CHAPTER 101

Advanced Colonoscopy, Polypectomy, and Colonoscopic Imaging

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Summary

Technically difficult colonoscope insertions can generally be categorized as resulting from a very tortuous and angulated sigmoid or from a redundant colon. These categories guide instrument selection and the technical approach to achieving cecal intubation. Endoscopic submucosal dissection (ESD) is the newest approach to endoscopic resection of colorectal polyps, but is rarely used in the United States, where endoscopic mucosal resection (EMR) is still preferred. Cap-fitted colonoscopy produces small gains in adenoma detection. The Third-Eye Retroscope (TER) may produce gains in detection but is impractical for routine use. The Full Spectrum Endoscopy System and the G-EYE balloon system both produced substantial gains in adenoma detection in initial tandem studies. Though chromoendoscopy produces small gains in small adenoma detection, the more practical electronic forms of highlighting polyps (e.g., narrow-band imaging, NBI) have not successfully increased adenoma detection. A variety of imaging methods, including confocal laser microscopy, endocytoscopy, NBI, Fujinon Intelligent Chromo Endoscopy (FICE), and the Pentax i-SCAN, allow real-time recognition of polyp pathology, at least for differentiation of conventional adenomas versus lesions in the serrated class.

Insertion Techniques in Difficult Colons

Technically challenging colons that defy cecal intubation can be grouped into two categories: redundant colon and narrowed or angulated sigmoid colon [1]. When faced with a difficult sigmoid, the approach is to use a narrower colonoscope; first a pediatric colonoscope, and if that fails a gastroscope or a thin colonoscope with the diameter of a gastroscope, such as the Olympus PCF-PH190 (diameter 9.5 mm). Ultrathin colonoscopes or thin upper endoscopes will pass almost all benign left colon strictures. Aggressive loop reduction and abdominal pressure, sometimes applied with four hands, will advance an upper endoscope to the cecum in about two-thirds of cases [1]. If an upper endoscope is required and fails to reach the cecum, guidewire exchange can be attempted. This latter technique is performed by advancing a long, stiff guidewire with a soft tip into the transverse colon (or to the furthest extent to which the upper endoscope can be passed), then withdrawing the upper endoscope. The stiff end of the guidewire is then passed backwards through a pediatric colonoscope by protecting it in the sheath of a polypectomy snare that has been passed forward through the colonoscope. Next, the pediatric colonoscope is advanced over the guidewire. The wire itself straightens the angulation in the sigmoid sufficiently to allow the pediatric colonoscope to be passed. Other alternatives include a thin push enteroscope such as the Olympus SIF-180 or a balloon enteroscope.

In the very redundant colon, an initial attempt with a standard colonoscope and excellent standard technique is often successful. The responsive insertion technology introduced in the Olympus Exera III series (Olympus America, Center Valley, PA) may resist loop formation in the redundant colon [2]. Special tools may be needed, such as the push enteroscope, single- or double-balloon enteroscope (SBE and DBE), or standard colonoscope with back-loaded overtube [3].

Water immersion (filling the left colon with water and passing the colonoscope without air insufflation) has been found to reduce the need for external straightening devices in redundant colons to 7%, compared to 37% with gas insufflation [4]. Water immersion in the left colon causes the left colon to sink into the left lower quadrant when the patient is in the left lateral decubitus position, thereby straightening the sigmoid and keeping the colon short. Warm water can also relieve spasm, and water or cornseed oil may improve the hydrophilic forces between the colonoscope and the mucosa [5,6].

The VizBalloon system utilizes a cap on the tip of the colonoscope and a balloon attached to a catheter, which is passed through the instrument channel, filled with water, and then pulled back and centered by the cap on the end of the colonoscope. The balloon leads the colonoscope through a non-inflated colon. In a patient with 20 previous incomplete colonoscopies, cecal intubation was achieved in 9 minutes with one position change [7]. In the cecum, the balloon is usually deflated and removed.

Wireless capsule technology (PillCam Colon, Given Imaging, Israel) is an option for previously incomplete colonoscopies, giving better adenoma detection than computed tomographic (CT) colonography in portions of the colon not visualized by the colonoscope [8]. In the largest trial performed to date, the second-generation capsule had high sensitivity for conventional adenomas but was less effective for serrated lesions [9]. The device was recently approved by the Food and Drug Administration (FDA) for use in previously incomplete colonoscopies.

