Advanced Techniques in Therapeutic and Inflammatory Bowel Disease Colonoscopy

Alexander Worix, MD[a], Rajesh N. Keswani, MD, MS[b,*]

KEYWORDS

- Colonoscopy • Endoscopy • Therapeutic interventions
- Inflammatory bowel disease • Crohn's disease • Ulcerative colitis
- Imaging modalities

KEY POINTS

- Topical (dye-based) chromoendoscopy and high-definition/virtual chromoendoscopy have improved the identification and differentiation of neoplastic from nonneoplastic lesions.
- Confocal laser endomicroscopy and optical coherence tomography use real-time assessment of mucosal inflammation aiding in targeted biopsy and treatment strategies in inflammatory bowel disease (IBD).
- Endoscopic mucosal resection and endoscopic submucosal dissection are essential for achieving complete lesion eradication and mitigating the risk of disease progression.
- Self-expanding metal stents are a valuable and effective alternative to surgical interventions for colonic obstruction and refractory strictures in IBD.
- Multiple colonoscopic interventions regarding stricture, fistula, and abscess management offer numerous advantages over traditional surgical approaches.

INTRODUCTION

The pursuit of technological innovation and clinical excellence has propelled endoscopy to the forefront of modern medicine, revolutionizing the diagnosis, treatment, and prevention of myriad diseases. From its simple beginnings as a visual inspection tool, endoscopy has evolved into a multifaceted discipline, encompassing a diverse array of imaging modalities, therapeutic interventions, and emerging applications. Cutting-edge imaging technologies also provide unprecedented clarity to

[a] Hospital Medicine, Northwestern Feinberg School of Medicine, Chicago, IL, USA; [b] Division of Gastroenterology, Northwestern Feinberg School of Medicine, Chicago, IL, USA
* Corresponding author. 676 North Street Clair, Arkes Suite 1400, Chicago, IL 60611.
E-mail address: rkeswani@nm.org

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innovative therapeutic techniques that offer minimally invasive approaches to traditional surgery.

Within endoscopy, advances in colonoscopy techniques continue to expand the role of colonoscopy in the management of gastrointestinal diseases. Today, colonoscopy encompasses a wide array of interventions, including neoplasia identification, mucosal resection, and stricture dilation. These interventions not only offer patients a less-invasive alternative to traditional surgery but also facilitate faster recovery times and reduced hospital stays.

Advances in endoscopy also revolutionized the management of inflammatory bowel disease (IBD). The chief concern within ulcerative colitis (UC) is the detection of neoplasia prior to colorectal cancer (CRC) development. Despite regular screening, patients with UC remain at a 2 to 3 fold increased risk of developing CRC than the general population.[1,2] In contrast, Crohn's disease (CD), characterized by its transmural inflammatory process, can lead to multiple additional complications including sinus fistulas or abscesses[3] as well as fibrotic strictures.[4,5] Therapeutic endoscopy has provided options to address the complications of IBD including fistulas, abscesses, and strictures. In addition, imaging tools have emerged to improve lesion detection and characterization to detect dysplasia prior to development of cancer.

This review provides an overview of recent advances in colonoscopy techniques and technologies with a special focus on the intersection of colonoscopy and IBD. Understanding that there are a broad array of colorectal disease benefiting from advances in colonoscopy, we seek to describe the evolving landscape of colonoscopy practice.

ADVANCED IMAGING MODALITIES

In recent years, remarkable advancements in endoscopic imaging modalities have reshaped the landscape of gastrointestinal disease assessment, particularly in evaluating mucosal inflammation and dysplasia. Among these innovations, virtual chromoendoscopy, most commonly narrow-band imaging (NBI), has emerged as a transformative approach, improving the identification and differentiation of neoplastic from nonneoplastic lesions (Fig. 1).

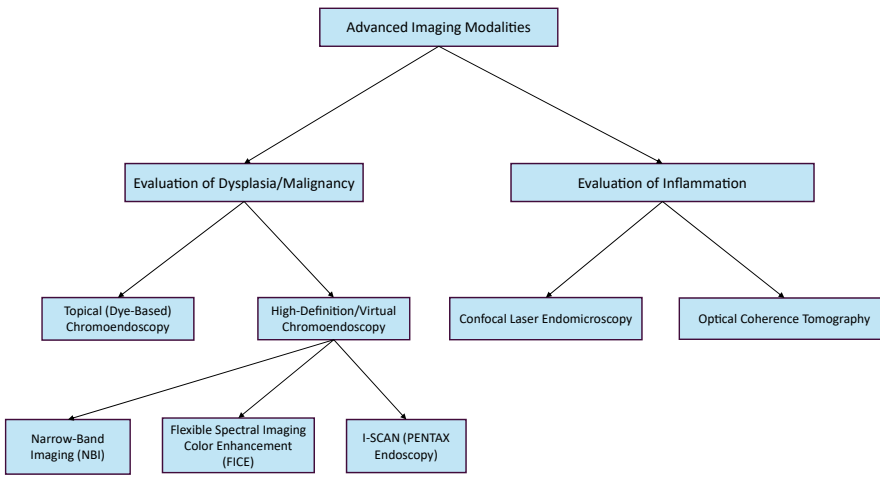

Fig. 1. Options for advanced imaging modalities in colonoscopy. Modalities are categorized by either evaluation of dysplasia/malignancy versus evaluation of inflammation.

