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Incomplete Resection Rates in Polyps Smaller Than 2 Centimeters

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Abstract: Colorectal cancer (CRC) is the second-leading cause of cancer-related deaths in the United States. Colonoscopy is the most effective strategy for preventing CRC. Although the benchmark of colonoscopy performance, the adenoma detection rate, clearly correlates with prevention of interval cancers and CRC-related death, it is clear that polyp (adenoma) detection is not enough. Adequate and complete resection of the adenoma is imperative to ensure effective CRC prevention. Polyp size is the primary risk factor for malignancy; in general, the bigger the polyp, the greater the risk for malignancy. This monograph, however, focuses on strategies to improve the incomplete resection rate for polyps smaller than 2 cm, as these represent the vast majority of polyps encountered in clinical practice. Selection of the polypectomy technique depends on the size and type of polyp. In general, cold forceps biopsy is used for polyps smaller than 4 mm, cold snare polypectomy is used for polyps 4 to 10 mm, and hot snare polypectomy and endoscopic mucosal resection (EMR) are highly effective for larger polyps. The combined use of submucosal lifting and snare, as is performed with EMR, allows full resection of virtually all lesions of any size. Typically, EMR begins with a submucosal injection to create vertical lift. The submucosal lift is one of the most significant advances in complete polyp removal. It is used with the goals of improving visualization of polyp margins, capturing the entire polyp, and facilitating safe and complete resection. Several solutions have been used to achieve a submucosal lift. Only one solution, Eleview, is approved by the US Food and Drug Administration for this procedure. In a clinical trial, Eleview decreased the mean total injected volume and the mean total injected volume per lesion as compared with saline. Proper application of the submucosal solution is imperative to optimize outcomes with EMR.

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Incomplete Resection Rates: Current Trends and Clinical Consequences

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There is growing recognition that adenoma detection is the key aspect in terms of preventing colorectal cancer (CRC) and CRC-related death. Polyp detection, however, is just the beginning. The paradigm begins with the effective identification and complete resection of polyps, which leads to cancer prevention. Additionally, it is not enough that just a single polyp is resected, but complete resection of all adenomas is imperative to achieve optimal CRC prevention.

Complete resection of all adenomas is challenging, as was demonstrated in the CARE study (Complete Adenoma Resection).[1] This study analyzed 346 neoplastic polyps from 269 patients that were removed by 11 gastroenterologists. Biopsy evaluation showed that 10.1% of these polyps were incompletely resected. This incomplete resection rate (IRR) increased with polyp size. For example, the IRR was significantly higher for large polyps that were 10 mm to 20 mm vs small polyps that were 5 mm to 9 mm (17.3% vs 6.8%; relative risk, 2.1). Another factor that impacted IRR was the polyp type. The IRR was higher in sessile serrated adenomas/polyps than conventional adenomas (31.0% vs 7.2%; relative risk, 3.7). Notably, the clinical experience of the endoscopist did not correspond to the IRR. The IRR for endoscopists with at least 20 polypectomies ranged from 6.5% to 22.7%. There was a 3.4-fold difference between the highest and lowest IRR after adjusting for size and sessile serrated histology. Thus, the CARE study clearly showed the alarming prevalence of incomplete resection.

There is a disconnect between high adenoma detection rates (ADRs), which should be associated with risk reduction and prevention of CRC and cancer-related deaths, and the polypectomy technique and adequacy of resection. Although historically colonoscopy performance has been predicated on adenoma detection, it is detection combined with adequate resection that improves clinical outcomes and consequences.

Adenoma Detection Rate and Colonoscopy

The ADR is recognized as the lead benchmark for assessing colonoscopy quality and thereby optimizing CRC prevention. The ADR is defined as the percentage of patients at average risk for CRC who are found to have at least 1 adenoma or adenocarcinoma during a screening colonoscopy.[2] The ADR applies to individuals with an average risk for developing CRC, and it is limited to the first screening colonoscopy. It refers to the detection of conventional adenomas and carcinomas; importantly, it does not encompass detection of sessile serrated polyps.

With these limitations to consider, why is the ADR important? There is a clear association between a higher ADR and lower rates of interval cancers, advanced cancers, and fatal cancers. An increase in ADR corresponds to a decrease in the incidence of CRC and cancer-related death (Figure 1).[2] Even small, incremental differences in the ADR have an important effect on cancer preven-

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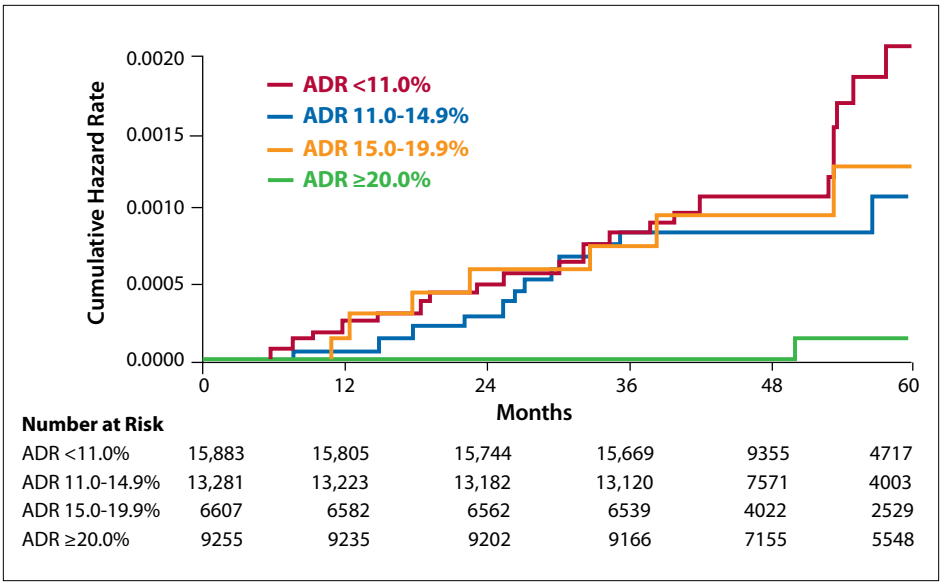

Number at Risk						
ADR <11.0%	15,883	15,805	15,744	15,669	9355	4717
ADR 11.0-14.9%	13,281	13,223	13,182	13,120	7571	4003
ADR 15.0-19.9%	6607	6582	6562	6539	4022	2529
ADR ≥20.0%	9255	9235	9202	9166	7155	5548

Figure 1. An ADR of 20% or higher was associated with a reduced rate of interval cancers in a Polish colonoscopy screening program. ADR, adenoma detection rate. Adapted from Kaminski MF et al. Quality indicators for colonoscopy and the risk of interval cancer. *N Engl J Med*. 2010;362(19): 1795-1803.[2]

tion. For example, in a study that evaluated 314,872 colonoscopies performed by 136 gastroenterologists, the ADRs ranged from 7.4% to 52.5%.[3] Each 1.0% increase in the ADR was associated with a 3.0% decrease in the risk of cancer (hazard ratio, 0.97; 95% CI, 0.96-0.98). During the follow-up period of this study, 712 interval colorectal adenocarcinomas and 147 deaths from interval CRC were identified. When the ADRs were grouped into quintiles, the unadjusted risk for interval cancer was highest in the lowest ADR quintile (9.8 cases per 10,000 person-years). This unadjusted risk for interval cancer decreased with each subsequently increasing ADR quintile (8.6, 8.0, 7.0, and 4.8 cases per 10,000 person-years). When the patients of endoscopists who had ADRs segregated to the highest quintile were compared with patients of endoscopists with ADRs in the lowest quintile, the adjusted hazard ratio for any interval cancer was 0.52 (95% CI, 0.39-0.69). Similarly, the adjusted hazard ratio was 0.43 (95% CI, 0.29-0.64) for advanced-stage interval cancers and 0.38 (95% CI, 0.22-0.65) for fatal interval cancers.

A recent study from Poland also evidenced the clinical impact of improving the ADR.[4] An increase of 1% in the ADR was associated with a 6% decrease in the incidence of CRC and a 12% reduction in deaths related to colon cancer.[4] This study tracked the ability of an individual endoscopist to increase his or her ADR, and how this effort translated to patient outcomes. During the study, 219 endoscopists (74.5%) increased their annual ADR category. In the 895,916 person-years of follow-up evaluation, a total of 168 interval CRCs and 44 interval cancer deaths were identified. An increased ADR was associated with an adjusted hazard ratio of 0.63 (95% CI, 0.45-0.88; *P*=.006) for interval CRCs and 0.50 (95% CI, 0.27-0.95; *P*=.035) for cancer-related deaths. The adjusted hazard ratios for interval CRCs decreased to 0.27 (95% CI, 0.12-0.63; *P*=.003) when the highest-quintile ADR category was reached and to 0.18 (95% CI, 0.06-0.56; *P*=.003) when the highest category was maintained.

