Colonoscopic Complications: Colonic Perforations

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Refer to Algorithm in Fig. 84.1

A. Colonoscopy is one of the most frequently performed medical procedures. Its use is predicated upon the ability to diagnose diseases of the colon and identify premalignant lesions by visual inspection. In addition, such lesions can most often be excised or destroyed to prevent progression to malignancy. While the procedure has become routine throughout the world, complications continue to occur. Iatrogenic perforation is both the most frequent and serious of major complications. Recent estimates from large multicenter trials and databases estimate perforation to occur in 0.015–0.24% of all colonoscopies. Perforation rates increase to near 0.1% when restricted to only colonoscopies that include therapeutic interventions. The procedure most likely to produce a perforation is endoscopic submucosal dissection (ESD), with rates around 5%. While early studies estimated mortality up to 5% with iatrogenic perforations, that number has decreased to less than 1 in 1000 in more recent larger studies.

Prior to discussing management of iatrogenic colonic perforations it is important to have a conceptual framework of the etiologic mechanisms related to colonoscopy that lead to such perforations, as this can inform the appropriate options for management. Perforation may result from a variety of injury mechanisms that may occur during colonoscopy. Some of these mechanisms are common to any colonoscopy, whether undertaken for diagnostic or therapeutic intent, others are specific to therapeutic techniques and devices. Errors in technique that can lead to perforation with any colonoscopy included barotrauma, direct trauma from the scope tip, blind advancement, and bowing or looping. Inadequate bowel preparation can provide a more injury-prone environment. Devices used for hemostasis, biopsy and polypectomy can lead to tissue trauma and add additional risk of perforation. Recent advances in techniques of endoscopic resection have pushed the frontier of the size and type of lesions that can be endoscopically addressed, including endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD) and submucosal tunneling; however larger areas of resection are associated with larger areas of weakness and greater rates of perforation. Perforation management is

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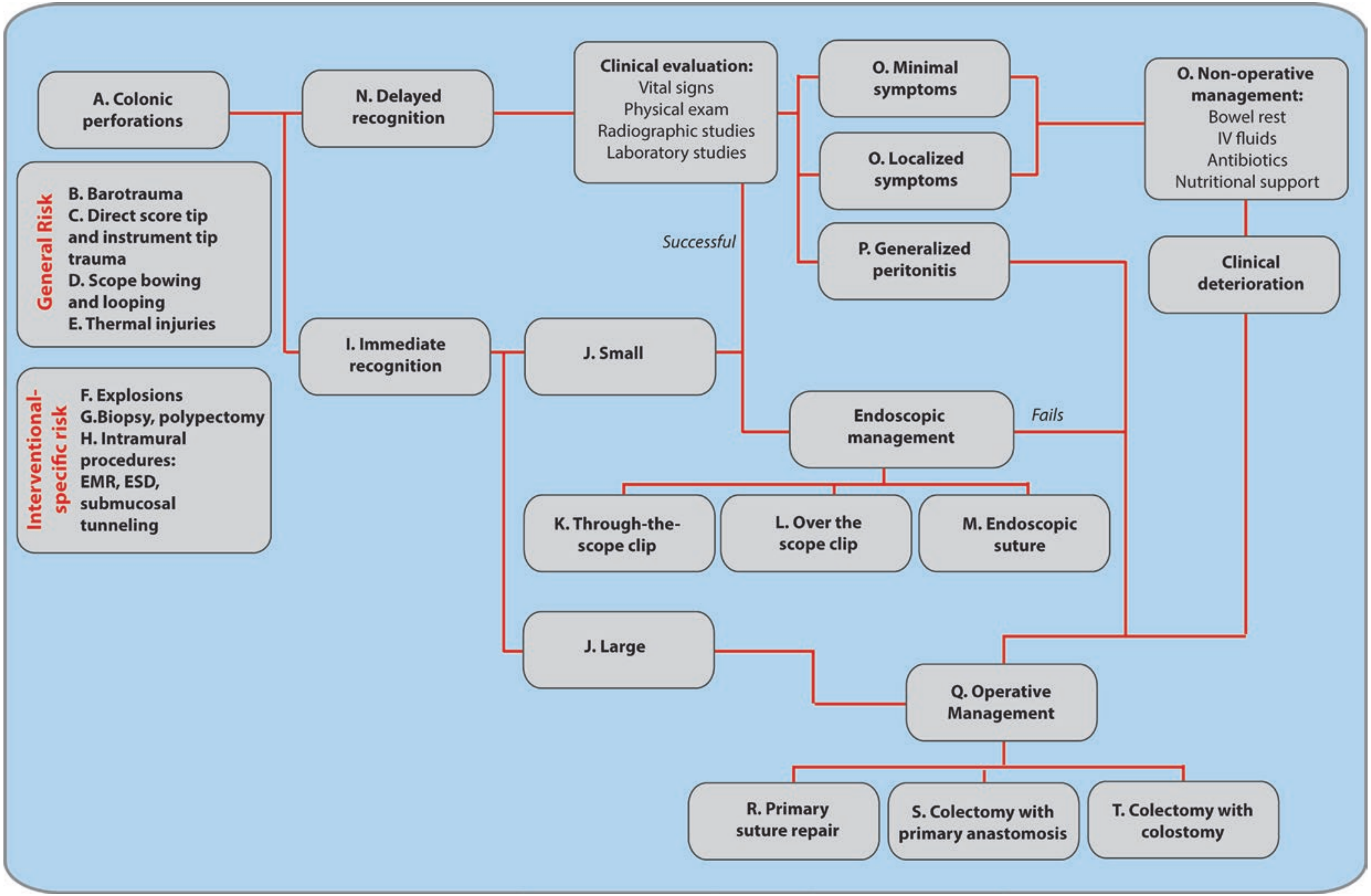