High-Definition Endoscopy and Chromoendoscopy

High-definition (HD) endoscopes were introduced in the mid-2000s, offering state-of-the-art optics and digital imaging capabilities and represented a transformative leap in gastroenterological diagnostics. While they are considered "standard of care" currently, it is illustrative to understand how this improvement in imaging has altered colonoscopy.

Patients with chronic inflammation of the large bowel from IBD are at increased risk of developing colitis-associated neoplasia (CAN).[6] Patients with colitis, whether due to CD or UC, have a significant risk for CAN development.[7] Recent guidelines emphasize careful endoscopic inspection of the colonic mucosa using HD colonoscopies as essential in this patient population.[6] Additionally, the application of imaging techniques such as chromoendoscopy enhances lesion detection and characterization, offering the opportunity of endoscopic identification and management of CAN and avoiding colectomy.[8]

Chromoendoscopy is broadly divided into topical (dye-based) and virtual chromoendoscopy. Studies have investigated the utility of virtual chromoendoscopy using NBI in the setting of IBD. While earlier studies did not show a significant benefit compared to conventional colonoscopies,[9] newer data support the effectiveness of either dye-based magnifying chromoendoscopy or HD colonoscopy with virtual chromoendoscopy.[10,11] There are limited data comparing dye-based versus virtual chromoendoscopy. A multicenter study by Bisschops and colleagues[12] evaluated the diagnostic accuracy in patients with long-term UC undergoing surveillance using traditional methylene blue chromoendoscopy versus virtual chromoendoscopy with NBI. Diagnostic accuracy of neoplastic lesions based on the presence of pit pattern was significantly higher for NBI in comparison to chromoendoscopy.

Virtual Chromoendoscopy

NBI is an established endoscopic technology designed to enhance visualization of mucosal surface structures and microcapillaries.[13] Leveraging optical filters to emit sequential green and blue illumination, NBI achieves tissue illumination within select narrow wavelength bands, thereby accentuating the contrast between vascular structures and the surrounding mucosa.[13,14]

The diagnostic ability of NBI in discerning colorectal neoplasia, both in patients with and without concomitant IBD, surpasses that of conventional colonoscopy and is on par with dye-based chromoendoscopy.[15] A meta-analysis by East and colleagues affirms NBI's accuracy and high diagnostic precision for neoplasia diagnosis across diverse organs, including the colon, esophagus, duodenal ampulla, and lung.[16] Specifically with regard to CRC detection, the heightened mucosal contrast afforded by NBI has been shown to improve the detection of colon polyps compared to standard white light colonoscopy.[17]

Significantly, NBI has an essential role in dysplasia detection among patients with long-standing UC. Detection of CAN is more challenging as the neoplasia tends to be nonpolypoid and colonoscopies have difficulty differentiating neoplasia from inflammation. However, use of NBI improves diagnostic accuracy and polyp detection in clinical studies. A retrospective study by Akiyama and colleagues[18] demonstrated that dysplastic lesions in patients with UC can be recognized as "demarcated, red-colored areas with increased vascular densities" on NBI. These lesions were found to be histologically consistent with low-grade or high-grade dysplasia. Other studies reported that NBI can classify different capillary patterns that had a sensitivity of 72.2% and a specificity of 85.7% to diagnose high-grade dysplasia or submucosal

deep invasive carcinoma in patients with UC.[19] However, conflicting data exist. A systematic review and meta-analysis revealed that the sensitivity and specificity of NBI to discriminate neoplasia from nonneoplastic lesions were 0.64 (95% confidence interval [CI], 0.50–0.77) and 0.74 (95% CI, 0.69–0.79), respectively.[20] Though the exact benefit concerning CAN detection compared to standard white light colonoscopy remains uncertain, the collective body of evidence emphasizes NBI's benefit in the monitoring and treatment of CAN.