Incomplete Resection Rates and Clinical Implications

Colonoscopy has a miss rate of approximately 17% for larger polyps (≥10 mm).[5,6] Interval cancers (with rare exceptions, such as hereditary syndrome cancers) indicate that the endoscopist missed lesions or did not completely remove them during the baseline examination (regardless of whether the examination was for screening or surveillance). Missed lesions reflect the quality of the examination. In an analysis of the Polyp Prevention Trial, which included 2079 patients, 13 had cancer detected throughout 5810 person-years of observation.[7] Among these 13 cases, 7 (53.8%) were a potentially "avoidable" cancer or one detectable at an earlier time interval owing to either incomplete removal (4/13) or missed cancer (3/13). In another study, 0.7 per 1000 persons who underwent a screening colonoscopy had a cancer that was missed at the baseline colonoscopy, and an additional 1.1 per 1000 persons subsequently developed an interval cancer from a missed adenoma.[8] Based on these data, it is expected that missed adenomas will lead to CRC in 1.8 per 1000 persons within 5 years.

The US Multi-Society Task Force (USMSTF) reported that while most interval cancers arise from missed lesions, a significant prevalence correspond to the site of polyp resection.[6] This finding implies the presence of an incompletely resected polyp at that site, resulting in residual neoplastic tissue. Flat lesions, particularly ses-

sile serrated polyps, are thought to be at higher risk. As these polyps increase in size, they become more challenging, and their edges become somewhat indiscriminate. These polyps are now increasingly being removed with submucosal lift techniques to optimize visualization of complete margins of the polyp and more accurately target complete resection.[9]

Incomplete polypectomy is related to interval cancers. Among patients with interval cancer, the cancer arises in an area of previous polypectomy in 19% to 27%.[5,7,8] Furthermore, in keeping that large sessile lesions (≥2 cm) have a greater risk of incomplete polypectomy, 17.6% of these patients have a residual adenoma at repeat examination.[10]

Another study assessed the quality of resection of smaller diminutive polyps.[11] A total of 117 polyps (mean polyp size, 3.66 mm ±1.13 mm) were randomly assigned to undergo resection with a cold snare vs cold forceps. The rate of complete eradication was 93.2% with cold snare vs 75.9% with cold forceps (*P*=.009). In a multivariate analysis, incomplete eradication was associated with the cold forceps method of polypectomy (odds ratio [OR], 4.750; 95% CI, 1.459-15.466; *P*<.05) and a polyp size of 4 mm or larger (OR, 4.375; 95% CI, 1.345-14.235; *P*<.05). The study authors concluded that 4 mm is too large to be successfully resected using the cold snare resection technique. Therefore, this study confirmed that optimal resection of diminutive polyps occurred with cold snare polypectomy, which showed better histologic eradication and greater efficiency.

A study evaluating interval CRCs attributed to endoscopists showed that even "good" endoscopists have room to improve.[12] The rate of interval CRCs diagnosed per outpatient colonoscopy examination was determined by measuring the incidence of CRC diagnosis in practice and by assessing, via a literature review, the percentage of cancers that were interval. Among 93,562 colonoscopies (performed by 120 physicians between 2013 and 2015), 526 CRCs were diagnosed (0.6%). The interval CRC rate was 5.25% based on the literature review. Thus, the rate of interval CRC among these cases was 1 per 3174 colonoscopies. Based on this model, an endoscopist with a median colonoscopy volume (316/year) in the lowest ADR quintile of detection (7%-19%) was calculated to have 1 interval CRC every 8.2 years. In comparison, this duration was 16.7 years among endoscopists in the highest ADR quintile of detection (33%-52%). During a 35-year career, this translates to 4.2 cases for those in the lowest ADR quintile vs 2.0 cases for those in the highest quintile.

Optimal colonoscopy performance includes both lesion recognition and appropriate intervention/resection. The ADR is necessary, although insufficient, for distinguishing high vs low endoscopist performance. The ADR assigns the same score regardless of whether 1 or more adenomas were detected. A study that compared the ADRs among 2 different endoscopy groups that treated the same patient pool demonstrated that despite minimal differences in the ADR between the 2 endoscopist groups, there were substantial differences in the total adenomas detected.[13] The reported ADR was 28.8% in the teaching endoscopist group (n=1218) and 25.7% in the nonteaching group (n=2100), a difference that was not significantly different (*P*=.052). Despite the relatively similar ADRs, endoscopists at the teaching site had higher detection rates of mean total adenomas (23.5% higher) and advanced adenomas (28.7% higher; *P*<.001). They also had a higher mean number of incremental adenomas detected after the first one (29.5% higher; *P*<.001). The results of this study imply that an endoscopist's performance may be more accurately measured by calculating the total number of adenomas instead of the ADR.

Incomplete resection has several negative sequelae. Importantly, an incomplete resection makes the subsequent resection more difficult; it may lead to a build-up of scar tissue and fibrosis. Incomplete resection, as discussed previously, is also associated with interval cancers.[6] In addition, it increases incremental cost owing to the need for a follow-up resection.

Achieving Complete Resection

The European Society of Gastrointestinal Endoscopy published performance measures for colonoscopy that specifically address polypectomy technique (a gap in the assessment by the USMSTF).[14] These guidelines recommended that a threshold of 80% be considered as adequate for endoscopists to choose the appropriate polypectomy technique, as selecting an inappropriate technique for polypectomy clearly increases the risk for inadequate resection.

Smaller Polyps

Cold snare polypectomy can be used for smaller polyps (Table 1).[15] A prospective, randomized controlled study from Japan compared outcomes from resection of small colorectal polyps with cold snare polypectomy performed with 2 types of snares that differed in wire thickness.[16] A total of 76 patients (210 polyps) were randomized to cold snare with each type of snare. The complete resection rate was significantly greater with the Exacto snare vs the SnareMaster (traditional) snare (91% vs 79%; *P*=.015). Notably, there was a marked, significant difference with flat and pedunculated larger (8-10 mm) polyps (83% vs 45%; *P*=.014).

As it relates to optimizing quality removal of smaller polyps, there is clear evidence that cold snare has better

Table 1. Cold Snare Endoscopic Resection of Diminutive Polyps: Clinical Pearls

• Secure a 2- to 4-mm clear margin
• Position the colonoscope straight, with a 5 o'clock position to the polyp
• Open the snare and lower it over the polyp – Tip the snare catheter, anchored several millimeters distally – Advance forward and angle the scope tip down into the wall – Deflation may improve submucosal gathering – Larger polyps may require partial release if there is entrapment in the muscularis
• For smaller polyps, withdraw to biopsy the channel – Suction as cut

Data from Hewett DG. Cold snare polypectomy: optimizing technique and technology (with videos). *Gastrointest Endosc*. 2015;82(4):693-696.[15]

histologic eradication.[17] A braided snare is another option, and may be particularly beneficial in sessile polyps smaller than 10 mm.[18]

A study from South Korea aimed to compare the complete resection rate of hot snare polypectomy with that of endoscopic mucosal resection (EMR) for small, sessile, or flat polyps sizes 5 to 9 mm.[19] For these small, nonpedunculated polyps, EMR was not superior to hot snare polypectomy with regard to complete resection or safety. Among 353 polyps (mean polyp size 6.3 mm ±1.3 mm), the rate of complete resection did not significantly differ between the hot snare polypectomy and EMR groups (88.4% vs 92.8%, respectively; *P*=.2). In a multivariate regression analysis, sessile serrated adenomas/polyps or hyperplastic polyps were nearly 3 times more likely to be incompletely resected compared with other conventional adenomatous polyps (OR, 2.824; 95% CI, 1.03-7.75; *P*=.044).

In the CARE study, larger polyps and serrated polyps were at higher risk for incomplete resection.[1] The IRR increased with increasing polyp size, and was 5.8% for polyps 5 to 7 mm, 9.4% for polyps 8 to 9 mm, 13.4% for polyps 10 to 14 mm, and 23.3% for polyps 15 to 20 mm. The resulting relative risks also increased with increasing polyp size, and were 1.66 (95% CI, 0.62-4.46) for polyps 8 to 9 mm, 1.95 (95% CI, 0.87-4.37) for polyps 10 to 14 mm, and as high as 3.21 (95% CI, 1.41-7.31) for polyps 15 to 20 mm. Polyp histology also impacted resection success, with an IRR of 7.2% with adenoma polyps, which increased 4-fold to 31.0% with sessile serrated adenomas/polyps (relative risk, 3.74; 95% CI, 2.04-6.84).