Fig. 84.1 Algorithm for colonic perforations. *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection

based on patient condition, time of recognition, and extent of injury (see Fig. 84.1).

B. Iatrogenic perforation due to barotrauma results from aggressive insufflation. Thankfully, barotrauma is easily preventable by both minimizing insufflation, and/or use of carbon dioxide insufflation. Conditions predisposing to barotrauma include prolonged procedures, poor bowel preparation, strictures, or obstructing lesions. In cases where multiple strictures are present, gas can become trapped between the narrowed areas and quickly lead to over distension and perforation. Barotrauma related perforations are often large and are difficult to endoscopically manage.

C. Perforations due to pressure from the endoscope tip may occur when the scope inadvertently enters a diverticulum, or is blindly advanced against the colonic wall. These perforations tend to be small, often smaller than the scope diameter. Maintaining a view of lumen should prevent this type of injury.

D. Scope looping and bowing can introduce longitudinal injuries to the colonic wall. While most injuries of this type only affect the mucosa, aggressive maneuvering can lead to transmural injuries. Tears that result tend to be large linear tears, and most often occur in the sigmoid secondary where the scope is also most likely to form loops. Longitudinal tears are generally difficult to endoscopically close and best dealt with surgically. Early surgical intervention, when indicated, will often permit primary repair of the colon.

E. Thermal injuries can occur by means of several different therapeutic technologies available for use through the colonoscope. Electrocautery used for hemostasis or resection can be monopolar electrocautery, hot biopsy forceps, hot snares or bipolar coagulators. These devices utilize electrical current applied to a resistive metal tip to generate heat. The endoscopist must recall that that the instrument remains hot, and capable of tissue injury, even after the current is turned off. Thermal energy spread, and as such, thermal tissue damage spreads radially from the instrument tip and can cause thermal injury over a much broader area than intended. It is not uncommon for these injuries to create large perforations with a delayed presentation. Argon plasma coagulation (APC) is used primarily for hemostasis. Hot plasma generated from argon gas provides a narrowly targeted area of high temperature. However, the concentrated high temperature can easily cause thermal injury to deeper levels of tissue. In addition to thermal injury, these when the tip of electrocautery or APC devices is allowed direct tissue contact the destroyed tissue can coagulate around the tip of the device, which when freed can lead to traction injuries.

F. An extreme example of thermal injury relates to inadequate preparation. Prior to colonoscopy, typically colonic contents are purged with laxatives, cathartics or osmotic agents. Underappreciated is the fact that colon preparation evacuates not only solid components, but also explosive methane and hydrogen gases produced by colonic bacterial flora from ingested fermentable compounds. If these gases are not adequately evacuated prior to the introduction of electrocautery or APC, the thermal energy is sufficient to cause ignition of these gases and resultant explosion. When inadequate preparation is noted during the examination, no attempt to utilized electrosurgical instruments should be entertained. Therapeutic maneuvers requiring cautery should be re-scheduled after adequate preparation. Thankfully, such occurrences are extremely rare, and there are only nine cases reported in the literature. Explosions and perforations that result from gas explosions can cause tremendous damage to the colon and other organs and should be managed rapidly in the operating room.