While the majority of research has focused on the role of NBI in neoplasia detection, recent advancements have brought forth alternative modalities such as flexible spectral imaging color enhancement (FICE) and i-SCAN.[21] FICE, pioneered by Professor Yoichi Miyake from Tokyo, employs a sophisticated processing circuit to estimate various pixelated spectrums within captured images. Noteworthy studies, such as a randomized cross-over trial by Pohl and colleagues, have compared FICE with dye-based chromoendoscopy for the detection of high-grade dysplasia. FICE exhibited a nonsignificant improvement in sensitivity (92% vs 83%), suggesting comparable performance between the two modalities.[22]

Similarly, i-SCAN (PENTAX Endoscopy), offers an additional digital postprocessing image enhancement technology. i-SCAN enhances endoscopic images with digital contrast, offering an improvement over conventional white-light endoscopy.[23] More recent work has evaluated the combination of both optical and dye-based chromoendoscopy. A recent study by Lipman and colleagues demonstrated the benefit of i-SCAN in dysplasia when combining optical chromoendoscopy using acetic acid. Results showed that this augmentation substantially improved the accuracy of the i-SCAN classification system (69%–79%, $P = .01$), outperforming HD white-light endoscopy and i-SCAN alone (83% vs 76%; $P = .047$).[24]

The widespread availability of virtual chromoendoscopy heralds a new era in endoscopic imaging, offering endoscopists a powerful on-demand tool to enhance diagnostic precision and therapeutic outcomes in the evaluation of colorectal neoplasia and UC-related dysplasia. While the choice of optical chromoendoscopy modality centers on which endoscope manufacturer is utilized with an endoscopy practice, research will continue to identify the precise benefit of optical chromoendoscopy in practice.

Advanced Imaging Techniques

The emergence of advanced imaging modalities, such as confocal laser endomicroscopy (CLE) and optical coherence tomography (OCT), offers real-time assessment of mucosal inflammation at a microscopic level.[25] These techniques provide subsurface imaging with cellular resolution, offering insights into the histologic features of inflamed tissue. This facilitates targeted biopsy sampling and guides treatment strategies in patients with IBD. Importantly, CLE and OCT may alter our ability to detect dysplasia and early neoplastic lesions, enabling timely therapeutic interventions and optimizing long-term patient outcomes.

While mucosal visualization is the cornerstone of colonoscopy, this offers only a macroscopic view of colon health. CLE represents a groundbreaking advancement in the field of endoscopy, providing microscopic imaging below the epithelial surface in real-time. By incorporating a confocal fluorescence microscope into an endoscope probe, CLE enables magnified visualization of the mucosa, allowing endoscopists to assess microscopic processes during ongoing endoscopy.[26] Thus, CLE is complementary to colonoscopy offering a real-time surrogate for histopathology.

The microscopic images generated by CLE closely resemble histologic images of biopsy specimens, providing a detailed view of architectural changes characteristic

of active inflammation, especially seen in CD.[27] For instance, CLE has demonstrated the ability to identify increased epithelial gaps, indicative of elevated shedding of epithelial cells—a hallmark of mucosal inflammation in CD.[28] A study by Neumann and colleagues has shown that CLE can accurately predict disease activity, even in quiescent CD, outperforming standard white-light endoscopy by revealing inflammation in segments that appear uninflamed under conventional examination.[26]

Furthermore, CLE holds promise for enhancing surveillance of dysplasia in chronic inflammatory states through microscopic-guided targeted biopsies.[27] Unlike conventional random biopsies, which have a low yield for dysplasia detection, CLE-guided biopsies target areas of abnormal mucosa identified during endomicroscopy, thereby maximizing diagnostic yield.

Despite these advancements, further research is warranted to explore the potential of CLE in predicting sustained remission in patients with otherwise quiescent inflammatory states. Additionally, investigations are needed to assess whether CLE findings can inform treatment decisions, particularly regarding the discontinuation of anti-inflammatory therapy. Through ongoing research and clinical application, CLE has the potential to significantly enhance the management of IBD and improve patient outcomes.

OCT is capable of high-resolution, cross-sectional tomographic imaging of internal microstructures within materials and biological systems through the measurement of backscattered or back reflected light.[29] In the context of gastrointestinal pathology, OCT generates 2 dimensional data sets that delineate the optical backscattering in a cross-sectional plane through the tissue.

Transmural inflammation, the distinguishing feature of CD, poses a diagnostic challenge as biopsies are generally limited to the superficial colon layers. However, the emergence of OCT, like CLE, has revolutionized the ability of endoscopists to visualize the colonic wall with real-time, cross-sectional, high-resolution images.[30]

Recent studies have demonstrated the safety and feasibility of OCT imaging during colonoscopy, both in ex vivo and in vivo settings.[30] Shen and colleagues[31] showed in an in vivo study that OCT provides impressive diagnostic accuracy for transmural inflammation in CD, boasting sensitivity and specificity rates of 86% and 91%, respectively. Moreover, OCT imaging of colectomy specimens has confirmed the ability of OCT to identify transmural inflammation.[32] In addition, OCT's capability to scan large areas of ex vivo specimens within a short timeframe, reaching the level of the muscularis propria, enables assessment of subsurface microstructures previously inaccessibly to conventional biopsy.[30]

In conclusion, OCT represents an important technological advance in the diagnosis and management of complex diseases like IBD, but its precise role remains unclear. The ability of OCT to identify transmural inflammation and subsurface microstructures may enhance diagnostic precision and guide therapeutic decision-making with improved patient outcomes. However, this requires confirmation in clinical studies.