In a prospective observational study that evaluated 13 high-volume colonoscopists, the IRR increased with increasing polyp size. However, even with the smaller polyps, a significant IRR was observed.[20] Competency, as measured by a grade scale, was not reached; it was 70% for diminutive polyps, and dropped to 50% for small or large polyps.

Summary

Ultimately, the detection and complete removal of adenomas and sessile serrated polyps will have the greatest impact on outcomes in CRC. Although it can be helpful to improve the ADR, the completeness of polypectomy is the cornerstone of prevention. The challenge is in recognizing the consequences of incomplete resection and instituting ways to improve the IRR.

Disclosure

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Best Techniques to Perform a Submucosal Lift

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The combined use of submucosal lifting and snare, as is performed with EMR, allows full resection of virtually all lesions of any size. In fact, the completeness of the resection is limited only by the depth of invasion. Only approximately 2% of polyps are large (>2 cm). The majority of polyps are small (<1 cm) or intermediate (1-2 cm). In general, sessile or flat polyps that are 1 to 2 cm should be removed with submucosal lift coupled with EMR. This technique should also be used for all sessile serrated adenomas/polyps that are located in the right colon, particularly those larger than 1 cm.

Submucosal Lift Tips and Techniques

The general technique of submucosal lift begins with a needle device (Table 2). The injection is typically started on the immediate near side of the lesion and ideally extends through the normal adjacent mucosa. The injection can be administered to the near side or the far side of the lesion. In my practice, this choice is based on the need to use the injection to change the angle of approach. Polyps facing toward the endoscopist are in a favorable position. In contrast, polyps that are facing away from the endoscopist—for example, on the back of a fold—may be more difficult to inject. In this example, the injection of the solution may be applied at an angle to intentionally roll the polyp toward the endoscopist. The solution would be injected on the side farthest from the endoscopist, taking advantage of the lift to cause the polyp to become more en face to the endoscopist.

As the needle is advanced, the most common mistake is to inject too deeply. Some endoscopists may incorrectly attribute a nonlifting polyp to invasion or scarring. The more common reason for a nonlifting polyp is inappropriate injection depth. The needles, which are 4 mm to 5 mm, are capable of traversing the entire width of the bowel wall, which is 2 to 3 mm in the right colon. Thus, if

Table 2. Other Tips During Submucosal Lift and Polypectomy

• Biopsies are needed only when there is ample reason to believe that the lesion is an invasive cancer that would require surgery. A biopsy is often not necessary. For example, in cases of a laterally spreading granular polyp, a biopsy risks creation of scar tissue that could complicate subsequent resection.
• A tattoo should be placed at least 2 to 3 cm away from the lesion and on the opposite wall. The tattoo should not be placed too close to the polyp, in order to avoid scarring and fibrosis that can hinder subsequent resection.
• It cannot be predicted where the injectate will travel once injected; multiple injections may be needed to fully lift the polyp.
• In general, a stiff snare is desired. If a soft snare is used, the tip of the snare will flip up on the opposite side of the polyp when the hub of the catheter is pushed down. The shape of the snare chosen is less important than the fact that it is stiff.
• After the snare is carefully placed over the polyp with some margins, the colon is deflated slightly and the snare is closed tightly. A current is then applied, with the goal of minimal thermal injury, particularly to the deeper layers of tissue.
• It is critical to place the hub of the catheter below the level of the polyp. When the catheter is closed, the wires all pull toward the catheter. Thus, if the catheter is above the level of the polyp, the wires will pull up into the lumen and will either slip or not grab onto the polyp. Pushing the hub below the surface of the polyp forces the wires to pull downward upon closing.
• Turning the scope around in a retroflexion view can improve visualization of a polyp on the back side of a fold.
• It is advisable to avoid pure coagulation and deep cautery. Microprocessor-controlled currents, such as Endo Cut Q or the equivalent, are preferred.

the needle is pushed all the way into the hub of the catheter, the distal end of the needle may end up outside of the bowel wall. To overcome this, it is better to inject the needle at a shallow angle, thus reducing the angle between the needle approach and the wall. The needle should be angled just into the submucosa.

Two approaches may be used during the injection. The first is a "punch-and-pull" technique, in which the needle is pushed all the way to the hub, then the injection is started, and the needle is slowly pulled back. At the point where the needle tip enters the submucosal space, one can immediately start to see lifting. A benefit to this approach is that it is easy to reproduce. A drawback is that often the beginning of the injectate travels extraluminally (although this is likely not of clinical consequence). The second approach to injection is the "slow-push" technique, in which the tip of the needle is rested on the luminal surface without puncturing it. The assistant starts the injection while the endoscopist slowly pushes the needle forward, with lift beginning as the needle enters the submucosal space. The advantage to this approach is that the extraluminal injectate is avoided; however, the disadvantage is that there is occasionally an intramural injection between the lamina propria and the epithelium. I typically favor the punch-and-pull method. Once injected, the solution is distributed fairly evenly under the polyp.

An important technique during the submucosal lift is the dynamic scope deflection. The overall goal during submucosal lift is to create vertical height. The more vertical the polyp can be made, the more it becomes separated from the deeper layers (increasing safety) and the easier it becomes to grab with a snare. Thus, while the needle is first placed at a low angle into the deeper layers of the submucosa to start the injection, as lift begins to occur, the endoscopist may tip up with the scope and direct the needle into the superficial-most aspects of the submucosa. A higher vertical lift of the polyp is created both physically with the needle, as well as with the injectate.

Multiple punctures are typically needed to fully lift polyps larger than 2 cm. For these lesions, we inject enough solution to take 2 or 3 snare bites, then repeat the injection and follow with another 2 or 3 more snare bites.

During the submucosal lift, the placement of the snare is similar to that used in the cold snaring technique. Typically, the snare is opened above the lesion and then carefully lowered onto the lesion. Ideally, the snare emerges horizontal to the surface. When the snare emerges in another orientation, it is placed with the nearest side positioned to the surface first. Then the endoscope is turned so that the opposite side of the snare can come down. Often, the snare must be manipulated to achieve an ideal position.

General Considerations for Submucosal Lift

A good-quality submucosal lift with EMR requires adequate time and a dedicated team trained in the procedure. It is imperative to use the right tools (eg, a stiff wire gauge snare or a particular endoscope). It can be helpful to keep generator settings specific to the needs for EMR. The choice of the endoscope depends on the endoscopist's preference. An adult scope may be used for most lesions. A pediatric scope may be preferable if the polyp is located in the right colon or around the ileocecal valve, where there is a higher need to retroflect. In the rectum, an upper endoscope may prove more useful in order to improve the ability to retroflect. It is imperative to continually improve technical skills. Data suggest that it takes more than 125 of these procedures before the endoscopist becomes fairly proficient (IRR <25%).[1]

There are other more general considerations when it is known that the patient requires a submucosal lift with EMR. A perfect bowel prep is desired to minimize the likelihood of contamination in the rare event of a perforation. Split bowel preps are preferred. Longer appointment times are booked (eg, an hour) because it is critical to fully resect the entire polyp during the initial procedure. If only part of the polyp is removed, the remainder tends to become deeply scarred and will be even more difficult to resect at a later time. Most of these procedures are performed during monitored anesthesia care with propofol sedation. Moderate sedation is typically adequate, and can allow the patient to assist in moving and provide feedback regarding pain. Full anesthesia may be needed in certain cases, such as for lower rectal lesions, a patient with a low pain threshold, or a patient who had undergone a difficult colonoscopy previously.

Carbon dioxide (CO_2) is imperative for these procedures owing to the potential for perforation. CO_2 reduces this risk and also reduces postprocedural pain. The source of postprocedural pain can be difficult to ascribe to gas vs perforation. Tattooing capabilities are important to have, as are retrieval nets and baskets. There must be access to the tools necessary to manage complications, including epinephrine (1:10,000), clips for both bleeding and perforation, and thermal probes and coagulation graspers, which are particularly helpful for managing some larger bleeds.

Potential Benefits of the Submucosal Lift

Efficacy is one of the benefits to performing a submucosal lift. Flat and sessile polyps are particularly difficult to resect, and many snares (eg, nondedicated snares or softer wire snares) tend to slip over the top of them. When possible, stiff snares should be chosen, as they can be pushed down into the tissue. A submucosal lift creates a vertical height within an otherwise flattened polyp. A sessile

Figure 2. A 1-cm flat lesion in the ascending colon with a slight central depression. Image reprinted from Wallace MB. New strategies to improve polypectomy during colonoscopy. *Gastroenterol Hepatol (N Y)*. 2017;13(10)(suppl 3):1-12.[4]

Figure 3. The same lesion after a submucosal lift using a viscous agent with methylene blue. Image reprinted from Wallace MB. New strategies to improve polypectomy during colonoscopy. *Gastroenterol Hepatol (N Y)*. 2017;13(10)(suppl 3):1-12.[4]

Figure 4. The same lesion after en bloc resection, with clear lateral margins. Image reprinted from Wallace MB. New strategies to improve polypectomy during colonoscopy. *Gastroenterol Hepatol (N Y)*. 2017;13(10)(suppl 3):1-12.[4]

polyp, particularly a flat one, by definition does not have any vertical edges, and therefore there is little to grab onto with a snare. Vertical height must be created to snare the polyp effectively. Safety is another benefit. The procedure allows better separation of the polyp tissue being resected from the deeper layers. This separation can help to reduce perforation and injury, particularly to the muscle layer.

