Endoscopic removal of large colon polyps

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INTRODUCTION

The removal of large colon polyps during endoscopy raises a number of concerns, including the risk of the procedure and the possibility of inadequate polypectomy. The latter is particularly concerning since large polyps have an increased risk of harboring invasive carcinoma [1-5]. Endoscopic resection of large polyps, especially laterally spreading sessile polyps, is also more time-consuming and requires more resources compared with polypectomy of smaller lesions [6].

Because of these issues, surgical resection is often performed, particularly for large sessile polyps and for those in locations that are difficult to manage endoscopically. However, some large polyps can be successfully removed with endoscopic methods, provided that an endoscopist who is experienced in large polyp removal is available [1-5,7]. Thus, some patients can avoid surgery.

This topic will review endoscopic removal of large colon polyps. The definition of "large" varies in the literature; for the purpose of this discussion, the definition of large will refer to polyps that are ≥2.0 cm in their greatest dimension. An overview of colonoscopy, colorectal polyps, and the treatment and prevention of postpolypectomy bleeding are discussed separately. (See "Overview of colonoscopy in adults" and "Overview of colon polyps" and "Management and prevention of bleeding after colonoscopy with polypectomy".)

DEFINITIONS

A polyp refers to a protuberance into the lumen above the surrounding colonic mucosa, and the Paris classification of superficial neoplastic lesions of the gastrointestinal tract can be used to classify adenomas into polypoid and nonpolypoid lesions (figure 1 and table 1). The endoscopic features of adenomatous polyps are discussed separately. (See "Overview of colon polyps", section on 'Clinical features'.)

The term "laterally spreading tumor" (LST) is used to describe a large, flat neoplastic lesion with a diameter beyond 10 mm growing laterally along the surface of the bowel [8].

Endoscopic polyp removal techniques include the following (see "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic resection techniques'):

- **Polypectomy** – Snare resection of a pedunculated polyp or small sessile polyp (ie, up to 10 mm). Submucosal injection prior to resection is generally not performed.

- **Endoscopic mucosal resection** (EMR) – Snare resection of a larger sessile polyp, whereby the plane of resection is in the submucosa, thereby enabling complete resection of the mucosal layer. Resection can be en bloc, but piecemeal resection is generally required for larger (ie, >20 mm) polyps. Conventional EMR technique utilizes the injection of a solution into the submucosa to raise the mucosal layer, whereas underwater EMR is performed without submucosal injection [9].

- **Endoscopic submucosal dissection** – Use of a specialized dissection knife to enable en bloc resection of a larger polyp.

PATIENT SELECTION

Endoscopic removal can be performed for large polys with the following characteristics:

- Risk of invasive cancer is low (see 'Features suggesting invasive cancer' below)
- Polyp size and location are amenable to complete endoscopic resection
- Risk of serious adverse events (eg, perforation, bleeding) is low

In addition, endoscopic resection may be appropriate for patients who do not meet these criteria but who are poor surgical candidates.

Features suggesting invasive cancer — Some polyps may contain invasive cancer (ie, submucosal invasion equivalent with early stage [T1] colon cancer). In these cases, polypectomy alone is curative, provided there is no lymphovascular invasion, no poorly differentiated histology, the resection margins are free of cancer, and for nonpedunculated polyps (ie, polyps that lack a stalk), the depth of submucosal invasion is ≤1 mm [10,11].

Large polyps are assessed for endoscopic features associated with invasive cancer, including Kudo classification type V (figure 2) or Narrow Band Imaging International Colorectal Endoscopic (NICE) classification type 3. The NICE classification type 3 describes lesions with an amorphous surface structure and a vessel pattern demonstrating loose vessel areas and interruption of thick vessels [10,12-14]. Reports have suggested that 83 to 96 percent of polyps that lack these features will be nonmalignant [1-5,7].

Whether to proceed with endoscopic resection is based on polyp morphology and appearance [10] (see 'Polyp removal techniques' below and "Overview of colon polyps"):

- Pedunculated polyps - Pedunculated polyps (ie, polyps with a stalk (picture 1)), even with features of deep (≥1mm) submucosal invasion should undergo endoscopic polypectomy provided that the stalk appears normal.

- Nonpedunculated polyps - Nonpedunculated polyps with features of deep submucosal (SM) invasion (defined as ≥1mm, into the SM2 layer) are biopsied in the area of surface feature disruption. Tattoo placement is performed if the polyp is not at or near the cecum or rectum, and patients are referred for surgical management. (See "Tattooing and other methods for localizing gastrointestinal lesions".)

Lateral spreading tumors (LSTs) are large polyps that are flat or sessile and extend laterally along the colonic wall. LSTs may have features of submucosal invasion such as nongranular morphology, multi-sized nodules, and central depression. Higher rates of submucosal invasion have been described for LSTs with a smooth, velvety surface (ie, laterally spreading tumor-nongranular type [LST-NG]) compared with those with even-sized nodules on the surface (ie, laterally spreading tumor-granular type [LST-G]) [15]. LST-NG are more frequently located in the right colon, and due to their flat morphology, they can be difficult to detect. Mild central depressions within LST-NG may indicate the presence of submucosal invasion.

For polyps with features indicating carcinoma with submucosal invasion (ie, Kudo pit pattern V or NICE classification type 3), en-bloc resection of the lesion is required to assess the extent of submucosal invasion and adequacy of resection. To achieve this, endoscopic submucosal resection (ESD, if available) or surgical resection is performed because piecemeal resection must be avoided in such cases. In addition, biopsy or tattooing adjacent or close to the site of the lesion is avoided if ESD is anticipated because such maneuvers may limit efforts for a curative endoscopic resection [16]. If surgical rather than endoscopic resection is planned, biopsies of the large polyp are taken from areas of surface feature disruption. (See "Tattooing and other methods for localizing gastrointestinal lesions".)

Other methods to assess for submucosal invasion include:

- Non-lifting sign – A positive non-lifting sign (ie, failure of the mucosa to elevate following submucosal injection) may indicate an early colorectal cancer that has invaded the submucosa [17-20]. However, false positives can occur after prior biopsy or attempts at polyp removal, and one study found that patients with a history of biopsy exhibited the non-lifting sign more frequently than did those without a history (30.4 percent versus 3.3 percent) [21]. Endoscopic assessment with electronic or topical chromoendoscopy, preferably using magnification endoscopy, has been shown to be superior to the non-lifting sign for predicting submucosal invasion [22].

- Endoscopic ultrasound – Endoscopic ultrasound (EUS) can be used to assess for features suggesting malignancy (such as submucosal invasion or enlarged lymph nodes), particularly for sessile lesions in the rectum. Some authors use high-frequency miniprobes that can be inserted through the biopsy channel of the colonoscope and thus can be used in the entire colon, unlike dedicated EUS scopes that can only examine the distal colon. EUS is most often employed when submucosal invasion is suspected. EUS is not generally regarded as a prerequisite prior to polypectomy of large colon polyps [1,17,18].