ENDOSCOPIC MANAGEMENT OF COLONIC DYSPLASIA/NEOPLASIA

The management of complex colorectal polyps has evolved from surgical to primarily endoscopic management. However, these lesions present challenges due to size, location behind folds, and/or nonpolypoid morphology; these polyps often require advanced polypectomy techniques. In such cases, advanced endoscopic interventions such as endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) are indispensable for achieving complete lesion eradication and

mitigating the risk of disease progression.[8] Management of complex colon polyps in the absence of colitis is covered elsewhere (Editor: Chapter).

For patients with colitis due to IBD, there is an elevated risk of developing colitis-associated dysplastic lesions and CRC.[8] The risk escalates with persistent inflammatory activity, prior dysplasia, and concurrent primary sclerosing cholangitis.[33] Previously mentioned, advanced endoscopic imaging techniques such as NBI and chromoendoscopy have emerged as vital tools in early lesion detection and cancer prevention.[9]

Advances in colonoscopy offer minimally invasive alternatives to conventional surgical approaches. These advancements not only enhance lesion visualization and characterization but also enable precise and effective intervention, thereby optimizing patient outcomes.

Endoscopic Mucosal Resection

The inflammatory milieu characteristic of colitis poses unique challenges in the delineation and resection of lesions, complicating the management of either colitis-associated or non-colitis-associated dysplasia and colorectal neoplasia. Inflammation-induced alterations in mucosal architecture and increased submucosal fibrosis render lesion identification and resection technically demanding.[34]

EMR, a technique rooted in the principles of traditional polypectomy, is pivotal in the endoscopic management of difficult dysplastic lesions. In conventional EMR, a lesion with well-defined borders is first lifted from the underlying submucosa through a submucosal injection, facilitating subsequent resection using a hot snare in either a piecemeal or in en bloc manner.[34] While conventional EMR is very effective in patients without colitis, the extensive submucosal fibrosis present in patients with colitis can make adequate submucosal injection challenging or impossible in practice.

Despite its widespread adoption, EMR is not without limitations, particularly in achieving complete excision.[35] While initial studies showed high rates of incomplete resection, recent technical advances continue to improve EMR quality.[36,37] The challenge in achieving complete excision underscores the need for meticulous lesion characterization and careful postresection surveillance to mitigate the risk of recurrence and residual disease.

A multidisciplinary approach, incorporating advanced endoscopic techniques and histopathological assessment, is essential to navigate the complexities of colitis-associated and non-colitis-associated lesion management effectively. While EMR remains a valuable tool in the endoscopic armamentarium for colitis-associated lesions, the associated fibrosis makes EMR challenging in practice.

Endoscopic Submucosal Dissection

ESD is now an established technique in the management of CAN. ESD generally is performed with initial circumferential marking of the lesion, followed by circumferential incision and then submucosal dissection using an electrosurgical knife.[8] This technique offers precise en bloc resection which may be advantageous in patients with scarring from chronic colitis, which may hinder the lifting effect observed in EMR. Recent studies have shown that majority of ESD-resected colitis-associated lesions had submucosal fibrosis contributing to non-lifting or partial lifting. Bang and Bourke and colleagues have demonstrated a lower recurrence rate of only 2% with ESD compared to 10% to 15% with EMR[38]; a meta-analysis by Wang and colleagues revealed that ESD offered a significantly higher rate of en bloc resection and a lower recurrence rate compared to EMR in average-risk patients.[39]

However, this improvement in neoplasia eradication must be balanced with the greater risk profile of ESD. While colon ESD is technically complex, it is even more challenging in the setting of fibrosis from chronic colitis preventing demarcation of the colon wall layers. While offering en bloc resection rates and lower recurrence rates, ESD is associated with a higher risk of procedure-related complications and is more time-consuming to perform. Thus, the precise role of ESD in colitis requires study.

In the West, EMR still is the first-line therapy for most CAN despite the greater recurrence rates. The choice between ESD and EMR necessitates careful consideration of lesion characteristics, provider experience, procedural outcomes, and risk of adverse events.