Comparing Submucosal Solutions

The injectate chosen for the submucosal lift procedure is also important. Saline is convenient. Historically, many endoscopists compounded their own mixtures to use for submucosal lift. These products were not standardized, and consisted of viscous solutions that had been shown in meta-analyses to be preferred over nonviscous solutions with regard to technical outcomes.[2] Some reports have included the addition of epinephrine (at a ratio of 1:20,000 to 1:200,000), but there is no clear evidence that adding epinephrine reduces clinically relevant bleeding. It may minimally reduce intraprocedural bleeding.

An agent with a colored dye allows the endoscopist to see both the polyp that is lifted, as well as the margins of the polyp. This visualization is particularly helpful for sessile serrated adenomas/polyps. These polyps tend to have indistinct lateral margins, which can lead to a significant underestimation of the lateral extent of the polyp. Use of a blue-colored submucosal injection agent can help show the true extent of the polyp (Figures 2-4).

Both indigo carmine and methylene blue have been used effectively. They are added to achieve a light ("sky blue") coloring, which is light enough to permit visualization of the submucosal blood vessels and the submucosal tissue. When a viscous solution is used, the injection needle may need to be switched to a slightly larger gauge (eg, 21 G). Notably, this switch does not apply to Eleview. Although Eleview is considered a viscous agent, it is not viscous at the time of delivery. Instead, it becomes viscous when it cross-links with the submucosal tissues. As a result, Eleview does not require a large gauge needle for injection.

Trial Data

We recently conducted a study in which Eleview was compared with a standard methylene blue saline solution in a double-blind manner.[3] The methylene blue saline solution was mixed so that it looked identical to Eleview. Patients who were undergoing EMR for colorectal non-pedunculated lesions sizes 20 mm or larger were randomly assigned to Eleview or the methylene blue saline solution. The primary endpoints were total volume to complete EMR and per lesion size and time of resection. Secondary endpoints included the Sydney Resection Quotient (SRQ), as well as other EMR outcomes and the rate of adverse events. The final analysis included 211 patients.[3] The mean size of the lesions was 33 mm ±13 mm, and 74% were located in the proximal colon. EMR was complete in all cases.

The total volume needed for EMR was significantly less in the Eleview arm compared with the methylene blue saline solution arm (16.1 mL ±9.8 mL vs 31.6 mL ±32.0 mL; $P<.001$; Table 3).[3] This difference translated to an average volume per lesion size of 0.5 mL/mm ±0.3 mL/mm with Eleview and 0.9 mL/mm ±0.6 mL/mm with the methylene blue saline solution ($P<.001$). The mean time needed to completely resect the lesion tended to be lower with Eleview vs the methylene blue saline solution (19.1 min ±16.8 min vs 29.7 min ±68.9 min), but this difference did not reach statistical significance ($P=.297$). The SRQ was significantly improved with Eleview vs the methylene blue saline solution (10.3 ±8.1 vs 8.0 ±5.7; $P=.04$). Trends for a lower number of resected pieces (5.7 ±6.0 vs 6.5 ±5.04; $P=.052$) and a higher rate of en bloc

Table 3. Outcomes in a Study of Eleview vs a Saline Solution

Endpoint	Eleview (n=102)	Saline Solution (n=109)	Difference: Eleview – Control	*P* Value
Total injected volume needed to complete the EMR procedure (mL)	16.1 ±9.8	31.6 ±32.0	–15.5	<.001
Total injected volume per lesion size (mL/mm)	0.5 ±0.3	0.9 ±0.6	–0.4	<.001
Injected volume needed to provide an initial lift (mL)	10.4 ±7.0	15.2 ±11.7	–4.8	<.001
Number of reinjections	1.0 ±1.4	1.8 ±2.7	–0.7	.159
Time to resect the lesion (minutes)	19.1 ±16.8	29.7 ±68.9	–10.5	.297
Time to perform the whole colonoscopy procedure (minutes)	46.4 ±18.2	51.8 ±28.4	–5.4	.188

EMR, endoscopic mucosal resection. Data from Repici A et al. A novel submucosal injection solution for endoscopic resection of large colorectal lesions: a randomized, double-blind trial [published online May 8, 2018]. *Gastrointest Endosc*. doi:10.1016/j.gie.2018.04.2363.[3]

resections (18.6% vs 11.0%; *P*=.1) were observed with Eleview; however, these differences were not statistically significant.

A similar rate of adverse events was reported in the 2 arms (18.6% with Eleview vs 17% with the methylene blue saline solution). No serious adverse events in either arm were considered related to the study treatment. There was a single perforation, occurring in the saline arm.

Disclosure

Dr Wallace has performed consulting for Olympus (2015), iLumen (2017), Cosmo Pharmaceuticals (2018), and Elsevier (2015-2019). He has received research grants from Boston Scientific, Medtronic, NinePoint Medical, and Cosmo Pharmaceuticals. He has stock/stock options in iLumen.

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Strategies to Lower Rates of Incomplete Resection in Small Polyps

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For polyps that are 1 to 2 cm in size, the risk of incomplete resection is greater with piecemeal resection vs en bloc resection. Piecemeal resections and fragmented polyp specimens are associated with a higher likelihood of an incomplete resection. In a recent study, piecemeal resection was the most important risk factor for IRR (OR, 28.696; 95% CI, 3.620-227.497; *P*=.001).[1] However, it is important to consider that en bloc resection of larger polyps (>2 cm) may pose safety concerns as well, and therefore the risk/benefit in each case should be customized.

EMR should be considered over standard (cold or hot) snare polypectomy for flat polyps that may be particularly difficult to capture with a snare, and for larger polyps, particularly those approaching 2 cm or greater in size. EMR should be favored especially in the proximal colon and cecum, where the colonic wall is the thinnest and the risk for perforation is the highest. In a recent

study that compared EMR vs cold snare polypectomy, particularly for the removal of small polyps (6-9 mm), the overall IRR for adenomatous polyps was significantly higher with cold snare compared with EMR (8.5% vs 1.5%; *P*=.001).[1] The cold snare technique was a stronger risk factor for incomplete resection (OR, 6.924; 95% CI, 2.098-24.393; *P*=.003) compared with EMR, in logistic regression analysis.

A submucosal lift can also help delineate polyp margins and improve complete resection rates. Adding a contrast dye agent to the submucosal injection solution can further help distinguish normal tissue from polyp margins more clearly and improve overall visualization of the lesion. This is especially true for sessile serrated adenomas/polyps, where a contrast dye agent can help delineate where the polyp margin ends and where the normal mucosa begins.

Additionally, it is possible that IRR may decrease when EMR is used together with thermal destruction (electrocautery) of any potential residual polyp tissue at the edges. It does seem that thermal destruction can lead to a benefit from the halo effect of thermal cautery. Thus, if an edge is not completely resected, thermal cautery can act to ablate the remaining polyp tissue around the resection margin. However, even with cautery-based resection, residual adenoma at the resection edges is present in approximately 10% of cases overall.[2]

For polyps smaller than 1 cm, EMR is superior to snare polypectomy for nonpolypoid lesions. However, flat lesions are most likely to be incompletely resected. It is usually possible to use a cold snare to remove truly polypoid lesions smaller than 1 cm. However, lesions with a sessile morphology are more likely to be completely resected when using some form of the submucosal lift and EMR technique. Once the lesion is lifted, there remains the question of whether a cold snare or a hot snare is better. Currently, there appears to be a trend toward the use of cold snare for these small lesions, but either approach is reasonable.

Cold Snare vs Hot Snare for Polyps <1 cm

A snare resection (either cold or hot) is superior to forceps removal. Previously, hot biopsy forceps were routinely used, but they have fallen out of favor. It is increasingly clear that cold snare is advantageous compared with hot snare. This is particularly true for high-risk locations, such as small polyps around a diverticulum or in the cecum. For example, in a prospective, randomized, single-center study that compared cold snare polypectomy with hot forceps biopsy in 283 polyps, cold snare was found to be more effective for resecting diminutive polyps.[3] The en bloc resection rate was significantly higher with cold snare vs hot forceps biopsy (99.3% vs 80.0%; *P*<.0001). Overall, the rate of complete resection was almost doubled with cold snare polypectomy vs hot forceps biopsy (80.4% vs 47.4%; *P*<.0001).