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Advanced Techniques for Polyp Resection

The newest method of advanced polypectomy is ESD [10]. This technique was developed for resection of early gastric cancers in Japan but has been used (primarily by Japanese physicians) to resect large, broad colorectal polyps, especially in the rectum. A long-acting solution such as hyaluronidate is injected into the submucosa. A needle-knife is then used to make an incision into the submucosa around the circumference of the lesion and a special knife dissects through the submucosa under the polyp. The advantages of this technique include an extremely high rate of cure on the initial resection compared to piecemeal polypectomy (98% versus a maximum of 90%). Additionally, the quality of the pathologic specimens is superior to that produced by piecemeal polypectomy. The downsides include a long learning curve, longer procedural times, and an approximate 5% risk of perforation, though most perforations can be closed with endoscopic clips [10].

In the United States, most large sessile polyps are removed using EMR, which involves piecemeal or *en bloc* snare resection following submucosal injection. In a randomized trial, hydroxyethyl starch proved a better injection fluid, providing a more sustained cushion and allowing faster resection in fewer pieces compared to saline [11]. If possible, the entire lesion should be snare-resected. Application of argon plasma coagulation (APC) to any flat polyp remaining after snare resection, as well as to the perimeter of the polypectomy site, can reduce the risk of local recurrence [12]. Patients should undergo an initial follow-up examination 3–6 months after the initial resection, with careful inspection and biopsy of the polypectomy scar. If the base of the polypectomy site is clear at 3–6 months, a second follow-up examination a year later is warranted to look for so-called "late recurrences" [13].

Inclusion of epinephrine in submucosal injection fluid has been shown in randomized controlled trials (RCTs) to prevent immediate bleeding, but there is no effect on delayed bleeding [14]. For large pedunculated polyps with sufficient stalk length, placement of detachable snares has been shown to prevent postpolypectomy bleeding [15–17].

Endoscopic resection of large sessile polyps has one-fifth the cost of surgical resection [18]. All pedunculated colorectal polyps are endoscopically resectable, as are nearly all sessile polyps less than 2 cm in size, and a substantial fraction of those >2 cm.

A shallow cap on the colonoscope tip can facilitate resection of very flat colorectal lesions by allowing tissue to be suctioned through a snare in the cap [19,20]. Barbed and spiral snares can also sometimes enable the resection of extremely flat lesions. In a cohort study, prophylactic clipping of large polypectomy sites decreased delayed postpolypectomy bleeding [21].

Endoscopic Imaging in the Colon

Detection of Neoplasia

Colonoscopy misses neoplastic lesions when the bowel preparation is inadequate, when lesions are hidden on the proximal sides of folds, and when flat lesions are present on the screen but not recognized by colonoscopists. Technical aids to detection have focused on exposing more colorectal mucosa or highlighting flat lesions.

Exposing Hidden Mucosa

"Wide-angle colonoscopy" refers to the use of lenses with a wider angle of view than the standard 140°. In Olympus 180 and 190 series colonoscopes, the angle of view is 170° as standard. The Full Spectrum Endoscopy (FUSE) system allows right–left 330° visualization displayed across three screens. Tandem colonoscopies with the traditional forward viewing (TFV) scope and FUSE had an adenoma miss rate of 42.9 and 8.1%, respectively [22].The SMART Medical G-EYE colonoscope (GEC) has a balloon on the bending section, which inflates during withdrawal, straightening the folds to increase visibility. GEC has a 4% adenoma miss rate, compared to 44% with standard colonoscopy [23].

"Cap-fitted colonoscopy" refers to the use of a clear plastic hood on the tip of the colonoscope to flatten haustral folds. RCTs have collectively shown small increases in polyp detection with this technique, and a tandem study showed an increase in adenoma detection [24].

The TER (Avantis Medical Systems, Sunnyvale, CA) is a disposable device that is inserted down the instrument channel of the colonoscope. After exiting the channel, it is advanced 3–4 cm, where it automatically retroflexes. The device has a lens on the tip with a complementary metal-oxide semiconductor (CMOS) video chip and a 135° angle of view. The colonoscopist watches both the forward view from the colonoscope and the retroflexed view through the TER. In a tandem study, the adenoma miss rate was 15% with TER versus 28% without, but the withdrawal time was longer when TER was used [25]. The device is FDA approved, but there are practical obstacles to its use, including its cost, the need to remove it for each polyp that is detected, and the difficulty of keeping the lens clear in a poorly prepared colon.

Highlighting Flat and Depressed Lesions

The best studied technique for this purpose is chromoendoscopy or dye-spraying. Chromoendoscopy has two uses: one is to evaluate already detected lesions by examining the pit pattern in combination with high-magnification endoscopy, the other is to highlight and detect flat lesions via pancolonic spraying. Several RCTs have been performed for the latter indication [26]. Generally, chromoendoscopy has been associated with higher detection rates of adenomas, though the detected adenomas are typically small tubular adenomas with low-grade dysplasia. However, in the largest trial to date there was a nearly significant increase in advanced adenoma detection in the chromoendoscopy arm [27]. The technique requires time for application and is often not considered practical for routine use. Pancolonic dye-spraying has greater value in chronic ulcerative colitis, where RCTs have shown that it allows targeted biopsying of dysplasia. Detection of dysplasia in ulcerative colitis is improved with chromoendoscopy, even though fewer (but targeted) biopsies are taken.