In summary, therapeutic colonoscopy is now essential to the management of dysplastic lesions and early-stage neoplasms. By leveraging the appropriate utilization of established techniques such as EMR and ESD, endoscopists can navigate the complexities of dysplastic lesion management balancing safety and effectiveness. When technically feasible, for visible dysplasia with distinct margins, these endoscopic procedures have replaced the traditional approach for surgical management while preserving bowel function. Continued refinement of techniques and advances in endoscopic imaging modalities are central to enhancing efficacy and safety in managing patients with IBD, optimizing patient outcomes and reducing the burden of neoplastic lesions.

ENDOSCOPIC MANAGEMENT OF STRICTURES

Colonic strictures occur due to inflammatory, postoperative, and malignant causes with management options varying based on stricture etiology. Strictures generally develop 4 to 5 years after diagnosis of CD.[40] While surgery remains an option for CD strictures, the emergence of therapeutic endoscopy has altered the treatment landscape for these complications, offering less-invasive alternatives to traditional surgical interventions.

In CD, there is sequential progression from chronic inflammation to stricture formation, followed by fistula formation and abscess formation. In the absence of effective anti-fibrotic therapy, interventional endoscopy remains essential to treatment of these complications.

Endoscopic therapy for strictures relies on fundamental principles of increasing lumen diameter which can be accomplished using balloon dilators, strictureplasty, and self-expanding metal stent (SEMS) placement.[40] Improving luminal diameter offers a minimally invasive means of symptom relief and restoration of bowel function.

Endoscopic Balloon Dilation

Balloon dilation is a prevalent and effective method for the management of gastrointestinal strictures, offering a minimally invasive yet highly effective therapeutic option. Intestinal strictures are a common complication in IBD, specifically CD, affecting approximately 30% of patients within 10 years of disease onset.[40] While anti-inflammatory therapies like anti-tumor necrosis factor-alpha antibodies have revolutionized the medical management of CD-related strictures, they may paradoxically increase the risk of stenosis.[41] Consequently, a substantial proportion of patients ultimately require interventions for severe stenosis; when surgery is performed, this can predispose them to potential complications such as short bowel syndrome[41,42] and even recurrent stricturing at the surgical anastomosis.

Endoscopic balloon dilation (EBD) is a valuable alternative for the treatment of CD-related strictures, offering a less invasive approach with favorable safety, efficacy, and

patient satisfaction profiles.[43] Despite the greater risk of stricture recurrence with EBD compared to surgery in managing strictures, EBD is an ambulatory intervention that can avert surgical interventions that require inpatient admission and reduce the amount of functional bowel.

EBD demonstrates high technical (74%–100%) and short-term clinical success rates as well as low adverse event rates (0%–10.6%).[44,45] Meta-analyses estimate short-term success rates of approximately 90% in terms of technical success and 70% in terms of symptomatic response.[46] Reassuringly, long-term follow-up studies by Navaneethan and colleagues report that only 27% of patients required surgical interventions over a median follow-up period of 15 to 70 months, with 44% achieving long-term success after a single dilation.[47] However, late recurrence remains a challenge, with nearly half of patients experiencing recurrent symptoms.[42] Repeated EBD, or in some cases subsequent surgery, is necessary in approximately two-thirds of patients,[47] highlighting the need for ongoing vigilance for recurrent symptoms.[48] As our understanding of CD-related strictures continues to evolve, EBD remains an integral component of the multidisciplinary approach to stricture management, enhancing patient outcomes and quality of life.

Endoscopic Strictureplasty

Endoscopic strictureplasty (ES) is an evolving technique for treating intestinal strictures, also offering a minimally invasive alternative to traditional surgical approaches. In ES, a stricture is opened by performing a radial incision typically utilizing either a needle knife or an insulated tip knife.[49]

ES is particularly well suited for managing short, refractory, and fibrotic strictures in the distal bowel, esophagus, and stomach. Recently, Lan and colleagues, demonstrated comparable efficacy of ES compared to ileo-colonic resection (ICR) for CD-related distal ileal strictures, with comparable surgery-free survival with lower postoperative complication rates.[49] They evaluated 43 CD patients with primary distal ileum strictures treated with ES versus ICR. Patients in both groups achieved immediate technical success after treatment. The median follow-up durations were 1.8 and 1.5 years in the ES and ICR groups, respectively. Subsequent surgery rates were similar between the two groups (15.4% vs 18.8%, $P = .79$) and overall surgery-free survival was also comparable ($P = .98$). Post-procedural adverse events were seen in 2 of 29 ES procedures (6.9% per procedure) and 8 of 32 (25.0%) patients receiving ICR ($P = .05$). Additionally, ES is increasingly utilized as an alternative primary therapy for short (<3 cm) and anastomotic strictures.[49,50]

ES is more technically complex than EBD and is generally performed by endoscopists with advanced training. However, studies have shown that ES offers superior short-term clinical and long-term efficacy compared to EBD, with a lower need for reintervention or surgery (9%–22.5%).[21,50] Perforation rates with ES are reported to be similar (~1%) compared to EBD (1%–5%), although bleeding requiring transfusion may be higher with ES (6%–10%, compared to EBD: 3%–5%).[51]