Figure 5. A 6-mm sessile polyp (not shown) was removed from this site by cold snare polypectomy. The histology was tubular adenoma. Image reprinted from Wallace MB. New strategies to improve polypectomy during colonoscopy. *Gastroenterol Hepatol (N Y)*. 2017;13(10)(suppl 3):1-12.[2]

Use of cold snare helps reduce the risk of perforation, postpolypectomy electrocoagulation syndrome, and delayed bleeding (although intraprocedural bleeding may still occur and is generally self-limited). Use of cold snare polypectomy is in fact thought to completely eliminate the risk of perforation.

Cold snare may be a faster alternative to hot snare (depending on how a particular unit is set up), reducing the total colonoscopy time. In a meta-analysis of randomized controlled trials, the average procedure durations ranged from 16.0 minutes to 23.3 minutes in the cold polypectomy group vs 25.0 minutes to 29.6 minutes in the hot polypectomy group.[4] Across studies, cold polypectomy procedures are significantly shorter in duration than those using hot polypectomy. Therefore, in busier units, cold snare may be a more efficient strategy for polypectomy while still maintaining high-quality polypectomy standards. Additionally, use of hot snare may lead to cautery artifacts that can confound assessment of histology.

In a technical review published by the American Society for Gastrointestinal Endoscopy (ASGE) in 2015,[5] cold snare polypectomy was recommended for all polyps sizes 1 mm to 9 mm (Figure 5).These guidelines note that cold biopsy forceps may be used, but only for polyps smaller than 3 mm that are in a difficult position for cold snare polypectomy. An example of this situation might be a polyp located in the upper field, where the colonoscope may not easily be rotated and maintained in position. The endoscopic visual field orientation may similarly impact the choice between cold snare and cold biopsy forceps. In the ASGE guidelines, cold snare polypectomy was also recommended for polyps sizes 6 mm to 9 mm.[5] Although

Table 4. Use of Submucosal Injection Solutions by Lesion Size

	<1 cm	1-2 cm	>2 cm
None used	87%	42%	24%
Normal saline without contrast agent	4%	14%	15%
Normal saline with contrast agent	3%	19%	26%
Eleview	2%	13%	23%
Voluven	0%	2%	2%
Other	4%	9%	9%

Data on file. Aries Pharmaceuticals Survey; 2018.[6]

hot snare polypectomy was also suggested for small polyps, in practice, it is generally recommended to use cold snare polypectomy for any polyp smaller than 10 mm.

Submucosal Lifting Agents

Submucosal lifting agents are routinely being used for EMR in many practices. The addition of dyes to these agents is a noted method to help achieve better delineation of lesion margins. Although traditionally these agents were mixed with methylene blue or indigo carmine, there has been a trend toward using the premixed solution, Eleview, since it gained approval from the US Food and Drug Administration for use in EMR. Anecdotally, nursing and support staff report that the premixed solution saves time, as mixing dye with another agent routinely takes 10 to 12 minutes. In busy units, this efficiency can be a strong benefit, particularly when considering the time needed for the procedure, sedation, and/or anesthesia and recovery times. In addition, many hospital-based pharmacies are now prohibiting ectopic site–based (endoscopy unit) mixing of submucosal solutions. Newer premixed solutions are currently in clinical development, and may become approved in the future.

A recent survey measured the awareness, trial, and usage of Eleview and other lifting agents.[6] A total of 426 physicians, both gastroenterologists and colorectal surgeons, were included. All physicians performed at least 40 colonoscopies and at least 15 polypectomies per month. They reported the use of submucosal injection agents in at least 5% of their interventions. A direct relationship was found between the use of submucosal injection solutions and polyp size (Table 4). For example, although 13% of physicians reported use of submucosal injection solutions for polyps smaller than 1 cm, this proportion increased to 58% with polyps 1 to 2 cm, and to 76% with polyps larger than 2 cm. For polyps smaller than 1 cm, 4% used a submucosal injection solution without a contrast agent and 3% used a solution with a contrast agent. There was an increase in the use of a contrast agent as the polyp size increased. For polyps 1 cm to 2 cm, 14% used a submucosal injection solution without a contrast agent and 19% used a solution with a contrast agent. For polyps larger than 2 cm, these rates were 15% vs 26%, respectively.

Disclosure

Dr Kaul is a consultant/speaker for Aries Pharmaceuticals and Olympus.

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Improving Rates of Incomplete Resection: New Approaches to Training and Education

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The detection and removal of colon polyps has made great strides in preventing colon cancer and reducing the incidence and mortality of CRC. Even with an ever-growing number of alternative options, colonoscopy remains the gold standard because it allows for not just the detection, but also the removal, of colon polyps. However, although colonoscopy with polypectomy is the key to preventing CRC,[1] quality metrics for polyp removal have not been a focus in teaching.

Optimally, a colon polyp is found and completely removed. The patient then undergoes appropriate surveillance at intervals based on his or her risk. In contrast, inadequate polypectomy can lead to an inappropriate surveillance recommendation or even interval cancer.[2,3] The CARE study demonstrated that incomplete resection is common, particularly for the smallest polyps.[4] The IRR was approximately 10% for polyps sizes 6 mm to 20 mm, and ranged from 8% to 38% for polyps that were 5 mm or less in diameter. Importantly, the participating physicians were aware that the aim of the study was to assess the completeness of polyp resection. Thus, these high IRRs occurred even when the physicians understood that their success rate would be measured.

Polypectomy Competency

We recently assessed colon polypectomy competency and its association with established quality metrics among a cohort of 13 high-volume screening attending gastroenterologists at an academic medical center.[5] In this assessment, polypectomy competency was measured using the Direct Observation of Polypectomy Skills (DOPyS) tool. We applied this tool to a group of practicing gastroenterologists to measure the correlation between polypectomy competency and established quality metrics (ADR and withdrawal time), and to determine if physicians who were competent in polypectomy showed similar competency in ADR and withdrawal time, and vice versa (ie, to determine whether high-performing detectors were also high-performing resectors).

The DOPyS tool was first developed and validated in the United Kingdom, where it was used to systematically evaluate competency in the UK bowel cancer screening program.[6,7] The DOPyS tool measures 33 individual skills. For example, one of the skills is "achieves optimal polyp view and position." Specific descriptors assigned to each skill provide guidance on how it should be scored. In this example, descriptors include "ensures clear views by aspiration/insufflation/wash"; "maintains optimal polyp position (5-6 o'clock)"; and "takes appropriate action for position correction and clear views throughout the procedure."

Overall polypectomy competency is graded from 1 to 4; a score of 3 or higher denotes competency. Specific parameters and descriptors within the tool help to guide the determination of the score, with 1 indicating many errors and incompetency; 2 indicating errors, with not all corrected; 3 indicating that errors were made but corrected; and 4 indicating expert competency.

Using this DOPyS competency assessment tool, we noted significant variability among gastroenterologists in terms of their polypectomy performance (P=.001), with overall polypectomy competency rates ranging from 30% to 90%.[5] In particular, there was significant variability, with an alarming number of attending practicing gastroenterologists who were not competent overall in their polypectomies. The mean score was 2.8, less than the score of 3 that reflects competency. Just 83 of 130 polypectomies (64%) were rated as competent; polypectomies were more likely to be judged as competent when performed on polyps smaller than 6 mm (70%) vs polyps 6 mm or larger (50%; P=.03). The mean DOPyS score with diminutive polyps was 2.9, vs 2.5 with small and/or large polyps (Figure 6).

