Prateek Sharma, Section Editor

How to Perform High-Quality Endoscopic Mucosal Resection During Colonoscopy

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Colonoscopy with polypectomy reduces mortality from colorectal cancer.[1,2] A small fraction of polyps are >2 cm and termed lateral spreading lesions (LSLs) of the colon.[3] These polyps require advanced resection techniques such as endoscopic mucosal resection (EMR) for safe and effective removal. However, colonic EMR is not routinely part of the general endoscopic curriculum available to gastroenterologists upon completion of their training. It requires dedicated training in advanced endoscopic resection techniques, the acquisition of clinical and interpretive skills, and the knowledge and ability to manage complications.[4]

Performing high-quality, safe, and effective colonic EMR requires a team effort both inside and outside the endoscopy suite. To achieve this, colonic EMR for advanced lesions should be performed preferably in tertiary referral centers. This provides a large case volume for training fellows and the opportunity for a multidisciplinary team structure including surgical, radiologic, and anesthetic support. This multifaceted and comprehensive approach provides the necessary context for advanced endoscopic tissue resection procedures.

Over the last decade, a steady accumulation of scientific evidence has elucidated the technical aspects of colonic EMR,[5] including safety and efficacy,[6] long-term outcomes,[7] and the clinical and economic benefits compared with surgery.[8,9] An intimate knowledge of the evidence base is critical to achieve technical competence. Herein we review the step-by-step evidence-based methodology for performing best practice colonic EMR.

Preprocedural Assessment and Care: "This Is Not Your Standard Open-Access Procedure"

Community gastroenterologists who discover large LSLs during routine colonoscopy usually refer patients for colonic EMR. It is important to emphasize to the patient the differences between standard polypectomy and EMR, and to ensure the patient is fully consented to the procedure and its alternatives. The patient's medical history including medication list need to be reviewed thoroughly and the patient's comorbidities constantly factored into the therapeutic process.

Be prepared and organized. Preferably, a dedicated list should be scheduled for such procedures. All the required equipment should be readily available in the endoscopy suite and both physician and nurse need to be familiar with their use (Table 1).

Before commencing resection, take time to meticulously inspect the lesion with high-definition white light and chromoendoscopy or "virtual chromoendoscopy" (we use narrow band imaging). A thorough assessment can identify lesions with possible submucosal invasion. This is of great importance, because it may result in a different endoscopic approach or referral for surgical treatment.

Lesion Assessment: "Not Every Lesion That Can Be Removed Should Be"

The Paris classification of superficial neoplasia should be used for morphologic classification[14,15] in combination with surface topography (granular or nongranular). The Paris classification and surface topography are helpful in stratifying the risk of submucosal invasion.[6,16,17] Focal interrogation uses narrow band imaging to assess the surface pit pattern according to the Kudo classification[18] and the vascular patterns according to the Sano classification or more recently the Narrow-Band Imaging International Colorectal Endoscopic (NICE) criteria.[19,20] In expert hands, focal interrogation is accurate in identifying histologic subtypes and predicting submucosal invasive cancer.[20–23] Tubular adenomas typically have large or elongated pits (Kudo type III) and an organized brown capillary network surrounding the pits (Sano type 2/NICE type 2). Villous adenomas have more complex branching gyrus like pits (Kudo type IV). Submucosal invasive cancer is suspected when irregularly mixed types or nonstructural or absent pits are present (Kudo type V), or when irregular complex branching

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0016-5085/$36.00
http://dx.doi.org/10.1053/j.gastro.2016.12.029

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Table 1. Recommended Endoscopic Equipment for Colonic EMR

Equipment	Recommendations/Evidence
Microprocessor-controlled electrosurgical generators	Minimizes potential for deep tissue injury during resection Snare excision - Endocut Q effect 3 (ERBE VIO, Tübingen Germany) Coagulation of bleeding – Soft coagulation 80-W effect 4 (ERBE VIO)[10]
Insufflation	CO_2 significantly reduces post procedural admissions for pain during colonic EMR[11]
Colloid solution for submucosal injection	Succinylated gelatin (Gelofusine; Braun, Melsungen, Germany) was superior to normal saline in a randomized trial requiring significantly fewer injections, fewer resections, and an overall reduced EMR time[12] Alternatives: Normal saline, hydroxyethyl starch
Inert dye	80 mg indigo carmine or 20 mg methylene blue in 500 mL solution
Adrenaline	1:100,000 May be effective in decreasing delayed bleeding[13]
Snares	Stiff 20- or 15-mm snares with a braided wire are preferred for en bloc and piecemeal EMR, respectively. Small thin wire (0.3-mm monofilament) snares may enable better tissue capture in poorly lifting lesions (ie, previously attempted lesions, recurrence after EMR, periappendiceal lesions)[5]
Coagulation of IPB	Management of IPB can be achieved quickly, safely and effectively with STSC[10] Coagulating forceps are used for more severe bleeding or if STSC fails after 2-3 attempts Clips are used less often as they tend to get in the way, and may not adequately compress small bleeding vessels[4]

EMR, endoscopic mucosal resection; IPB, intraprocedural bleeding; STSC, snare tip soft coagulation.

capillaries or avascular areas are seen (Sano type 3/NICE type 3). Often, a clear demarcation line can be discerned between the background regular pattern of the noninvasive adenoma and the irregular area of the suspected invasive component.

Resection Technique: "Make a Plan and Be Prepared"

EMR is a multistep process (Figure 1).

- Optimize your access and secure a good endoscopic position with a shortened, straight, and relaxed endoscope. Position the lesion at 6 o'clock in the endoscopic field. Position the patient in a way that any fluid or resected specimens accumulate away from the lesion. This ensures a clean, unobscured working field and enables optimal views and swift therapy in the event of a complication.
- Formulate a resection strategy; ideally, commence in the least accessible area.
- An uncomplicated inject and resect piecemeal EMR is then typically composed of 3 steps which are performed repetitively: injection, 1–3 snare excisions, and then inspection of the mucosal defect (Figure 2).
- A good injection should be dynamic and elevate the tissue into the lumen and toward the colonoscope.
- For piecemeal EMR, start at 1 edge of the lesion and try to include a 2- to 3-mm margin of normal mucosa. Use the edge of the advancing mucosal defect as a convenient step for the next snare placement to reduce the risk of adenoma islands.
- En bloc snare excision is appropriate for lesions up to 20–25 mm and is associated with lower rates of recurrence compared with piecemeal resection.[24] Larger LSLs require piecemeal EMR for complete removal.[5,25]
- Thermal ablative techniques (argon plasma coagulation) to treat visible residual adenoma should be avoided as this is associated with high rates of recurrence.[26,27] Complete snare excision should be the goal.
- After each resection, the mucosal defect should be cleaned with the colonoscope fluid jet (these authors use saline because it is isotonic) to ensure no adenoma islands remain and to exclude deep mural injury; it also provides some tissue elevation.
- Some LSLs are found in unique locations. In such cases, small adjustments to the standard technique may be necessary (Table 2).

Dealing With Complications: "Anticipate, Prevent, and Treat With Confidence"

Complications during or after EMR are inevitable with any significant procedural volume and to some extent predictable; however, they are managed readily and safely if recognized early. Delayed recognition may lead to serious sequelae. As such, endoscopists performing colonic EMR need to be familiar with their presentations and management. Bleeding is the most common complication and can be categorized as intraprocedural bleeding (IPB) or delayed bleeding.

- IPB occurs in up to 11% during EMR, is rarely serious and readily amenable to endoscopic hemostasis.[32] Risk

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