Polyp size and location — Size of the polyp (even those >20 cm or with circumferential growth) is not a contraindication to endoscopic resection. However, subsequent surveillance is mandatory to evaluate for residual or recurrent adenoma. Stricture formation after resection of circumferential lesions is common and may require endoscopic dilation. These considerations should be explained to the patient prior to embarking on endoscopic resection.

Polyps that occupy more than one-third the circumference of the colon wall, cross two haustral folds, or involve the base of the appendix, should be referred to an endoscopist with expertise in endoscopic mucosal resection and endoscopic submucosal dissection [23].

Surgery may be a better initial option for patients with multiple large polyps in the right colon since these polyps often require several endoscopic sessions for complete removal and are associated with increased procedural risk [24,25]. Endoscopic polypectomy should not be performed if circumstances do not permit repeated treatment and surveillance sessions. Furthermore, it should not be attempted in patients with uncorrectable bleeding disorders. (See 'Follow-up' below and "Gastrointestinal endoscopy in patients with disorders of hemostasis".)

PATIENT PREPARATION

The preparation for endoscopic removal of large colon polyps is the same as that for routine colonoscopy and includes dietary changes and consumption of a bowel preparation. Polypectomy is considered a high-risk procedure with regard to bleeding, so patients taking anticoagulants or antiplatelet agents may need to discontinue the medications. Antibiotic prophylaxis is not recommended for polypectomy.

- (See "Overview of colonoscopy in adults", section on 'Patient preparation'.)
- (See "Management of anticoagulants in patients undergoing endoscopic procedures", section on 'Elective procedures'.)
- (See "Management of antiplatelet agents in patients undergoing endoscopic procedures".)
- (See "Bowel preparation before colonoscopy in adults".)

EQUIPMENT

In addition to the standard endoscopic equipment, additional equipment that may be used for the removal of large colon polyps includes:

- Transparent cap attachment
- Polypectomy snares and dissecting knives
- Hot biopsy forceps (for polypectomy and hot avulsion)
- Electrosurgical generator
- Injection needles
- Solutions for submucosal lifting
- Chromoscopy dye (eg, methylene blue or indigo carmine)
- Ink for tattooing
- Polyp retrieval net
- Clips
- Nylon loops
- Argon plasma coagulation
- Fluid pump for irrigation
- Carbon dioxide for insufflation

POLYP REMOVAL TECHNIQUES

There are two primary goals of colonic polyp removal:

- To completely remove all neoplastic tissue
- To provide a tissue specimen that can be evaluated histologically

Biopsies alone are inadequate for establishing or excluding the presence of malignancy (figure 3). Only complete excision of the polyp permits accurate histologic diagnosis.

There are a number of techniques for endoscopic excision of large colon polyps [26,27]. The approach chosen will depend on the characteristics and location of the polyp and the endoscopist's preference:

- Snare polypectomy – Large pedunculated polyps can be removed by transecting the stalk of the polyp with a snare, usually with electrocautery. (See 'Snare polypectomy' below.)

- Endoscopic mucosal resection (EMR) – Large sessile polyps (laterally spreading tumors) are removed using EMR. (See 'Endoscopic mucosal resection techniques' below.)

  Histologic confirmation of curative resection will be more difficult after piecemeal resection since the lateral tissue margins may not be clear. This is particularly important if a polyp is found to contain an early carcinoma since curative resection cannot be guaranteed and additional treatment including surgery may be required. (See "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic mucosal resection techniques'.)

- Endoscopic submucosal dissection (ESD) – An alternative to EMR is ESD. ESD is a variant of EMR in which a specialized dissecting knife is used to dissect lesions from the submucosa. The advantage of ESD is that it usually permits removal of large sessile polyps en bloc (eg, in one piece), whereas EMR often removes the polyp piecemeal. However, the technique requires specialized training and is especially challenging when used for resection of lesions in the colon. ESD is typically not required for colon polyps because the majority of colon polyps are benign [27]. (See "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic submucosal dissection'.)

The following should be kept in mind when performing endoscopic polypectomy:

- Ensnaring of a colonic fold must be carefully avoided. Large pedunculated or sessile lesions can initially obscure the anatomy. Thus, resection should only be carried out if the ensnared portion can be clearly visualized.

- Delayed perforation may occur due to the spread of thermal injury to the deeper layers of the bowel wall. This can occur if a pedunculated polyp is resected too near to the bowel wall, leaving no residual stalk. This can also happen if an ensnared polyp is not lifted into the lumen of the bowel before current is applied.

- The snare has to be closed tightly before applying coagulation since thermal injury with delayed perforation may occur if the tip of the snare inadvertently touches the bowel wall behind the polyp. Sometimes this cannot be accomplished without cutting through the polyp. However, it is safer to transect a polyp mechanically (ie, without coagulation), since the major risk will be bleeding, which usually occurs immediately and can be controlled endoscopically.

Snare polypectomy — Most large pedunculated polyps can be removed by transection of the polyp's stalk with a polypectomy snare using electrocautery (picture 2). Snare polypectomy is also used to remove sessile polyps. Polyps ≥10 mm in size usually require electrocautery for en bloc resection. Piecemeal cold snare polypectomy for polyps ≥10 mm has been reported [28,29], but further studies are needed to compare the clinical outcomes with hot snare polypectomy. Snares differ in size, shape (eg, oval, hexagonal, crescent) and constitution (eg, monofilament or braided) that result in different degrees of stiffness. The choice is personal preference; no advantage to any particular snare type has been shown.

Endoscopic mucosal resection techniques — Conventional EMR technique for colon polyps involves raising the polyp using submucosal injection followed by removal of the polyp with a snare (injection-assisted EMR) [1-3,5,30]. Sessile polyps larger than 2 cm should be resected in a piecemeal fashion to avoid perforation, and some experts suggest that any polyp greater than 1.5 cm be resected piecemeal (picture 3) [23]. Endoscopists who are experts in EMR techniques may consider en bloc removal of larger polyps using EMR. Alternatively, ESD can be considered if en bloc resection is needed. (See 'Endoscopic submucosal dissection techniques' below.)

Underwater endoscopic mucosal resection (UEMR) is a technique that eliminates the need for submucosal injection, because of the "floating" effect of water submersion on the mucosa and submucosa, resulting in separation from the muscularis propria [9,31-33]. In a study of 60 patients with a total of 62 large sessile polyps resected using UEMR, delayed bleeding occurred in three patients (5 percent) and no perforations occurred [9]. Of 54 patients who underwent follow-up colonoscopy at a three-month interval, one patient had a 5 mm adenoma along a fold outside the resection scar.

As an alternative to hot snare resection using electrocautery, cold snare resection (ie, without electrocautery) and cold piecemeal mucosal resection with submucosal injection have been used for removing large sessile polyps [34-37]. Adverse events such as delayed bleeding or perforation have been rarely reported with cold techniques, possibly related to a lack of deep thermal injury. In addition, polyp recurrence rates following cold resection have been comparable to electrocautery-based resection techniques.