Polypectomy competency rates, as assessed by DOPyS, did not correlate well with ADR (P=.2).[5] The data showed that even if the gastroenterologist was able to detect a polyp, this did not necessarily correlate with the competency to remove that polyp. For example, among the 4 gastroenterologists grouped into the highest ADR tertile (46% to 59%), 1 had a competency below the median score of 2.8. Among the 5 gastroenterologists grouped into the middle ADR tertile (36% to 42%), 3 scored below the median competency. In contrast, 2 of the 4 gastroenterologists grouped into the lowest ADR tertile

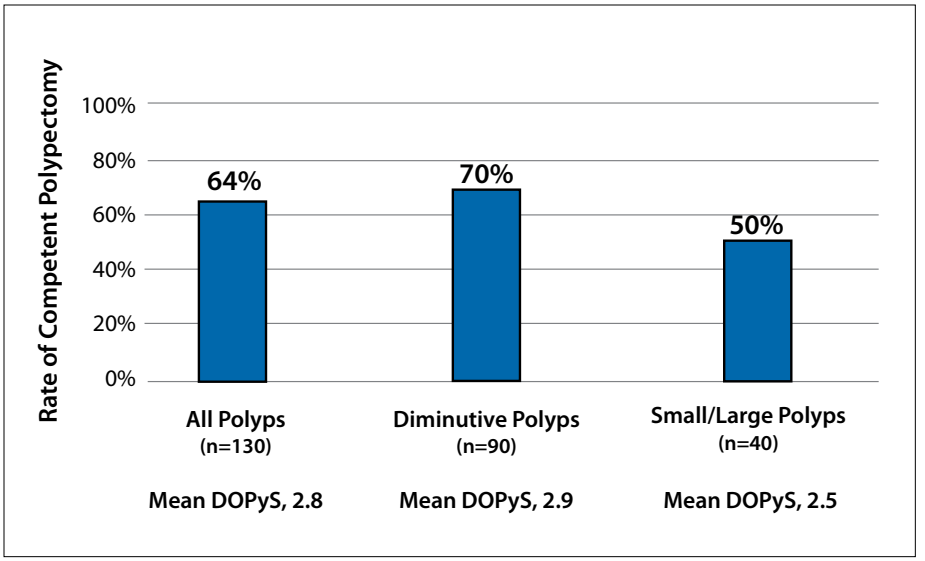

Figure 6. In a recent study of colon polypectomy, competency varied according to the size of the polyp. DOPyS, Direct Observation of Polypectomy Skills. Data from Duloy AM et al. Assessing colon polypectomy competency and its association with established quality metrics. *Gastrointest Endosc*. 2018;87(3):635-644.[5]

(25% to 33%) scored above the median polypectomy competency. Similarly, there was no significant correlation between polypectomy competency and the historical withdrawal time of the gastroenterologist (*P*=.5).[5] A gastroenterologist with a fast withdrawal time may still prove to be skillful in polyp removal, whereas a slow and meticulous withdrawal time did not necessarily translate to polypectomy competency.

Competency for individual skills was also assessed.[5] Among the 130 polypectomies evaluated, 61% showed competency to achieve optimal polyp position (*P*<.001 among gastroenterologists), 72% showed competency to determine the full extent of the polyp (*P*<.04 among gastroenterologists), and 70% showed competency in use of the appropriate technique (*P* value not significant among gastroenterologists). Competency in the adjustment or stabilization of the scope position was seen in 58% of polypectomies (*P*=.001), examination for the remnant or stalk base was seen in 57% (*P*<.001), and identification and treatment of residual polyps was seen in 58% (*P*<.001). However, only half of the polypectomies evaluated (50%) showed competency in capturing the appropriate amount of tissue within the snare. This skill also proved to significantly vary among the colonoscopists (*P*=.001).

This study indicates a significant need for training on polypectomy, with a focus on improving polypectomy techniques overall. Additionally, it is apparent that a global improvement in polypectomy across all polyp sizes is needed, as inadequate competency was observed for both diminutive polyps (which account for 70% to 80% of all polyps), as well as small and large polyps (which represent 10% to 15% and 5% to 10% of all polyps, respectively).

Polyp Removal Recommendations by the ASGE

In 2015, the ASGE published a technical review on the management of colorectal polyps, with recommendations regarding the endoscopic treatment of colon polyps.[8] For diminutive polyps (1-5 mm), cold snare polypectomy was suggested, with a note that cold biopsy forceps should be reserved for polyps less than 3 mm or for those polyps in a difficult position for cold snare polypectomy. For small polyps (6-9 mm), suggested approaches included cold snare or hot snare polypectomy. Suggested techniques for the removal of larger polyps differ according to the type of polyp. For example, EMR with blended or microprocessor-controlled current is recommended for flat and sessile polyps (10-25 mm). The suggested strategies for the removal of sessile polyps (>15 mm [nongranular] or >25 mm [granular]) include EMR with microprocessor-controlled current and endoscopic submucosal dissection (particularly for lesions with a moderate risk for submucosal invasion in the rectum or low sigmoid colon). Also for these polyps, the ASGE review notes that patients should be referred to a tertiary care polypectomy service.

Removal of Diminutive Polyps (≤3 mm)

In clinical practice, there is variability in the methods to remove diminutive polyps (≤3 mm). A survey of 285 US gastroenterologists between 2002 and 2003 showed marked differences in the removal techniques for small polyps, according to their size.[9] For example, cold forceps (50%) followed by hot forceps (33%) were the preferred methods for polyps 1 mm to 3 mm, whereas cold snare (5%) or hot snare (5%) were less common. In contrast, for polyps 7 to 9 mm in size, few gastroenterologists

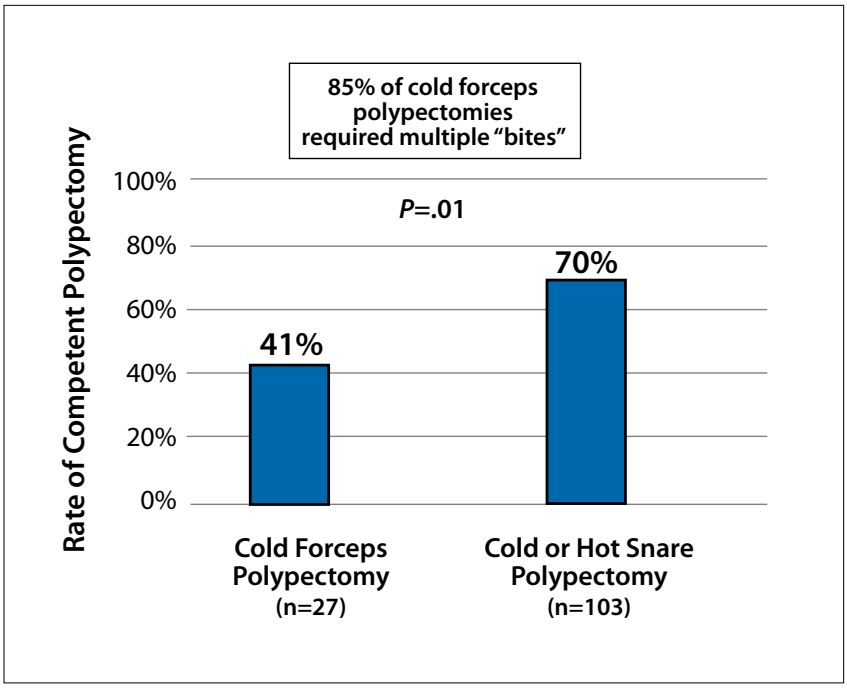

Figure 7. Significantly less competency was observed when polyps were removed with cold forceps vs either cold or hot snare. Data from Duloy AM et al. Assessing colon polypectomy competency and its association with established quality metrics. *Gastrointest Endosc*. 2018;87(3):635-644.[5]

reported using cold forceps (2%), hot forceps (4%), or cold snare (6%). For these polyps, hot snare was by far the most preferred technique (80%). For polyps of intermediate size (4 to 6 mm), there was no clear preferred technique (18% preferred cold forceps, 21% preferred hot forceps, 15% preferred cold snare, and 31% preferred hot snare).

A similar survey that evaluated US practitioners in 2013 showed practice shifts in preferred polypectomy techniques for diminutive polyps.[10] For polyps 1 mm to 2 mm, use of cold forceps was the preferred method (80.5%), followed by cold snare (9.5%); the use of hot forceps (5.3%) and hot snare (1.8%) was more rare. Polyps sizes 3 mm to 4 mm were most likely to be removed using cold forceps (60.4%) or cold snare (35.5%), followed by hot forceps (10.1%) and hot snare (7.7%). For polyps that are 5 mm, either cold snare (53.9%) or hot snare (34.3%) techniques are preferred, although a significant proportion of gastroenterologists preferred cold forceps (27.2%) or hot forceps (11.2%). Importantly, hot biopsy forceps have little role in the removal of diminutive polyps, as they are associated with higher rates of incomplete resection and can make tissue difficult to interpret pathologically.[11] Additionally, the use of hot biopsy forceps may result in increased rates of complications, including postpolypectomy syndrome, delayed bleeding, and perforation.

Several studies have evaluated the use of cold forceps to remove polyps smaller than 5 mm.[12-16] Together, these studies show an unacceptably high average IRR of approximately 26%. One reason for this high rate is that in cold forceps biopsy, 1 bite is not enough. As demonstrated in one of these studies, complete visual eradication of the polyp with 1 forceps bite was achieved in just 78.8% of polyps resected using jumbo forceps and in 50.7% of polyps resected using standard forceps.[16] In fact, to achieve full polypectomy, a median of 2.5 bites was needed with standard cold forceps, and a median of 2.2 bites was required with jumbo cold forceps. In these cases, cold snare provides an effective alternative to avoid a need for multiple bites with cold forceps.