Luminal Stent Placement

SEMSs are a valuable and efficacious alternative to surgical interventions for colonic obstruction.[51] Characterized by woven, knitted, or laser-cut metal mesh cylinders, SEMSs exert self-expansive forces, gradually attaining their predetermined diameter. The spectrum of indications for stent placement have progressively broadened, encompassing myriad conditions ranging from malignant strictures, obstructions, and external compressions of the gastrointestinal tract to malignant gastrointestinal

(GI) perforations and fistulae.[52] The choice of stent type varies based upon stricture etiology and length.

Endoscopic stenting is a potential option for the management of refractory strictures in IBD, particularly after the failure of EBD or ES. Fully covered (FC) SEMSs are recommended for benign strictures, due to relative ease of removability. However, ease of removability is balanced by increased risk of stent migration. In the setting of short, generally anastomotic strictures, lumen-apposing metal stents may be effective. In general, partially covered SEMSs are avoided in benign disease due to risks of tissue ingrowth preventing removal.

Recent meta-analyses have reported pooled rates of technical and clinical success for endoscopic stenting in IBD-related strictures at 93% and 61%, respectively.[53] However, notable adverse events including stent migration (43.9%), abdominal tenderness (17.9%), and perforation (2.7%) prevent SEMS placement from being a first-line option for IBD strictures.[54] Notably, a randomized controlled trial comparing endoscopic stenting to EBD demonstrated inferiority of stenting in terms of need for reintervention after 1 year, with FC SEMS exhibiting a reintervention rate of 49% compared to 20% with EBD.[55]

Despite these challenges, endoscopic stenting still plays a limited role in the management of refractory and long strictures seen with chronic inflammation. Careful patient selection and close monitoring are paramount to mitigating the risk of complications and optimizing treatment outcomes. Ongoing research and improved technology will refine the role of SEMS in the management of benign colon strictures.

ENDOSCOPIC MANAGEMENT OF MALIGNANT COLON OBSTRUCTION

Malignant bowel obstruction, generally due to advanced CRC, is a life-threatening condition necessitating urgent intervention.[56] Historically, emergency surgery was the mainstay for addressing malignant colonic obstruction.[57] However, significant complication rates and resultant delay in oncologic therapy, resulted in the need for options beyond emergent surgery.[57]

Approximately 2 decades ago, SEMSs offered an alternative in the palliative management of malignant colonic obstruction. A comprehensive meta-analysis by Zhao and colleagues illuminated several key advantages of colonic stenting over surgical intervention. Notably, the stenting cohort exhibited a significantly lower 30 day mortality rate compared to surgically managed counterparts (4.2% vs 10.5%, $P = .01$).[58] Additionally, stented patients experienced abbreviated hospital stays (9.6 days vs 18.8 days), decreased rates of intensive care unit admissions (0.8% vs 18.0%), and lower stoma formation rates (12.7% vs 54.0%). Another advantage of colonic stenting is an earlier start of palliative chemotherapy (15.5 days vs 33.4 days), which is associated with better survival rates.[58,59] Considering these benefits, colonic stenting is often a first-line option for malignant obstruction in a palliative setting.

Furthermore, colonic stenting has emerged as a viable “bridge to surgery” strategy, particularly for patients with potentially curable and resectable lesions.[60] In contrast to the heightened mortality and morbidity associated with emergency surgical interventions, stenting affords a more controlled approach to surgery. By providing immediate decompression, stenting allows for needed staging evaluations, optimization of patients’ physical condition, and delivery of bowel preparation facilitating a smoother transition to elective surgery.[57]

Nevertheless, recent investigations have given pause to universally recommending colonic stenting as a bridge to surgery.[60] While certain studies have reported

comparable short-term mortality rates between the stenting and emergency surgery cohorts (9.6% and 9.9%, respectively), the former appears to confer a substantial advantage in terms of reduced short-term morbidity (33.9% vs 51.2%, $P = .023$).[61] However, the major risk of SEMS placement in the setting of malignant colon obstruction is iatrogenic perforation during placement of the stent or due to expansion of the stent. This has obvious oncologic implications, turning a curable disease into T4 disease. Moreover, some studies suggest an elevated risk of surgical failure and heightened local recurrence rates associated with colonic stents.[62,63]

Considering these concerns, the choice to use a colonic stent for bowel obstruction should account for all patient, oncologic, and surgical factors. Further definitive investigation is needed to delineate optimal patient selection criteria, thereby maximizing therapeutic efficacy while minimizing potential adverse outcomes.