Determine the polyp's margins — Prior to resecting the polyp, the margins of the lesion need to be defined. High-resolution endoscopes with high-definition monitors allow for clear visualization of the polyp margins in most cases, but sometimes it can be difficult to appreciate the extent of such lesions. Chromoendoscopy, narrow band imaging (picture 4), or addition of dye to the saline used to lift the polyp are all methods to help define the margins of the polyp [17-19]. (See "Chromoendoscopy".)

Submucosal injection — Injection of saline or an alternative solution into the submucosa below the polyp raises the polyp on a cushion of fluid. The rationale for a submucosal "lift" prior to resection is to facilitate endoscopic resection and potentially decrease the risk of perforation during subsequent snare excision [4,38,39]. Some experts have suggested that any sessile polyp larger than 1.5 cm that is located proximal to the rectum should be removed following saline-lift [23].

If submucosal injection is used, it is important to start with the proximal (upstream) side of the polyp as this can be difficult to access once the distal side of the polyp has been raised. Failure of the polyp to lift with saline injection raises concern for malignancy, provided the polyp has not undergone a prior attempt at resection (which could result in scar tissue anchoring the polyp to the submucosa).

Studies supporting the use of submucosal injection are limited. One study suggested that the penetration depth of ulcers due to electrocautery was shallower after submucosal saline injection than without saline injection [38]. Whether this translates into a lower risk of perforation or bleeding is unknown [3].

A problem with saline injection is that it is rapidly absorbed. As a result, alternative agents that are not as rapidly absorbed have been studied (with and without epinephrine), including hyaluronic acid [40,41], dextrose solutions [42], succinylated gelatin [43], and hydroxyethyl starch [44].

Injection of dilute epinephrine (1:10,000 to 1:20,000) into the stalk of the polyp or at the base prior to resection may help decrease the risk of immediate postpolypectomy bleeding. However, it is unclear whether dilute epinephrine is superior to saline or other agents such as hyaluronic acid in the prevention of postprocedural bleeding [45].

Submucosal injection prior to EMR can have drawbacks. The injected fluid may increase the submucosal tissue tension and make snare capture more difficult (ie, snare slips off the submucosal plane during closure). The injected fluid may dissipate along the submucosal plane, raising both the polyp and the adjacent normal mucosa. This may cause the polyp to flatten or become depressed, relative to the surrounding tissue. Injection may displace the neoplasia-bearing tissue into a less accessible location, such as behind a fold, or constrict the lumen, making access more difficult.

When injecting through an adenoma, there is the potential for needle track seeding of neoplastic cells into deeper wall layers.

Resection — The polyp should be oriented at the six o'clock position, which corresponds to the operating channel of the endoscope. The polyp is then ensnared and cautery applied to resect the tissue. Current settings are based on personal preference, but most endoscopists use a blend of coagulation and cutting current applied in bursts. Every part ensnared should be lifted away from the wall before application of current to prevent deep cauterization, which is associated with an increased risk of perforation.

If a sessile polyp covers a fold, both sides of the fold have to be cleared separately. The proximal side may be difficult to visualize, and maneuvers such as lifting of the lesion by well-directed submucosal injection or working in a retroflexed position (where possible) may help [46].

The use of a stiff monofilament snare can greatly facilitate resection since it allows for spreading out the fold. The tip is placed behind (proximal to) the fold and opened to gently push on the mucosa and flatten out the fold, exposing the polyp. The snare is then slowly closed and the catheter advanced simultaneously to keep the tip in position. It is important to maneuver the snare parallel to the colonic surface to avoid cutting too deeply. Suctioning air while maintaining a lumen view prior to closing the snare will reduce wall tension and may enable a better capture of tissue; however, suctioning should be avoided while closing the snare to avoid accidental capture of the muscularis propria.

Resection should be performed systematically, beginning at one margin. Once the muscle layer has been exposed, further resection steps are performed from there, avoiding any residual islands of tissue between resected pieces. Following resection, the polypectomy site should have a "clean" surface. High-definition white light endoscopy or narrow band imaging will usually identify any remnants of adenomatous tissue.

Complete resection of the polyp in a single session is critical since scarring will make a second attempt at resection more difficult.

We do not routinely treat the resection margins with ablative techniques [47]. (See 'Treatment of residual adenoma' below.)

En bloc resection is always preferred, but piecemeal resection is often necessary due to polyp size or location. Piecemeal resection is suggested for polyps larger than 2 cm in diameter to reduce the risk of perforation; however, no studies have defined a cutoff point for size where en bloc resection is unsafe.

For LST-granular type (LST-G) with a dominant nodule, en bloc resection of the dominant (ie, largest) nodule is attempted, rather than piecemeal technique [10]. (See 'Features suggesting invasive cancer' above.)

Treatment of residual adenoma — Residual adenoma can be resected with a snare to provide complete histologic assessment of the lesion. Use of underwater EMR has been reported as a salvage technique for recurrent colorectal adenoma after piecemeal EMR [48].

If snare resection fails, consideration should be given to referral to a center with expertise in EMR and endoscopic submucosal dissection (ESD). Coagulation of large areas of the adenoma should be avoided since the subsequent scarring will hamper any future attempt at snare mucosectomy. Remnants of adenomatous tissue that cannot be ensnared can be fulgurated with thermal coagulation modalities such as a hot biopsy forceps using proprietary microprocessor-controlled cutting current (ie, hot avulsion technique), or an automated endoscopic resection system [49]. Hot avulsion differs from hot biopsy forceps polypectomy in that forced coagulation current is avoided.

Endoscopic submucosal dissection techniques — ESD is a resection technique for early gastrointestinal tract cancers. It is used mainly in the stomach, but it is being applied increasingly in the colon and rectum [50-56].

The technique involves identifying the margins of the polyp, submucosal injection, and circumferential dissection of the tumor-bearing mucosa and submucosa using various diathermic dissecting knives. The aim of ESD is to achieve an en bloc resection, which provides more accurate oncologic evaluation of the deep and lateral margins for tumor involvement. En bloc resection also reduces the risk of adenoma recurrence that may result from residual islands remaining after piecemeal resection.

ESD is a complex and labor-intensive endoscopic technique with a steep learning curve, especially in the colon where maneuvering the endoscope is more difficult. As such, the indications for ESD for the removal of colon polyps are limited because most colon polyps are benign and can be removed piecemeal with high cure rates [27]. (See 'Determine the polyp's margins' above and "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic submucosal dissection'.)

Tattooing — Regardless of the technique used to remove the polyp, consideration should be given to tattooing the site where a large polyp was removed to permit identification of the site during follow-up endoscopy or surgery. A permanent dye will trigger scar tissue formation, which can lead to submucosal fibrosis that makes additional resections by EMR or ESD more difficult [57,58]. The injection should be performed at a distance of 3 cm or more away from the resection margin and ideally on the opposite wall to

ensure that the tattoo does not spread along the submucosal plane to the resection site. This is especially important if a polyp was incompletely resected and a second attempt at removal is planned. The location of the tattoos relative to the lesion should be noted in the endoscopy report to facilitate accurate identification of the polypectomy site. (See "Tattooing and other methods for localizing gastrointestinal lesions" and 'Effect of prior polyp manipulation' below.)