Cold snare has shown higher rates of complete histologic resection. In a meta-analysis of 5 randomized controlled trials, including a total of 668 patients and 721 polyps, incomplete polyp removal was significantly lower with the cold snare/jumbo forceps biopsy technique than with the cold biopsy technique (relative risk, 0.40; 95% CI, 0.26-0.62).[17] When considering just those studies which included cold snare (not jumbo forceps), there remained a significantly higher rate of complete histologic resection compared with cold forceps. Looking back at our study of polypectomy competency, significantly less competency was observed when polyps were removed with cold forceps vs either cold or hot snare (41% vs 70%, respectively; *P*=.01; Figure 7).[5] Additionally, we found that 85% of polyps removed using cold forceps required multiple bites.

Taken together, the evidence shows that for diminutive and small polyps, cold snare polypectomy should be considered the technique of choice to achieve complete

resection of colon polyps. Teaching this technique in academic institutions and fellowship curriculums, as well as communicating the benefits to community gastroenterologists, is of paramount importance in order to ensure complete polyp eradication.

Removal of Larger Polyps

In the CARE study, larger polyps (10 to 20 mm) were 2-fold more likely to be incompletely removed compared with smaller polyps (5 to 9 mm), with a relative risk of 2.1 (95% CI, 1.13-3.86).[4] The risk of incomplete resection increases with each incremental increase in polyp size. Compared with polyps sizes 5 to 7 mm (IRR, 5.8%), the relative risks for incomplete resection of larger polyps were 1.66 for polyps 8 mm to 9 mm (95% CI, 0.62-4.46; IRR, 9.4%), 1.95 for polyps 10 mm to 14 mm (95% CI, 0.87-4.37; IRR, 13.4%), and 3.21 for polyps 15 mm to 20 mm (95% CI, 1.41-7.31; IRR, 23.3%). Sessile serrated adenomas/polyps were nearly 4 times more likely to be incompletely resected than other types of adenomas/polyps (IRR, 31.0% vs 7.2%; relative risk, 3.74; 95% CI, 2.04-6.84).[4] Among the sessile serrated adenomas/polyps, size matters as well, with large (10 to 20 mm) sessile serrated adenomas/polyps showing a 47.6% IRR compared with 31.0% in smaller sessile serrated adenomas/polyps.

For these larger sessile serrated lesions, EMR is the preferred means for removal.[18] In this method, a fluid is injected into the submucosa to lift the lesion away from the mucosa. This creates a mound in the submucosa, lifting the polyp to allow a snare to be placed around the mound. The polyp can then be effectively captured, snared, and removed in a complete fashion, eradicating the polyp. EMR is a key method to help lift flat lesions, allowing them to be more easily captured in a snare. Advances in EMR have been made—for example, adding dye to the injected fluid—allowing for a contrast to help the inspection of the resected area and removal of any residual polyp tissue to achieve complete eradication.

We conducted a retrospective evaluation of EMR outcomes at 2 centers, with a focus on the use of EMR for resection of large sessile serrated adenomas/polyps.[19] Among 199 patients included in this analysis, the median size of the index polyp was 15 mm. After a median follow-up of 25.5 months (±17.4 months), the rate of local recurrence was 3.6% (95% CI, 0.5-6.7). Importantly, the lesions that recurred were diminutive (median, 4 mm), which allowed them to be treated endoscopically. These results suggest that implementing EMR for large (≥10 mm) sessile serrated adenomas/polyps is an effective strategy that can improve upon the IRRs observed with other techniques, such as hot snare alone.

Advancing Polypectomy Training and Education in Attending Physicians

Cumulative data show that the cold snare technique should be used for diminutive polyps and the EMR technique should be used for larger polyps, particularly for sessile serrated adenomas/polyps sizes 10 mm or larger. Based on these data, and with the knowledge of current competency deficits among attending gastroenterologists, we hypothesized that feedback with a focused polypectomy report card and video-based teaching could improve polypectomy competency. We created teaching modules on specific skill sets involved with polypectomy, focusing on optimal polyp position, adjustment/stabilization of scope position, selection of appropriate technique, accurate positioning of the snare over the polyp, trapping of the appropriate amount of tissue within the snare, and assessment and treatment of residual polyps. Each module was between 7 and 10 minutes long. We then evaluated the role of this video teaching, as well as feedback on achieving polypectomy competence, among 13 practicing gastroenterologists.[20]

Phase 1 of this study involved a baseline assessment of competence, in which 2 raters with expertise in polypectomy graded polypectomy technique (using the DOPyS tool) in 10 randomly selected polypectomies from each gastroenterologist.[20] Baseline competencies were then assigned to each gastroenterologist. In the second phase of the study, we recorded additional polypectomies (forming a pre–report card). In the third phase, a post–report card competency evaluation was performed. Between phases 2 and 3, personalized report cards with instruction videos were delivered to each of the gastroenterologists, with the goal of determining if this feedback resulted in a difference between the competency rates. The mean polyp size and the number of diminutive polyps did not significantly differ between the phases.[20]

In both phases, all polyps were less than 17 mm. The mean DOPyS score was significantly increased between the pre– and post–report card phases (2.7 ±0.9 vs 3.0 ±0.8; P=.01).[20] Notably, this improvement was observed for diminutive polyps (2.7 ±0.9 vs 3.3 ±0.8; P<.0001), but not for larger polyps (2.7 ±0.7 vs 2.4 ±0.9; P=0.3). The rate of competent polypectomy was significantly improved from the pre– to the post–report card phase (56% vs 69%; P=.04). Again, this improvement was observed for diminutive polyps (57% vs 81%; P=.001), but not larger polyps (55% vs 36%; P=0.2). Most polyps were removed by cold snare in both phases. However, cold snare use was increased significantly between the pre– and post–report card phases (58% vs 76%; P=.001). Additionally, the rate of piecemeal polypectomy significantly decreased from the pre– to the post–report card phase (40% vs 21%; P=.001).

Although this study showed that overall polypectomy competency among attending gastroenterologists could be significantly improved with a polypectomy report card and video-based teaching, most of the improvement was based on increased competency in the removal of diminutive polyps. Thus, different education strategies may be needed to improve the resection of larger polyps.

Advancing Polypectomy Training and Education in Fellows

The report card study can increase understanding of how to improve the education of practicing colonoscopists. However, education interventions earlier in the process—for example, for trainees during their fellowship—are an important means to ensure the highest competency rates from the beginning. In an effort to achieve this, we are currently conducting the COMPLETE study (Improving Competency and Metrics for Polypectomy Skills Using Evaluation Tools and Video Feedback) at various academic centers.[21] This study is evaluating the use of similar teaching modules and video feedback to improve IRRs and polypectomy technique among fellows. In COMPLETE, we are focused on the use of cold snare polypectomy of polyps that are 10 mm or smaller. We are assessing the trainees' competency using the DOPyS score, and providing them competency learning curves on a cumulative/sum analysis. We hope to gain a better understanding of the learning curve for cold snare polypectomy in trainees to ultimately optimize the teaching and performance of this procedure.

Summary

For diminutive or small polyps, cold snare polypectomy seems to be the best technique to achieve complete removal. For sessile serrated adenomas/polyps sizes 10 mm or larger, the most complete removal seems to occur with the EMR technique. Our data show that these techniques are underutilized for the appropriate polyps, creating a significant area of teaching for both attending physicians and trainees.

Disclosure

Dr Kaltenbach is a consultant for Olympus America and Aries Pharmaceuticals.

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Incomplete Resection Rates in Polyps Smaller Than 2 Centimeters: Q&A

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G&H How can training and education be improved to encourage a change in behavior?

Tonya Kaltenbach, MD, MS Our study that evaluated competency among attending endoscopists demonstrated that they did not increase their use of endoscopic mucosal resection (EMR) with submucosal injection, even after video education and direct feedback.[1] The reasons for this might be 2-fold. First, there were fewer large polyps (10 to 20 mm) in the study. Second, the EMR with submucosal injection is a technique that requires instruction before use in clinical practice. Teaching is critical.

Potentially, we could add injection methods and techniques as one of the education modules. We can highlight the studies that demonstrate a significant improvement with this polypectomy approach, perhaps leading to more widespread adoption.

Michael B. Wallace, MD, MPH It is necessary to undertake an initiative equivalent to the EQUIP trial (Endoscopic Quality Improvement Project), but for polypectomy technique. In the EQUIP trial, about a decade ago, we started retraining practicing physicians on how to increase their adenoma detection rate (ADR).[2] We took a multipronged approach to training. We presented lectures on why it is important to increase ADR, showed examples of subtle and difficult polyps, and presented better techniques to achieve good bowel prep, tip deflecting behind folds, good insufflation, and colonic washing. In EQUIP, we provided regular feedback, informing the participants of their ADR on a monthly basis. The study showed that these interventions resulted in widespread improvements in ADR.