ENDOSCOPIC MANAGEMENT OF FISTULA AND ABSCESS

Fistula formation represents a significant complication in inflammatory states, especially CD, often occurring in association with strictures and abscesses. The management of CD-related fistulas necessitates a multifaceted approach, incorporating both endoscopic and surgical interventions based on the characteristics and anatomic location of the fistula. Endoscopic management entails addressing associated strictures (with aforementioned techniques) and abscess drainage,[64] followed by targeted interventions.

The management approach varies depending on the nature and complexity of the fistula. CD-related de novo fistulas and those involving communication with organs such as the bladder or vagina typically require surgical intervention. Endoscopic procedures such as cutting (fistulotomy) or closure (clips, stents, sutures) are preferred for short (<3 cm), superficial, simple, bowel-to-bowel (distal), and pouch-to-pouch fistulas. These modalities, guided by endoscopic visualization, enable precise localization and treatment of fistulous tracts, thereby improving patient outcomes and quality of life.

Endoscopic Incision and Drainage

Endoscopic ultrasound (EUS)-guided drainage is essential to therapeutic endoscopy, utilized for its superior safety profile and efficacy compared to traditional surgical approaches.[65] While less commonly utilized, EUS has also emerged as a valuable tool in the assessment of perianal CD. Traditionally, surgical examination under anesthesia (EUA) or MRI is employed for suspected fistulae evaluation.[66] However, EUS has demonstrated equivalence to MRI or EUA in assessing perianal fistulae, offering the added advantage of real-time assessment in conjunction with traditional endoscopy.

In the realm of endoscopic fistula treatment, various techniques have been described, including endoscopic suturing, over-the-scope clipping, fistulotomy, and drainage with seton placement.[64] Endoscopic drainage of abscesses associated with CD-related fistulae can be achieved using a needle knife, particularly for perianal and intra-abdominal/pelvic abscesses.

For perianal fistulae, complete fistulotomy using a needle knife may be suitable for short, superficial fistulae outside the external anal sphincter, while partial fistulotomy is reserved for longer fistulae.[67] Studies by Kochhar and colleagues have demonstrated the safety and efficacy of endoscopic fistulotomy with a needle knife in treating IBD-related fistulae, with 89.6% of patients achieving complete resolution and 10.3% of patents with persistent fistulae requiring surgical intervention.[67] In cases where intra-abdominal or pelvic abscesses are not amenable to drainage by interventional

radiology, due to overlying bowel, endoscopic pigtail drainage, with or without EUS guidance, offers a feasible alternative.[64]

Endoscopic Fistulotomy

Endoscopic fistulotomy is a valuable therapeutic option for managing fistulae in IBD. This technique plays an important role particularly in cases of postoperative bowel-to-bowel fistulae (such as those occurring at the suture line or as an anastomotic leak into the distal bowel), pouch-to-pouch fistulae, perianal fistulae, and primary ileo-cecal fistulae. However, careful patient selection and consideration of fistula characteristics are paramount to optimizing treatment outcomes.

In terms of endoscopic therapy, fistulotomy is most suitable for short (<2 cm), superficial, and distal bowel fistulae. The largest case series, comprising 29 patients, demonstrated the efficacy of fistulotomy, particularly in perianal fistulae, fistulae from the tip of the J-pouch to the anastomotic site, and pouch-to-pouch fistulae.[68] Notably, fistula resolution and clinical success rates were reported at 89.6% and 75.8%, respectively, with post-procedural bleeding being the only significant complication observed. It is essential to emphasize that while fistulotomy is an attractive option for short, superficial, and simple fistulae, it should be approached with caution in cases of long and deep fistulae.

Overall, endoscopic fistulotomy holds promise as a minimally invasive and effective therapeutic modality for select cases of IBD-related fistula. With careful patient selection and adherence to established guidelines, endoscopic fistulotomy can serve as a valuable adjunctive therapy in the comprehensive management of fistulae, ultimately improving clinical outcomes and enhancing patient quality of life.

Endoscopic Closure

The evolution of advanced endoscopic devices, such as over-the-scope clips (OTSCs) and suturing, has provided an alternative modality to manage complex lesions in IBD. OTSCs are specifically designed for gastrointestinal defect closure, presenting an