Preventing bleeding — Measures to prevent postpolypectomy bleeding (PPB) may be aimed at decreasing the risk of immediate procedural bleeding or delayed bleeding. Options to decrease the risk of bleeding include injecting epinephrine at the polypectomy site, placing endoscopic clips across a polypectomy stalk (picture 5), using endoscopic clips to close the mucosal defect following polypectomy (picture 6), and placement of a nylon loop around the stalk of a pedunculated polyp (picture 7 and picture 1).

Pedunculated polyps with stalks >1 cm in diameter have an increased risk of PPB because of a large blood vessel within the stalk. Preventive measures include injection of dilute 1:1000 epinephrine into the stalk or placement of either a nylon loop (picture 1) or clip (picture 5) around the stalk prior to resection [59,60]. Nylon loops appear to decrease the risk of bleeding [59,61], but their presence may make the procedure more difficult. After securing the loop, a snare must be placed over the top of the polyp and positioned above the loop ligature while trying to avoid partial ensnaring of the loop (which would make transection impossible). The floppy loop can become entrapped within the interstices of a large polyp and, when tightened, constrict the polyp head rather than the pedicle, making subsequent transection of the stalk difficult or even impossible. Other problems with nylon loops include severing of the stalk by over tightening, slipping of the loop, and insufficient tightening [62]

For sessile polyps, adding epinephrine to the submucosal injectate solution can be performed. Clips can be used to close the defect following polypectomy (picture 6), but should only be placed after complete resection of the polyp since clips that remain in situ during follow-up may interfere with resection of polyp remnants or recurrences.

Studies looking at the efficacy of epinephrine injection and endoscopic clip placement for preventing bleeding have reached variable conclusions [45,63-67]. However, clipping the resection site may be more beneficial for patients with large polyps. In a study of over 400 patients with a total of 524 polyps ≥20 mm in size, clipping the resection site was associated with lower rates of PPB (2 versus 10 percent) [65]. In a trial evaluating clipping that included over 400 polypectomies (mean polyp size 7.8 mm), PPB rates were similar for the clipped and the non-clipped groups [63].

Other hemostatic techniques for preventing bleeding at the resection site have been studied. These include a mineral powder (Hemospray) [68], cyanoacrylate (eg, Glubran) [69], and a transparent matrix-forming gel (Purastat) [70], and they are sprayed or dripped on the site to cover it. Such techniques may be effective for achieving initial hemostasis, however, rebleeding rates of up to 40 percent have been reported. Thus, further studies are needed before using these methods routinely.

Specimen collection and histologic evaluation — Complete assessment of the resected tissue is required for accurate diagnosis. This may be cumbersome if a large number of pieces are obtained during piecemeal resection. If the pieces are relatively small, they can be suctioned through the suction channel of the colonoscope and collected in a trap. Otherwise they may be removed using a retrieval net. This device can be

opened and closed repeatedly until all the fragments of the polyps have been collected. The polyp tissue is then withdrawn along with the endoscope (picture 3).

Histologic evaluation may be more difficult after piecemeal resection. In the case of a benign adenoma, however, correct diagnosis is usually possible if all the pieces are collected. In the presence of cancer within an adenoma, complete resection with clean margins may still be diagnosed if the cancer is focal and contained entirely in one fragment. If margins cannot be clearly assessed, short-term endoscopic follow-up with biopsies may help to confirm absence or presence of tumor remnants. In case of doubt, subsequent surgical resection should be performed in operable patients. (See 'Follow-up' below.)

Lesions removed en bloc should be pinned to cork to optimize histological assessment.

EFFICACY

Endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD) are both associated with high success rates (85 to 95 percent). Recurrence rates generally range from 15 to 30 percent, but in most cases polyp recurrence can be treated with additional endoscopic therapy.

In a meta-analysis of 50 studies with 6442 patients with 6779 polyps, endoscopic removal was deemed successful in 96 percent of polyps [71]. Invasive cancer was detected in 8 percent of the polyps. A total of 543 patients (8 percent) underwent surgery following endoscopic resection. The indication for surgery was a non-curative resection in 503 patients (93 percent) and an adverse event in 31 patients (6 percent). Polyp recurrence was detected in 14 percent of patients, and invasive cancer was detected in 2 percent of patients during follow-up. Of those with polyp recurrence, 90 percent were managed with endoscopic treatment.

Conventional endoscopic mucosal resection — EMR is successful in approximately 95 percent of cases, although some patients require multiple endoscopic sessions for complete removal [18,72-74]. Following EMR for large (>20 mm) noninvasive lesions, the rate of residual/recurrent adenoma (as detected at the first surveillance colonoscopy) ranges from 15 to 30 percent [7,75,76]. Risk factors for recurrence after EMR include piecemeal resection, lesions larger than 40 mm, and need for argon plasma coagulation [47,75].

Whether routine thermal ablation of the resection margins results in better long-term outcomes compared with endoscopic treatment during the surveillance colonoscopy is unclear [77,78]. When follow-up examinations are performed within a short interval (eg, three to six months), any residual adenoma is usually benign and can frequently be successfully managed using a snare polypectomy technique. (See 'Polyp removal techniques' above and "Overview of colon polyps", section on 'Management'.)

Nevertheless, thermal ablation following piecemeal EMR of sessile polyps ≥20 mm reduces early adenoma recurrence rates [78]. In a trial of 390 patients with a total of 416 laterally spreading polyps ≥20 mm, thermal ablation of the resection margins after EMR was associated with lower adenoma recurrence rates at the six-month surveillance colonoscopy compared with no additional treatment (5 versus 21 percent; RR 0.25, 95% CI 0.13-0.48). No adverse events related to thermal ablation were reported.

Studies have illustrated the therapeutic success of piecemeal EMR, even for very large lesions when performed by experienced endoscopists [7,79,80]. In a series that included 1000 EMRs for polyps >20 mm in

size, 799 patients underwent colonoscopy four months after the EMR [7,79,80]. Recurrent or residual adenoma was present in 128 patients (16 percent). Of the 426 patients who had normal examinations at four months and had a second colonoscopy at 16 months, 17 (4 percent) had a late recurrence. Overall, 93 percent of the recurrent or residual polyps (early and late) were managed endoscopically.

Underwater endoscopic mucosal resection — Data have suggested that underwater endoscopic mucosal resection (EMR) was effective for removal of large polyps. In a systematic review of seven studies including 1237 polyps, underwater EMR was associated higher overall rates of successful en bloc resection compared with conventional EMR (63 versus 52 percent; OR 1.84, 95% CI 1.42-2.39) [81]. Underwater EMR was also associated with lower rates of polyp recurrence (OR 0.30, 95% CI 0.16-0.57), while there were no significant differences in risk of bleeding or perforation between the groups.

