bowel contents
- Presence of peritonitis
- Larger perforations usually >30 mm.

As highlighted before, diagnostic colonoscopy-associated perforations usually require surgical intervention,[4,5,11,25] mainly as the perforation defects tend to be too large to be sealed by clipping alone. Primary surgical repair can be seen in 29% to 55.6% of patients and between 10% to 28.6% needing rescue surgery after failure of endoscopic clipping.[5,15,16,25] Surgical closure can be achieved either laparoscopically or by laparotomy. Primary closure by surgical methods usually results in good outcomes. In severe cases, colonic diversion, resection or a Hartmann's procedure may be necessary. Laparoscopic surgery has been increasingly used as the preferred method of surgical therapy. Its minimally invasive approach results in lower morbidity, fewer complications, and a shorter hospital stay.[32]

Economic and clinical consequences of endoscopic therapy versus surgery

In general, the cost of hospitalization is significantly higher in those who undergo surgery compared to endoscopic clipping. The length of hospital stay post intervention is comparatively longer for those who are managed surgically. In a study from Malaysia, Chan *et al*. were able to compare the cost of colonoscopy-related perforations which were treated endoscopically initially versus those referred to surgery immediately following a diagnosis. The authors in this study reported that the cost of surgery was two times greater than endoscopic clipping (USD 3281 vs. USD 1481), and the duration of hospital stay is longer in the surgery group (13 days vs. 9 days).[16] In another European study, Magdeburg *et al*. reported a significantly longer hospital stay for patients who had surgical intervention compared to endoscopic clipping as the initial strategy (16.7 days vs. 4 days).[4] Sung Bak An *et al*. reported the length of hospitalization of up to 31 days in patients who needed surgery after failure of endoscopic clipping.[25] Mortality rate of those who needed surgery is usually higher with a rate of 5.71% to 8.6% compared to those who do not. Similarly, rate of complications and morbidity is significantly higher in those who required surgery.[12,25] As a result of these data and the recognized efficacy of endoscopic clipping for colonoscopy-related perforations, the recent ESGE guidelines have recommended that endoscopic therapy should be attempted in all cases of colonoscopy-related perforation as the initial step in definitive management.[11]

Conclusion

Colonoscopy-associated colonic perforation is an unpredictable complication which should be identified swiftly and managed appropriately. There is promising evidence pertaining to the usage of endoscopic clips as a minimally invasive treatment modality with good outcomes. If applied selectively in ideal situations (early recognition, perforation defect of <30 mm, readily availability of clipping devices, and endoscopist experience), closure of the defect can be achieved with optimal success. Although avoidance of surgery can be achieved in a fraction of uncomplicated cases, it is still indicated in patients who failed endoscopic therapy and those who show signs of overt peritonitis and clinical deterioration.

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Conflicts of interest

There are no conflicts of interest.

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