NBI has been evaluated as an aid to detection of adenomas in several tandem studies and RCTs. It could potentially improve adenoma detection, because the color contrast between adenomas (adenomas appear brown in blue light) and normal mucosa is greater in blue than in white light; however, adenomas seen in NBI are invariably still visible when viewed in white light. In a European multicenter study, adenoma detection was initially higher with NBI than with white light, but by the end of the study detection rates were equal [28]. This suggests that high-level adenoma detectors do not achieve improved adenoma detection using NBI [29], but NBI may have a useful learning effect in low-level detectors [28]. NBI on the latest generation of Olympus colonoscopes provides better mucosal illumination. It is awaiting additional study as a detection aid.

FICE (Fujinon, Wayne, NJ), a post-image-processing color-enhancement system, has been tested in RCTs and found not to improve adenoma detection [30]. i-SCAN, a post-processing technology in Pentax scopes, resulted in better detection in a randomized trial, but detection in the control group was lower [31,32]. High definition has achieved mixed results when tested for its impact on detection [33], but recent reports of adenoma detection rates exceeding 50% in screening patients have been achieved only with high-definition colonoscopes [34].

Determination of Histology in Real Time

A variety of endoscopic imaging techniques have been developed to allow determination of histology of colon polyps in real time. Real-time histology could be used to determine the appropriateness of endoscopic versus surgical resection in the case of early cancers, to decide whether or not to remove a non-neoplastic polyp, or to remove polyps and discard them (rather than send them to pathology) and then determine postpolypectomy surveillance intervals based on the endoscopic evaluation.

The American Society for Gastrointestinal Endoscopy (ASGE) established two clinical goals for real-time histology of colorectal polyps through its "PIVI" process [35]. The first is the "resect and discard" policy, in which polyps of a certain size have their pathology estimated by imaging and then resected and discarded without submission to pathology. Modeling predicts such a policy will have substantial cost savings [36]. The target set of polyps for resect and discard is those ≤5 mm in the United States and those ≤9 mm in the United Kingdom. ASGE recommends that in order for a technology to be used for resect and discard, it should allow assignment of post-polypectomy surveillance intervals with ≥90% agreement with those determined by pathology. The second goal is to leave diminutive rectosigmoid hyperplastic polyps in place without resection. ASGE recommends that in order to be accepted as effective, a technology should provide a negative predictive value (NPV) ≥90% for identifying diminutive adenomas in the rectosigmoid [35].

A recent meta-analysis of 91 studies evaluating real-time pathology estimates NBI, I-Scan, and FICE to have comparable sensitivity, specificity, and NPV for real-time pathology [37]. Confocal laser microscopy, which provides "virtual histology," gives comparable sensitivity and better specificity, while autofluorescence has comparable sensitivity and lower specificity [37]. All methods are considered adequate for everyday use, but the ability of technologies to meet PIVI targets has been assessed in few studies. A recent trial showing poor performance by community endoscopists [38] emphasizes the need for improved training methods. Validated classification systems for differentiating adenomas from hyperplastic polyps have been developed [39], and training methods are under development and undergoing testing [40]. Finally, the Olympus endocytoscopy system is a supermagnification system that allows endoscopic assessment of pathology.

Take Home Points

- Technically difficult colonoscopies can be categorized as difficult sigmoids or redundant colons. Narrower instruments should be used for angulated sigmoids. Redundancy can be overcome in most cases by meticulous standard techniques, water immersion, longer colonoscopes, overtubes, or double-balloon enteroscopy (DBE).
- Endoscopic submucosal dissection (ESD) is infrequently used in the United States at the time of this writing. Its advantages include higher initial cure rates and better pathologic specimens. Its disadvantages include longer procedure times and higher perforation rates.
- Endoscopic mucosal resection (EMR) of large sessile polyps leads to recurrence rates of 10–50%, so careful follow-up is needed.
- Prophylactic clipping of large polypectomy defects may prevent delayed bleeding. Randomized controlled trials (RCTs) are required.
- The FUSE system and the G-EYE balloon system were each superior to standard forward-viewing colonoscopy alone for polyp detection in initial tandem studies.
- Several methods allow accurate determination of polyp histology in real time. Confocal laser endomicroscopy provides "virtual histology." The Olympus endocystoscopy system and the Olympus narrow-band imaging (NBI) system, with or without high magnification, can both provide accurate information on pathology. The Fujinon Intelligent Chromo Endoscopy (FICE) system and Pentax i-SCAN are also effective at differentiating adenomas from lesions in the serrated class.

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