Endoscopic submucosal dissection — Multiple studies have shown high rates of successful neoplastic tissue resection with ESD and lower recurrence rates following ESD with en bloc resection compared with piecemeal EMR (0 to 2 percent compared with 6 to 14 percent) [82,83]. A meta-analysis of 97 studies using standard ESD technique for over 18,000 colorectal lesions reported successful R0 resection (ie, vertical and horizontal margins free of neoplasia) rate of 83 percent (96% CI, 80-85 percent) and recurrence rate at 12 months of 2 percent (95% CI, 1-3 percent) [83].

In a meta-analysis of 12 studies using the hybrid ESD technique in 720 colorectal lesions, the R0 resection rate was 61 percent (95% CI, 41-78 percent) and the recurrence rate at 12 months was 2 percent (95% CI, 1-6 percent) [83]. Although hybrid ESD may be a faster technique, standard ESD achieved higher resection rates compared with the hybrid technique (OR 2.4, 95% CI 1.2-4.9) [83] (See "Overview of endoscopic resection of gastrointestinal tumors", section on 'Hybrid endoscopic submucosal dissection'.)

Effect of prior polyp manipulation — Manipulation of colon lesions prior to endoscopic resection lowers complete resection rates and increases recurrence rates. This was examined in a series of 132 nonpedunculated colorectal lesions [84]. Patients either had no manipulation of the lesion prior to endoscopic resection (ER; 46 lesions), biopsy sampling only (44 lesions), or prior advanced manipulations, including tattooing and/or snare sampling (42 lesions). Patients who had no manipulation of the lesion had higher en bloc resection rates than those who either had the lesion biopsied or had advanced manipulation (35 versus 16 and 5 percent, respectively), had higher complete resection rates (94 versus 68 and 50 percent, respectively), and had lower recurrence rates (8 versus 41 and 54 percent, respectively). This study suggests that if a need for ER is anticipated, manipulation of the lesion should be avoided. In particular, attempts should not be made to partially remove the lesion or to place a tattoo at the site of the lesion (instead, it should be placed several centimeters distal to the lesion and the location noted in the procedure report). (See 'Tattooing' above.)

Serrated lesions — With the use of high-definition endoscopes providing excellent imaging of the mucosal pattern, sessile serrated adenomas are being identified increasingly, especially in the right colon. Frequently, they are initially recognized because they are covered by a persistent mucus layer ("cap"). Detection and complete removal are important since the adenoma-carcinoma sequence also applies to these lesions, and, because they are difficult to detect, they are considered as possible precursor lesions for "interval" colorectal carcinoma. They may become large before malignant transformation. Endoscopic treatment is the same as

for adenomas. A multicenter study including 2000 serrated lesions of 20 mm or more showed that local recurrence is significantly less for serrated lesions compared with adenomas [85].

COMPLICATIONS

The two major complications of endoscopic removal of large colon polyps are bleeding and perforation. Reported bleeding rates following endoscopic mucosal resection (EMR) for colon polyps range from 2 to 11 percent [73,77,80,86-89]. The bleeding rate after endoscopic submucosal dissection is reported to be less than 2 percent [90]. Factors that have been associated with intraprocedural bleeding include polyp size (OR 1.2/10 mm), villous or tubulovillous histology (OR 1.8), and having the polypectomy performed at an institution that has performed fewer than 75 of the procedures (OR 3.8) [89]. Some factors that have been associated with an increased risk of postprocedural bleeding following EMR of large colon polyps include a proximal colon location (OR 3.7), use of electrosurgical current not controlled by a microprocessor (OR 2.0), and intraprocedural bleeding at the time of polyp removal (OR 2.2).

Perforation is the most serious complication of polyp removal, but it can usually be prevented by adherence to careful technique. Perforation following EMR is rare (0 to 1 percent) [1-5,38,80,88]. However, the rate may be as high as 10 percent with endoscopic submucosal dissection [90].

Prior to perforation with an obvious hole in the colonic wall, the so-called "target sign" may signal a deeper defect, including the muscle layer, which requires further measures [91]. A recognized obvious or imminent perforation can be frequently and adequately treated endoscopically by placement of clips [91].

Bleeding can often be managed endoscopically, whereas surgery is usually indicated if perforation occurs. However, since the bowel is usually clean at the time of the polypectomy, it may be safe to close a small or suspected perforation using clips, thus allowing for conservative management. We do not attempt this in patients, however, in whom air flows quickly into the peritoneal cavity. Patients treated conservatively should be observed closely for one week. The management of postpolypectomy bleeding and the endoscopic treatment of perforations are discussed elsewhere. (See "Management and prevention of bleeding after colonoscopy with polypectomy" and "Endoscopic clip therapy in the gastrointestinal tract: Bleeding lesions and beyond".)

FOLLOW-UP

Follow-up examinations are mandatory after endoscopic resection of large adenomas to detect residual adenoma tissue or recurrence [7,17,18,75,77,87,92,93]. Follow-up examinations should be repeated until a clean scar can be confirmed. The term "recurrence" should only be used if complete removal of the entire lesion has been established. Subsequent follow-up will depend on the polyp's size and histologic findings. (See "Overview of colon polyps".)

Follow-up protocols depend on the manner of resection and histology. Follow-up endoscopy for large pedunculated polyps can typically be performed in three years. (See "Overview of colon polyps", section on 'Adenomatous polyps'.)

Follow-up endoscopy after piecemeal resection is recommended in six months after the EMR procedure when most adenoma recurrences will be visible and amenable to retreatment [94]. A normal-appearing scar with negative biopsies at the first follow-up endoscopy is predictive of long-term eradication [79]. After confirming complete resection, the next follow-up examination is performed in one year and then at three years [94].

Treatment of residual/recurrent adenoma — Residual or recurrent adenoma is usually unifocal and diminutive and can be successfully retreated in over 90 percent of cases [7]. The endoscopic treatment of a large recurrent adenoma due to submucosal fibrosis is more challenging. Lifting of the lesion with submucosal injection will be difficult or unsuccessful (non-lifting sign). Underwater EMR, which eliminates submucosal injection, has been effective in managing recurrent adenoma after EMR [48,95].

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Colon polyps".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Colon polyps (The Basics)")
- Beyond the Basics topics (see "Patient education: Colon polyps (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Patients who are candidates for endoscopic removal of large colon polyps (ie, >20 mm) include those in whom the concern for invasive cancer is low and the size and location of the polyp are amenable to endoscopic resection with a low risk of complications. In addition, endoscopic resection may be appropriate for patients who do not meet these criteria but who are poor surgical candidates. (See 'Patient selection' above.)

- There are two primary goals of colonic polypectomy. The first is to completely remove all neoplastic tissue. The second is to provide a tissue specimen that can be evaluated histologically. There are a number of techniques for endoscopic excision of large colon polyps. The approach chosen will depend on the characteristics and location of the polyp and the endoscopist's preference (see 'Polyp removal techniques' above):

  - Snare polypectomy – Large pedunculated polyps can typically be removed by transecting the stalk of the polyp with electrocautery.