G. Many perforations are related to the combination of devices used for biopsies and polypectomy. Cold forceps and cold snares are appropriate to use for mucosal biopsies and for polyps under 1 cm, and infrequently lead to perforations. Hot forceps and snares are used for removal of larger polyps. There continues to be debate about which mode of current delivery (blend vs pure coagulate) is safer in terms of achieving adequate hemostasis and lower perforation risk. Post polypectomy syndrome describes transmural thermal injury that presents in a delayed manner after use of electrosurgical devices for polypectomy. Apart from thermal injury, perforations can result from excessive amounts of tissue being bunched into snares. The majority of perforations related to polypectomy occur in the cecum and ascending colon, presumed to be due to a thinner colonic wall.

H. EMR has been widely adopted to accomplish endoscopic resection of larger polyps. In EMR, saline or other fluids are injected into the colonic wall to provide a fluid cushion between the mucosa and deeper layers of the colon wall, followed by resection with a snare. This is particularly useful for sessile polyps. For lesions larger than 2 cm, a piecemeal resection is recommended to reduce the risk of perforation. ESD similarly begins with fluid elevation, but resection is accomplished by circumferential and deep dissection with a needle knife instrument in the submucosal plane. While this allows for complete resection of larger polyps, it leaves a large area of mural weakness. Recently, submucosal tunneling and dissection has been adapted to facilitate resection of intramural tumors of the colon. While both EMR and ESD confer additional risk of perforation, these perforations tend to be smaller than perforations that occur during diagnostic colonoscopies because they most often occur from injury with the small electrosurgical knives, which are typically 1–3 mm in diameter. Because of their small size, perforations occurring during ESD and EMR may be better amenable to endoscopic management.

I. Management of iatrogenic perforations is first dependent on recognition of an injury. In some cases perforations are obvious on endoscopy. Severe abdominal pain, hemodynamic changes and difficulty maintain colonic insufflation suggest the presence of a perforation during the procedure. Minimizing insufflation and/or switching to carbon dioxide insufflation at that point is prudent. Unfortunately, only around 25% of perforations are recognized at the time of colonoscopy. When noted at the time of colonoscopy, endoscopic techniques are available to attempt management for some perforations. The majority of lesions that either elude detection during colonoscopy, are recognized within 24 hours (~75%) of colonoscopy. The balance presenting by 96 hours (4 days) after the procedure with rare exceptions up to 2 weeks. Management of these perforations is typically not endoscopically pursued, and is dependent on the patient's clinical picture, symptoms and size of the perforation.

J. When perforation is recognized during the procedure, the endoscopist must assess the extent of injury and consider the modalities available to endoscopically address the perforation as well as comfort and skill to do so. Any time fat or muscle fibers are seen, a perforation likely exists. Some describe a "target sign" where the rings are comprised of the interfaces between the mucosa and submucosa and then the submucosa and muscularis propria, which may also include fat. This sign indicates that perforation is at least impending, if not already occurred. Typically lesions less than 1–2 cm in size are amenable to endoscopic management, with techniques discussed below. Large perforations and longitudinal injuries are best managed surgically. Two cautionary caveats to attempting endoscopic management should be noted. First, spillage of even modest amount of luminal contents should prompt surgical consultation. Secondly, the edges of the perforation must be free from other pathologies. Attempting to re-approximate tissue edges that themselves have thermal damage, are fibrotic or carry the possibility of residual malignancy are ill-suited to endoscopic management and better managed surgically, even when small. Rapid involvement of a surgical team in these circumstances limits spillage of intraluminal contents and bacterial migration, thus increases the likelihood primary suture repair can be accomplished. Failure of endoscopic management should prompt surgical repair.

Successful endoscopic management is predicated on the availability of the appropriate endoscopic instruments, and the comfort of the endoscopist in using them. Generally, three modalities present themselves as options, and they can be used alone or in combination. These modalities are through the scope clips, over the scope clips and endoscopic suturing. The latter two require removal of the endoscope for device assembly. Re-identification of the perforation is not always possible, especially if the perforations are within areas of natural flexion within the colon. Marking with tattoos or through the scope clips can be useful.

When endoscopic modalities are employed, effective closure of the perforation is often possible. However, patients should continue to be observed, including frequent assessment by physical exam and/or radiography. An antibiotic to cover enteric bacteria, including anaerobes, is generally indicated. Progression to peritonitis, or any sign of clinical deterioration should lead quickly to surgical exploration and repair.

K. Deployable metallic clips delivered through the working channel of the endoscope are a popular option (see Fig. 84.2c). In the absence of comparative study of through the scope clips, selection should be based on availability and the preference of the endoscopist. Clips can be sequentially deployed and are best suited to more linear lesions. When multiple clips are used, they should be placed close together to avoid small gaps and dog ears where tissue is less effectively approximated. Techniques to aid in successful closure include the use of a scope cap to better approximate tissue edges prior to clip application, and working from left to right and top to bottom if possible.