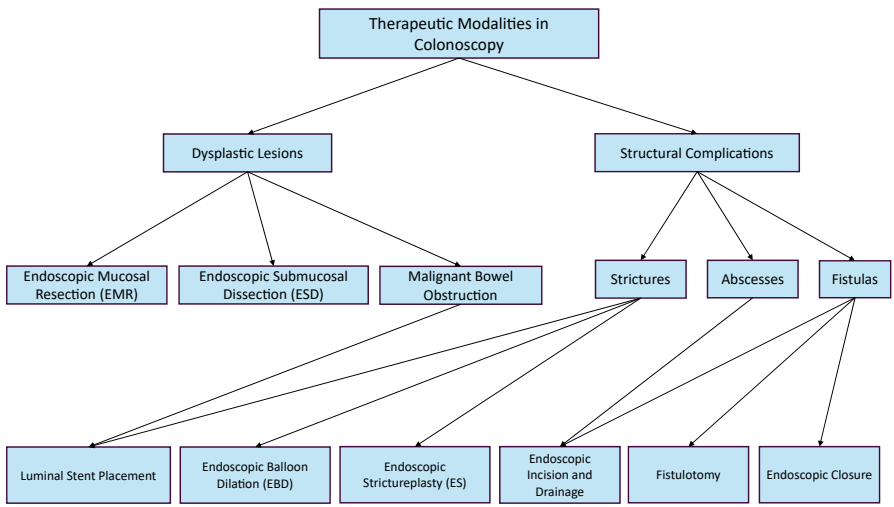

Fig. 2. Options for therapeutic modalities in colonoscopy. Therapies are categorized by dysplastic lesions versus structural complications.

advance over traditional through-the-scope (TTS) clips. While TTS clips are effective for general gastrointestinal interventions, OTSCs have demonstrated variable efficacy in addressing IBD surgery-related complications, such as anastomotic leaks or perforations. Case series and reports have showcased the successful use of OTSCs in treating leaks at the tip of J-pouches and perianal fistulas, achieving an overall technical success rate of nearly 70%.[69] However, caution is warranted when considering OTSCs for primary CD-related fistulas and bowel-to-hollow organ fistulas (eg, rectovaginal and pouch-vaginal), as suboptimal success rates and the risk of fistula worsening have been reported. Despite these limitations, OTSCs have demonstrated promise in managing select cases of fistulas, including rectovaginal fistulas, anovaginal fistulas, and enterocutaneous fistulas.

Overall, multiple endoscopic interventions regarding stricture, fistula, and abscess management offer numerous advantages over traditional surgical approaches, including reduced invasiveness, shorter recovery times, and preservation of bowel function. By providing effective alternatives to surgery, therapeutic endoscopy assumes a pivotal role in the comprehensive management of structural complications in both non-colitis and colitis-associated diseases, thereby optimizing patient care and enhancing overall quality of life (**Fig. 2**).

SUMMARY

Colonoscopy continues to evolve in the diagnosis, assessment, and management of various gastrointestinal manifestations, especially malignancy and IBD. Recent advancements in imaging modalities, therapeutic interventions, and emerging applications hold promise for optimizing patient care and improving clinical outcomes. By harnessing the power of innovative endoscopic technologies, endoscopists can achieve greater precision in diagnosing disease activity, monitoring treatment response, and delivering targeted therapies, enhancing the quality of life for patients.

The integration of advanced imaging modalities such as NBI and dye-based chromoendoscopy has revolutionized lesion detection and characterization, enabling endoscopists to discern subtle mucosal abnormalities and enhance diagnostic accuracy. In the realm of colonic dysplasia management, EMR and ESD have emerged as cornerstone interventions, offering curative options for select patients with early neoplastic lesions. These techniques not only obviate the need for surgical resection but also afford excellent outcomes with minimal morbidity, thereby redefining the therapeutic landscape for colonic dysplasia.

Furthermore, the advent of endoscopic modalities for the management of strictures, such as EBD and luminal stent placement, has revolutionized the approach to luminal narrowing. These interventions not only alleviate obstructive symptoms but also facilitate luminal patency restoration, thereby improving patient quality of life and reducing the need for surgical interventions.

Lastly, the evolution of endoscopic techniques for the management of fistulas and abscesses, including endoscopic drainage and fistulotomy, has transformed the therapeutic algorithm for these complex entities. By offering minimally invasive yet effective interventions, endoscopic approaches have become integral in the management of these complications, mitigating morbidity and facilitating timely resolution.

In conclusion, the rapid evolution of colonoscopy has revolutionized the care of patients with colorectal disease. These advancements not only enhance diagnostic capabilities but also expand the armamentarium of therapeutic options, thereby improving patient outcomes and redefining standards of care in gastrointestinal disease management.

CLINICS CARE POINTS

- Though the benefit concerning CAN detection via NBI compared to standard white light colonoscopy remains uncertain, evidence shows promising outcomes in monitoring and treatment of CAN.
- OCT may enhance diagnostic precision and guide therapeutic decision-making by identifying transmural inflammation; however, this still requires clinical studies.
- For visible dysplasia with distinct margins, EMR and ESD have replaced the traditional approach for surgical management while preserving bowel function.
- While studies have reported comparable mortality rates between stenting and emergency surgery cohorts for colonic obstruction, the former has an advantage in reducing short-term morbidity.

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