  - Endoscopic mucosal resection (EMR) – Large sessile polyps are removed using EMR. The conventional technique is a lift-and-cut technique in which submucosal injection is used to separate mucosal and submucosal lesions from the muscularis propria. Submucosal injection is then followed by removal of the polyp using a snare with electrocautery. Histologic evaluation may be more difficult after piecemeal resection since the tissue margins may not be clear. This is particularly important if a polyp is found to contain an early carcinoma since the presence of cancer at a resection margin requires additional treatment (eg, surgery). (See "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic mucosal resection techniques'.)

  - Endoscopic submucosal dissection (ESD) – An alternative to EMR is ESD. ESD is a variant of EMR in which a specialized needle knife is used to dissect lesions from the submucosa. The advantage of ESD is that it often permits removal of large sessile polyps en bloc (eg, in one piece), whereas EMR often removes the polyp piecemeal. However, the technique requires specialized training. ESD is typically not required for colon polyps because the majority of colon polyps are benign, so they can be removed piecemeal with a low recurrence risk [27]. (See "Overview of endoscopic resection of gastrointestinal tumors", section on 'Endoscopic submucosal dissection'.)

- EMR and ESD are both associated with high success rates (85 to 95 percent) with acceptable adenoma recurrence rates. In most cases, recurrent adenomas can be treated with additional endoscopic therapy. (See 'Efficacy' above.)

- The two major complications of endoscopic removal of large colon polyps are bleeding and perforation. Bleeding rates following EMR for colon polyps range from 2 to 11 percent. The bleeding rate after ESD is reported to be less than 2 percent. Perforation is the most serious complication of polyp removal, but it can usually be prevented by adherence to careful technique. Perforation following EMR is rare (0 to 1 percent). However, the rate may be as high as 10 percent with ESD. (See 'Complications' above.)

- Follow-up endoscopy is mandatory after endoscopic resection of large adenomas to exclude residual or recurrent adenoma. The follow-up protocol will depend on the manner of resection and histology. (See 'Follow-up' above and "Overview of colon polyps", section on 'Adenomatous polyps'.)

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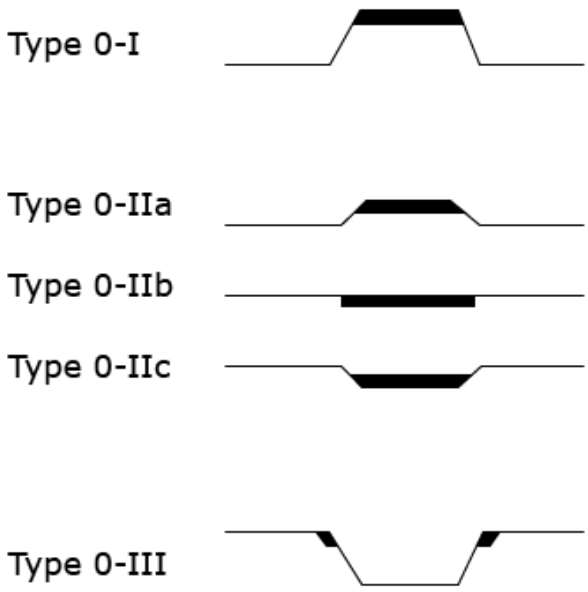
Topic 2577 Version 31.0

GRAPHICS

Paris classification system of superficial neoplastic lesions of the gastrointestinal tract



Paris classification system of superficial neoplastic lesions of the esophagus, stomach, and colon. Type 0-I lesions are polypoid (protruded or pendunculated); type 0-II lesions are nonpolypoid and may be slightly elevated (IIa), flat (IIb), or slightly depressed (IIc); type 0-III lesions are excavated.

Based on data from: The Paris endoscopic classification of superficial neoplastic lesions: esophagus, stomach and colon: November 30 to December 1, 2002. Gastrointest Endosc 2003; 58(6 suppl):S3.

Graphic 61277 Version 3.0

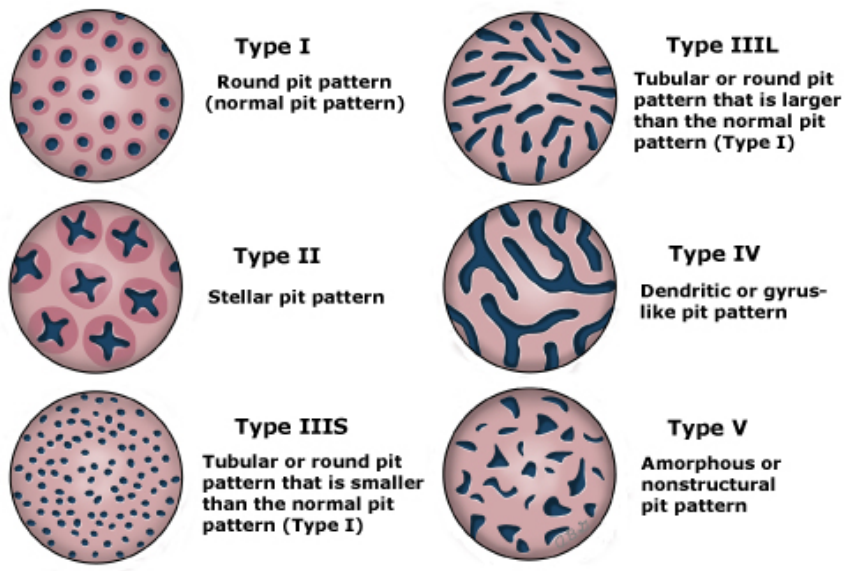
Paris classification system of superficial gastrointestinal neoplastic lesions

Type	Subclasses
0-I: Polypoid	0-Ip: Protruded, pedunculated
	0-Is: Protruded, sessile
0-II: Nonpolypoid	0-IIa: Slightly elevated
	0-IIb: Flat
	0-IIc: Slightly depressed
0-III: Excavated	

The Paris endoscopic classification of superficial neoplastic lesions: Esophagus, stomach and colon: November 30 to December 1, 2002. Gastrointest Endosc 2003; 58(6 suppl):S3.

Graphic 50239 Version 5.0

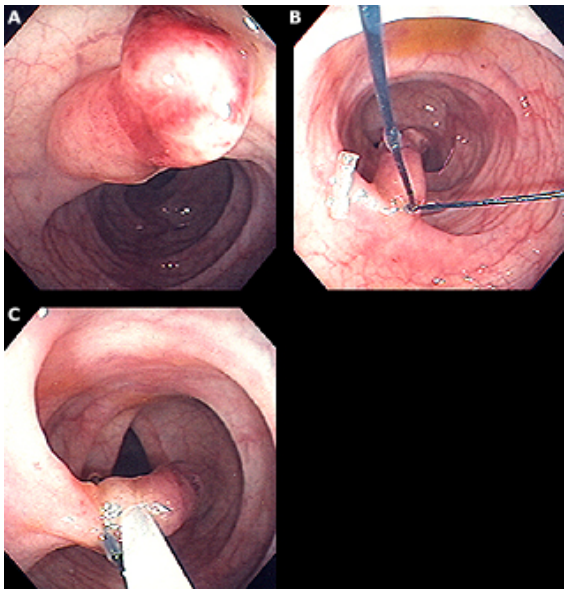
Kudo Pit Pattern Classification of colonic mucosal lesions



Pit pattern classification for colonic mucosal lesions.