Several manufacturers produce through the scope clips, each with subtle variations in the width of jaw opening, ability to rotate, and retention time in the tissue. Some of the

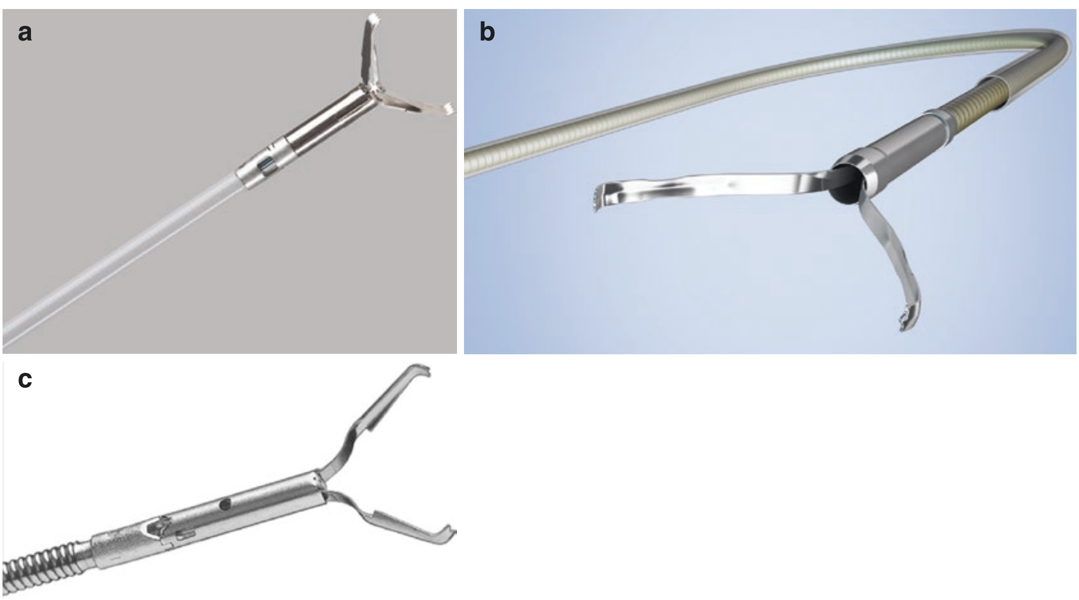

Fig. 84.2 (**a**) Instinct™ (Permission for use granted by Cook Medical, Bloomington, Indiana) through the scope clip; (**b**) QuickClipPro™ (Olympus America, Center Valley, PA) through the scope clip. Reused with permission from Olympus; (**c**) Resolution™ (Boston Scientific, Boston, MA) through the scope clip. (Images provided courtesy of Boston Scientific Corporation)

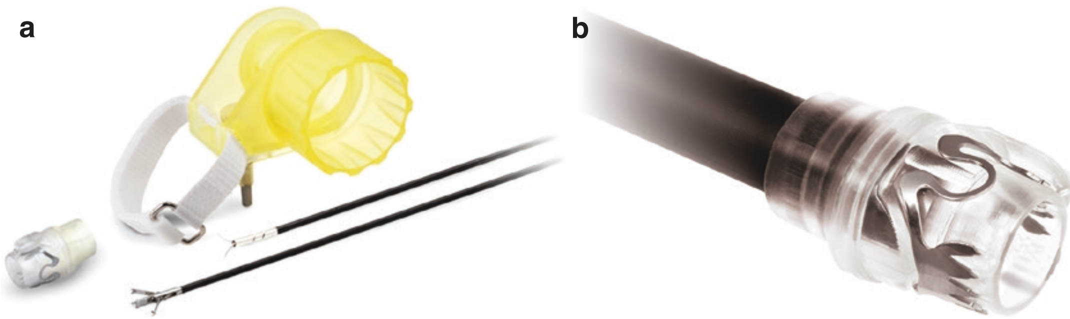

Fig. 84.3 (**a**) Components to assemble and deploy OTSC® clip (Ovesco Endoscopy USA Inc., Cary, NC); (**b**) Deployed OTSC® clips (Ovesco Endoscopy USA Inc., Cary, NC)

commercially available devices in the United States include Instinct™ (Cook Medical, Bloomington, IN) (Fig. 84.2a), QuickClip2™ (Olympus America, Center Valley, PA), QuickClipPro™ (Olympus America, Center Valley, PA) (Fig. 84.2b), and Resolution™ (Boston Scientific, Boston, MA) (Fig. 84.2c).