Applying these same principles to training in polypectomy could prove very effective. We can re-educate even practicing physicians on common areas that have room for improvement. It requires a multipronged approach. Other groups have tried just the feedback approach, and that did not work particularly well.[3] EQUIP showed the value of a multipronged approach, as well as the importance of regular, nonpunitive feedback.

Approximately 50% of interval cancers can be attributed to a missed lesion. Up to 20% to 25% of interval cancers are attributable to an incomplete polypectomy. This issue should be fairly easy to address. There is an important opportunity to improve polypectomy technique, both for small lesions and larger ones.

Disclosures

Dr Kaltenbach is a consultant for Olympus America and Aries Pharmaceuticals. Dr Wallace has performed consulting for Olympus (2015), iLumen (2017), Cosmo Pharmaceuticals (2018), and Elsevier (2015-2019). He has received research grants from Boston Scientific, Medtronic, NinePoint Medical, and Cosmo Pharmaceuticals. He has stock/stock options in iLumen.

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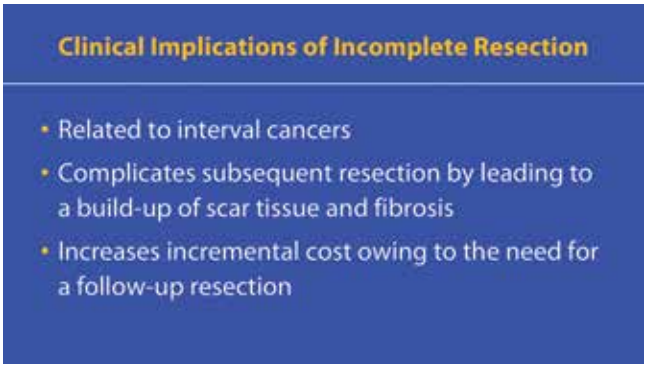

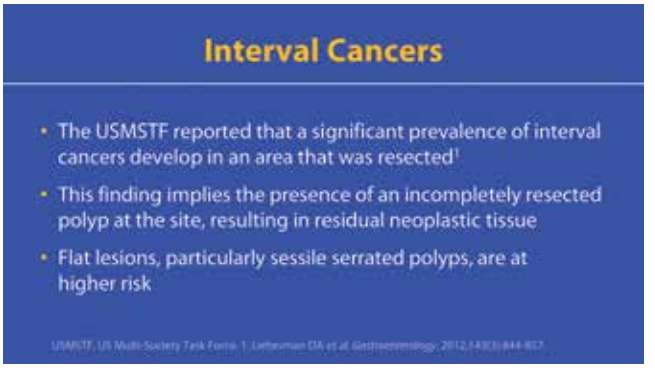

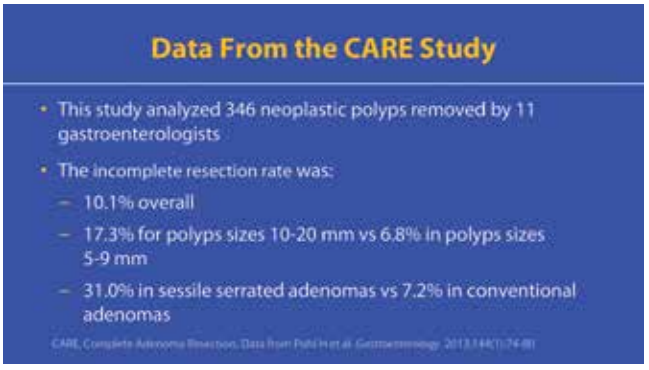

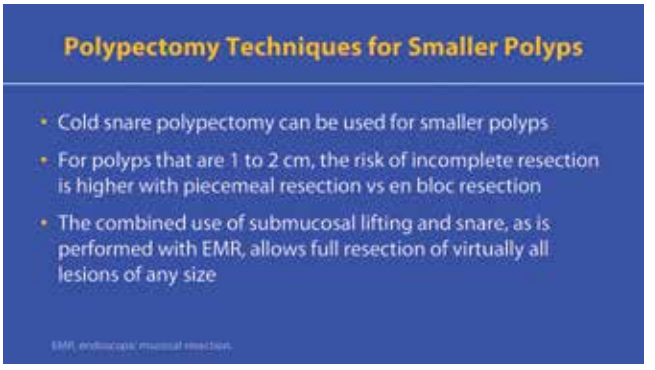

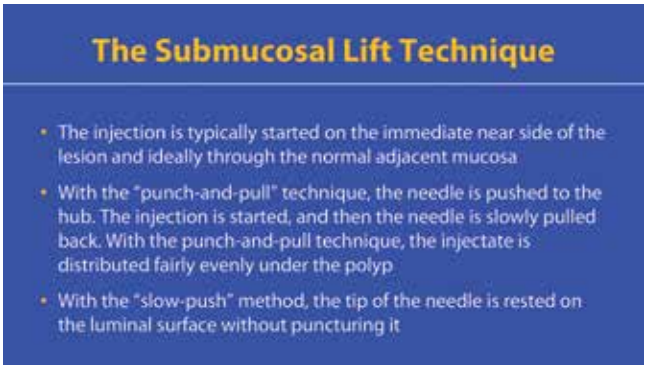

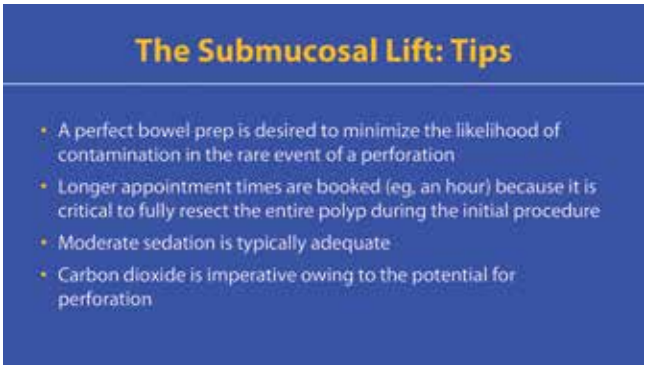

Agents for the Submucosal Lift Procedure

- Historically, many endoscopists compounded their own mixtures
- An agent with a colored dye allows the endoscopist to see both the polyp that is lifted, as well as the margins of the polyp. This visualization is particularly helpful for sessile serrated adenomas/polyps. These polyps tend to have indistinct lateral margins, which can lead to a significant underestimation of the lateral extent of the polyp

Data for Eleview

- Eleview was compared with a standard methylene blue saline solution in a double-blind study. The final analysis included 211 patients
- The total volume needed for EMR was significantly less in the Eleview arm compared with the methylene blue saline solution arm (16.1 mL ±9.8 mL vs 31.6 mL ±32.0 mL; *P*<.001). This difference translated to an average volume per lesion size of 0.5 mL/mm ±0.3 mL/mm with Eleview and 0.9 mL/mm ±0.6 mL/mm with the methylene blue saline solution (*P*<.001)
- The SRQ was significantly improved with Eleview vs the methylene blue saline solution (10.3 ±8.1 vs 8.0 ±5.7; *P*=.04)

EMR, endoscopic mucosal resection; SRQ, Sydney Resection Quotient. Data from Repici A et al. A novel submucosal injection solution for endoscopic resection of large colorectal lesions: a randomized, double-blind trial [published online May 8, 2018]. Gastrointest Endosc. doi:10.1016/j.gie.2018.04.2363.

Polypectomy Competency

- A recent study evaluated colon polypectomy competency and its association with established quality metrics among a cohort of 13 high-volume screening attending gastroenterologists
- Polypectomy competency rates among gastroenterologists ranged from 30% to 90%
- Among 130 polypectomies, 83 (64%) were rated as competent. Polypectomies were more likely to be judged as competent when performed on polyps <6 mm (70%) vs polyps ≥6 mm (50%; *P*=.03)
- Polypectomy competency rates did not correlate well with ADR

ADR, adenoma detection rate. Duloy AM et al. Gastrointest Endosc. 2018;87(3):683-644.

Training and Education to Improve Polypectomy Techniques

- An improvement strategy can follow the same approach as the EQUIP trial,[1] which increased ADRs
- The strategy in the EQUIP trial incorporated lectures on why it is important to increase ADR, showed examples of subtle and difficult polyps, presented better clinical techniques, and provided regular feedback
- EQUIP showed the value of a multipronged approach, as well as the importance of regular, nonpunitive feedback

ADR, adenoma detection rate; EQUIP, Endoscopic Quality Improvement Project. 1. Coe SG et al. Am J Gastroenterol. 2013;108(2):219-226.

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