Graphic 69425 Version 6.0

Colonic polypectomy using an endoloop



(A) Pedunculated polyp with a broad thick stalk; (B) Endoloop placed on the base of the polyp; (C) Polyp being transected with a snare placed above the endoloop.

Courtesy of Jerome D Waye, MD.

Graphic 59681 Version 2.0

Malignant polyp

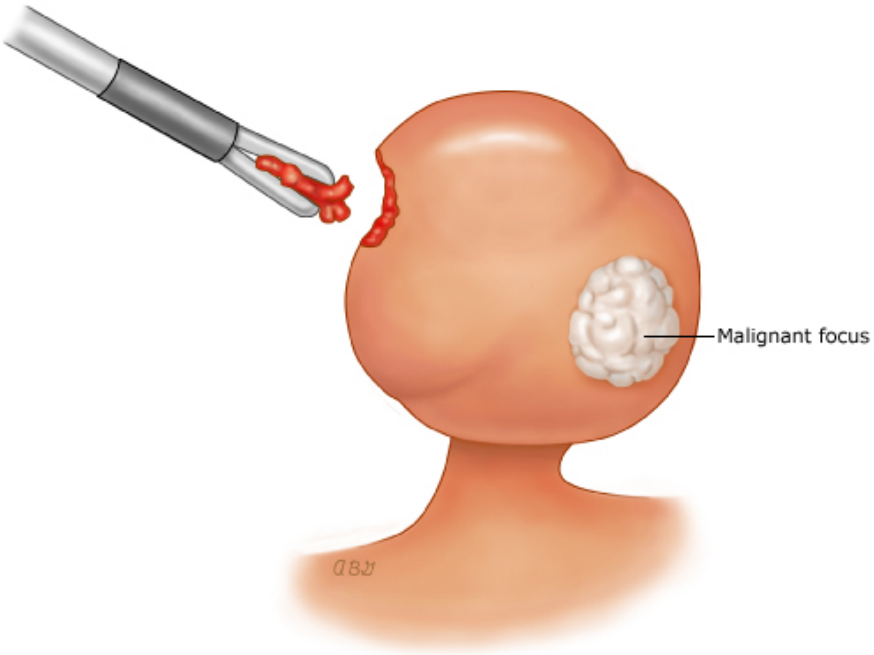
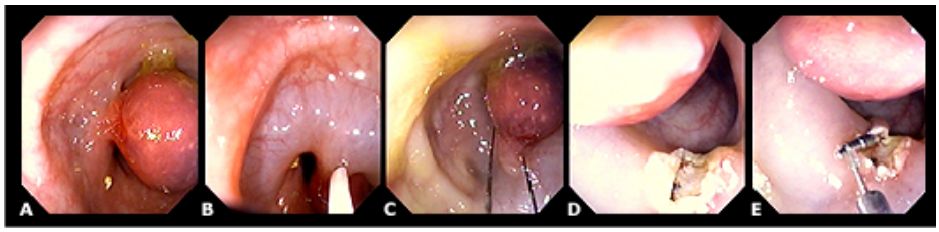


Illustration showing that biopsy of a polyp containing a malignant focus is inadequate for excluding malignancy.

Graphic 75488 Version 2.0

Resection of a pedunculated colonic polyp with a short stalk

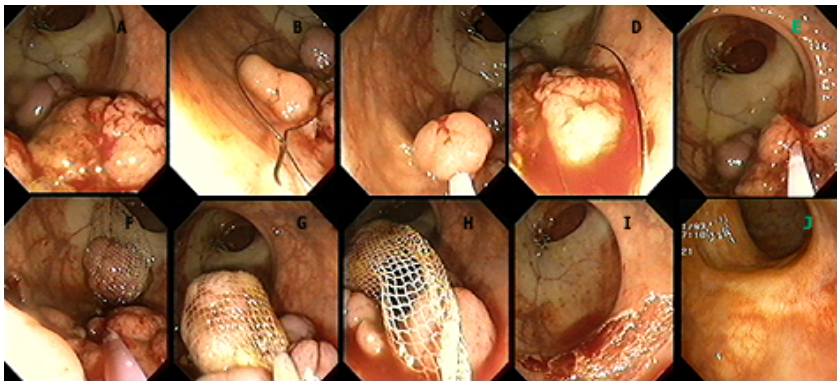


(A) 2 cm polyp in the descending colon, note the short stalk; (B) prophylactic injection of epinephrine solution 1:20.000; (C) polypectomy in toto; (D) resection site after polypectomy: a non-bleeding vessel is visible; (E) prophylactic placement of hemoclips.

Courtesy of Uwe Seitz, MD, Sabine Bohnacker, MD, and Nib Soehendra, MD.