L. Over the scope clips, also known as bear claw clips, resemble the jaws of a bear trap (see Fig. 84.3a). They are deployed from a clear cap applied to the tip of the endoscope, controlled by a string that must be fed through the working port. A grasper can be used as an aid to tissue positioning prior to clip deployment. Larger lesions can be successfully managed with over the scope clips, but serial deployment is difficult. It is important to reiterate that, as opposed to through the scope clips, over the scope clip requires removal of the endoscope for device assembly. This increased risk of injury on re-introduction, and also runs the risk of being unable to locate the perforation at repeat endoscopy. Currently there is only one clip of this type available in the United States, OTSC® (Ovesco Endoscopy USA Inc., Cary, NC). Figure 84.3a demonstrates the various components of the OTSC® system. Figure 84.3b is a magnified image of the two of the clips in their deployed state. Note that the shape of the teeth differs, and shapes are specialized for specific uses and applications.

M. Endoscopic suturing is a third technique for endoscopic management, but probably requires the greatest technical ability to successfully utilize. There is only one commercially available device in the United States, the OverStitch™ (Apollo Endosurgery, Austin, TX). The OverStitch™ has multiple components utilized through a dual channel endoscope, including a portion that must be applied to the tip of the scope. A retrievable curved needle places a suture with the assistance of an auger-like device to stabilize the tissue. The suture is secured by T-fasteners at either end. The greatest advantage of endoscopic suturing is the ability to approximate irregular edges or larger lesions. The two major disadvantages are the need to remove and reinsert the colonoscope to assemble the device, and the high degree of technical acumen needed to master this intervention.

N. The presence of hemodynamic instability, high fever, and/or generalized peritonitis typically obliges surgical exploration. If the patient is hemodynamically stable and has minimal or only focal symptoms, an abdominal plain film is a useful adjunct, as long as it includes a lateral decubitus or upright film.

O. Patients with minimal symptoms generally have very small perforations with no spillage of colon contents and quickly seal. Focal peritonitis suggests a larger perforation, contained by the omentum and the surrounding abdominal structures. Non-operative management is appropriate for these patients, and often successful. Non-operative management includes bowel rest, intravenous fluid resuscitation and antibiotics that will cover potentially pathogenic colonic flora, including anaerobes. While nutritional support with intravenous nutrition may be helpful, symptoms generally resolve or patients warrant surgical intervention prior to this being indicated. However, most patients were calorie deprived for 1–2 days prior to colonoscopy due to colon preparation, so earlier implementation of intravenous nutrition can be entertained. Frequent reassessment with physical exam, and/or abdominal X-ray is essential if non-operative management is pursued. Any evidence of clinical deterioration, or more extensive peritonitis should prompt surgical exploration.

P. Generalized peritonitis or large pneumoperitoneum on abdominal plain film generally warrants operative exploration. These findings suggest large perforations and/or large amount of spillage of intraluminal contents. Source control is the primary objective to limit abdominal sepsis and associated morbidity and mortality.

Q. When operative intervention is indicated, laparoscopic exploration is possible, and the presumed mechanism of perforation may aid in the decision in operative approach. Here discussion between the endoscopist and surgeon, if different providers, is beneficial. Small perforations that result from polypectomy, ESD or EMR can often be laparoscopically managed. If laparoscopic management is to be attempted a rectal tube can aid in reducing colonic distension and increase working space. Large perforations, multifocal injuries, unclear location of injuries, or significant spillage may be better addressed with exploratory laparotomy. Once perforations are identified, size, location, the condition of the tissue and contamination aid in determining appropriate methods to address the perforation. Thankfully, colonic prep generally limits luminal spillage, and resultant complications.

R. Small perforations, which are the most common, can often be repaired primarily with suture. The edges of the wound should be debrided to healthy tissue. Closure can be completed in single or double layer. With this technique, care should be taken not to significantly narrow the lumen.

S. Colectomy with anastomosis is appropriate if there is minimal contamination

Larger injuries that are associated with minimal contamination can be treated with segmental resection and primary anastomosis. Anastomotic technique should be dictated by the location of the perforation.

T. Excessive contamination, ischemic colonic segments, large injuries or operative delay may necessitate colectomy with an ostomy.

Colonoscopy has been and continues to be an outstanding asset in the diagnosis and therapy of colonic disease. Endoscopists and surgeons must be cognizant of the proper preparation for and conduct of the procedure and be prepared to recognize and treat its complications when they occur.

Suggested Reading

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