Graphic 53630 Version 1.0

Resection of a large sessile colonic polyp

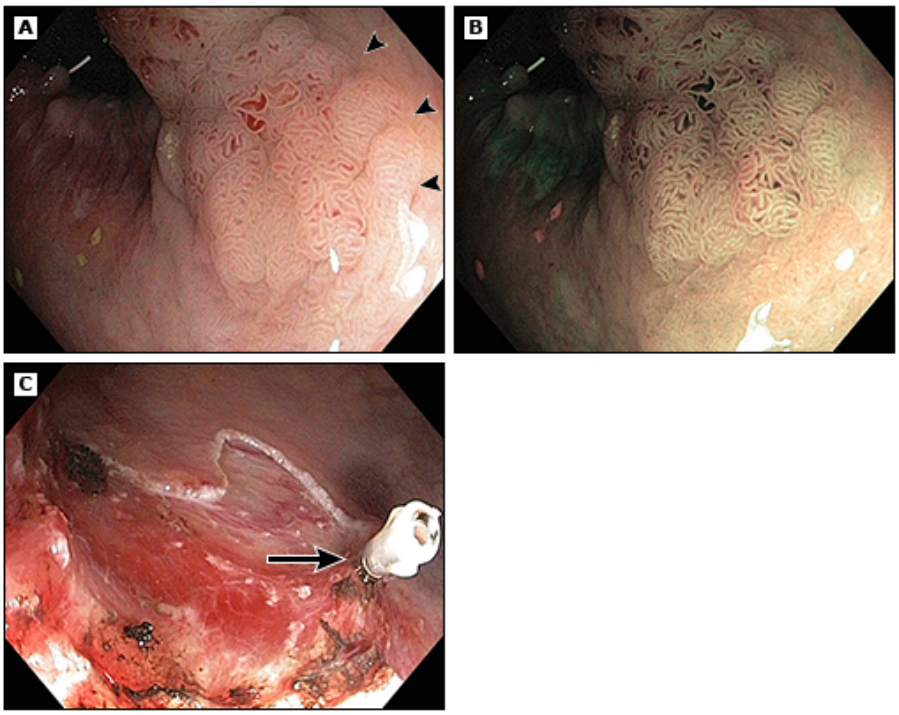


(A) Sessile polyp in the sigmoid colon measuring approximately 4 cm; (B/C) A monofilament stiff snare is applied tangentially to ensnare a flat portion of the lesion. For complete resection, it is advisable to begin working from a lateral margin of the polyp; (D/E) In repeated maneuvers the polyp is resected in a piecemeal technique. (F) A retrieval net is used to collect the resected pieces; (G/H) The net can be opened and closed repeatedly without losing the previously collected pieces; (I) Resection site after complete mucosectomy; (J) Clean scar at follow-up three months later.

Courtesy of Uwe Seitz, MD, Sabine Bohnacker, MD, and Nib Soehendra, MD.

Graphic 62455 Version 2.0

Adenoma in the rectum



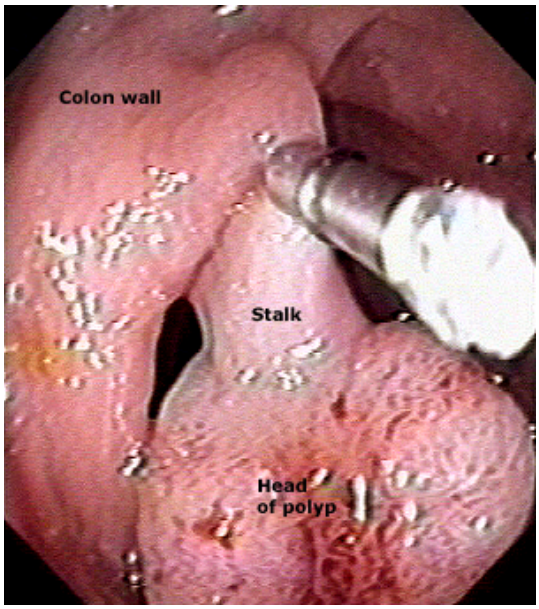
(A) Adenoma in the rectum shown with the colonoscope in retroflexion. The right margins of the adenoma are well demarcated using high-definition white-light endoscopy (arrowheads).

(B) The same polyp seen using blue light (narrow band imaging). The use of blue light enhances differences between polyp and normal mucosa.

(C) Following endoscopic resection, a clean resection margin is seen using high-definition white-light endoscopy. A hemostatic clip (arrow) was placed on a visible non-bleeding vessel.

Graphic 87242 Version 1.0

Prophylactic hemoclip placement prior to colonic polypectomy

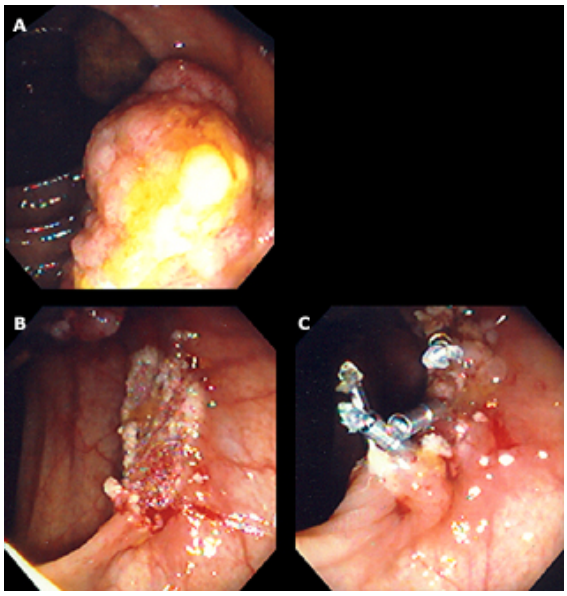


A hemoclip has been placed prophylactically to ligate a long thin polyp stalk prior to snare transection.

Courtesy of Uwe Seitz, MD, Sabine Bohnacker, MD, and Nib Soehendra, MD.

Graphic 56809 Version 2.0

Use of hemoclips after colonic polypectomy

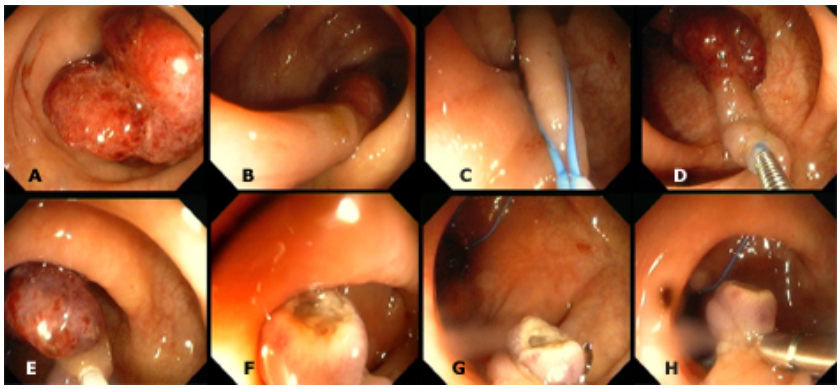


(A) Large sessile polyp in the right colon in a patient who requires Warfarin anticoagulation; (B) Polypectomy site after polyp removal; (C) Polypectomy defect closed with clips to ensure against further bleeding.

Courtesy of Jerome D Waye, MD.

Graphic 60247 Version 2.0

Resection of a pedunculated colonic polyp with a long stalk



(A) 2 cm polyp in the sigmoid; (B) after passing and retracting the endoscope, the long stalk is demonstrated; (C) the polyp is ensnared with an endoloop; (D) the endoloop is closed to ligate the pedicle; (E) the polyp is snared near to the head; (F) after resection a visible vessel is recognized at the resection site; (G) to achieve definitive hemostasis a hemoclip is placed; (H) final appearance.

Courtesy of Uwe Seitz, MD, Sabine Bohnacker, MD, and Nib Soehendra, MD.

Graphic 70345 Version 1.0

Contributor Disclosures

Uwe Seitz, MD Speaker's Bureau: Olympus [Capsule endoscopy]. All of the relevant financial relationships listed have been mitigated. **Sabine Bohnacker, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Kenneth F Binmoeller, MD, MASGE, FACG** Equity Ownership/Stock Options: Endeau, Inc [Colonoscopy]. All of the relevant financial relationships listed have been mitigated. **John R Saltzman, MD, FACP, FACG, FASGE, AGAF** No relevant financial relationship(s) with ineligible companies to disclose. **Kristen M Robson, MD, MBA, FACG** No relevant financial relationship(s) with ineligible companies to disclose.

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