EMR and ESD:
Tools and Techniques

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U.S. Colorectal cancer statistics
1990 - 2011

Number per 100,000 persons
Incidence
Mortality
Year
U.S. Colorectal cancer statistics 1990 - 2011

- Incidence:
  - 1991-2000: -9%
  - 2001-2010: -24% (+15%)

- Mortality:
  - 1990: -13.7%
  - 2011: -23.2% (+9%)

Large colon polyps

- Associated with higher rates of high grade dysplasia and carcinoma
- More difficult to remove
- Polypectomy associated with more complications
- Traditionally sent for surgical resection
- Endoscopic options now include EMR and ESD
Endoscopic mucosal resection (EMR): definition and rationale

Fluid is injected into the submucosal space to expand this layer, separating the mucosal lesion from the underlying muscularis propria. The lesion is then resected by snare electrocautery. The technique is intended to reduce the risk of inadvertent thermal injury or mechanical resection of the muscularis propria and lower the risk of perforation.

Burgess NG. Gastrointest Endosc 2014;81:813-835
EMR techniques

- Injection-assisted
- Cap assisted
- Ligation assisted (Duette)
Cap assisted EMR

Informed consent

- Greater risk of bleeding and perforation than standard colonoscopy
- Discuss surgical alternatives and need for shortened surveillance interval (especially with piecemeal resection)
- Possibility of surgery even if successful if carcinoma on the resection specimen

Conio M. Gastrointest Endosc 2004;60:234-41
EMR equipment

- Stiff monofilament wire snare
  - Variety of shapes and sizes
- Injection needle
  - Saline +/- methylene blue
  - Dilute epinephrine
- Cautery unit, APC
- Hemoclips
- Retrieval net

CO₂ insufflation

- CO₂ insufflation reduces post-procedure discomfort
- CO₂ insufflation reduces post-procedure hospital admission by 62%
  - Prospective cohort, 575 lesions
  - Mean size of 36.5 mm
  - No difference in complications

Wang WL. *Aliment Pharmacol Ther* 2012;35:1145-54
Bassan MS. *Gastrointest Endosc* 2013;77:90-5
Assessment of polyp

• Should not be firm, indurated, friable or eroded
• May require retroflexion to examine the proximal aspect
• Consider referral for lateral extent greater than 1/3 circumference, longitudinal extent greater than 2 haustral folds, extension into a diverticulum or appendiceal orifice


Imaging of polyp

• Indigo carmine/methylene blue spray to assess lateral margins
• NBI, i-Scan and FICE
• Plan approach for resection including subsequent piecemeal steps
Predictors of submucosal invasion

- Paris classification O-IIa+C
- Nongranular surface pattern
- Kudo pit pattern type V
- Failure to lift with injection

Paris classification

- 0-Ip: pedunculated
- 0-Is: sessile >2.5 mm
- 0-IIa: minimally elevated <2.5 mm above the surrounding mucosa
- 0-IIb: flat
- 0-IIc: depressed
- 0-III: excavated
- Combinations of these (i.e., 0-IIa + 0-Is)
Laterally spreading tumors (LST)

- **Granular**: incidence of submucosal invasion of 3.2% to 7.0%

- **Non-granular (smooth)**: incidence of submucosal invasion of 14.0% to 15.3%
Non-lift sign

- Definition: polyp does not fully lift despite an adequate injection plane and volume
- Indicates increased risk of an invasive lesion that has progressed beyond the submucosa
- Also occurs with previous (partial) polypectomy attempt, scarring or tattoo
- Lesions with overt cancer and non-lifting should be biopsied but not removed endoscopically
Saline-lift rationale

- Cushion of saline can facilitate ensnaring of sessile and flat polyps and allow for a more complete resection
- The saline cushion increases the distance between the cautery effect and muscularis/serosa, possibly reducing the risk of injury
- Chromic dye should be incorporated into the submucosal injection solution
  - Methylene blue or indigo carmine
  - Facilitates identification of fluid cushion extent and lesion margins (adenoma to normal tissue transition)
  - Identifies deep mural injury
- Can use epinephrine (1:100,000) to allow for a “dry” field

Chino A. Gastrointest Endosc 2004;59:374-9
Norton ID. Gastrointest Endosc 2002;56:95-9
Saline-lift technique

- Sclerotherapy needle, tangential approach (<30 degrees), starting proximal (cecal-side)
- Start injection upon entering mucosa, though some advocate on withdrawal
- Four quadrant lift not necessary
- Consider injecting within large polyps or re-injecting during piecemeal resection
- Slow injection, well coordinated with the endoscopy nurse or tech
- Technique of dynamic/active injection

Snare choice and shapes

- 20mm serrated
- 15mm oval
- Hexagonal
- Mini oval
- Micro oval
- Traction snare
- Combo
- Duckbill
Removal technique—initial approach

- Position polyp at 5–6 o’clock position
- Positioning often easier on withdrawal given natural reduction of loops
- Consider pediatric colonoscope, patient position, external manual pressure and upper endoscopy vs. double channel scope
- For polyps larger than 2 cm, plan a piecemeal approach
- Suction air while closing snare and re-insufflate to assess the ensnared portion of the polyp

Uno Y, Munakata A. Gastrointest Endosc 1994;40:485-9

Electrocautery is key

- Little evidence to guide exact practice and considerable heterogeneity of studies
- Currents are pure cut, pure coagulation and blended (spectrum between the two)
- Newer machines fractionate between cut and coag phases and adjust outputs based on tissue impedance
- APC used to treat areas with residual or equivocal adenoma/polyp (or snare tip soft coag or hot biopsy strip technique), although effectiveness of these technique unclear
Electrosurgery Modes

Blended fractionated mode

- Initial incision (phase)
- Cutting phase
- Coagulation phase
Polyp tattooing

- Submucosal tattoo should be used to mark difficult or high-risk lesions with a concern for HGD or cancer for subsequent surgical or endoscopic treatment
- Mark (2-3 times) 2 to 3 cm from lesions where subsequent endoscopic treatment is planned because of the risk of submucosal fibrosis
- Mark consistently and notify surgeon (distal alone, lateral, proximal + distal)
- Use similar tangential technique and consider submucosal injection with saline first to raise a bleb
- Carbon – particle suspension (SPOT)
Tips and tricks for EMR

- Carefully examine lesion, if too complex—refer
- Make sure the scope is straight without loops
- Position the patient such that the fluid pool is opposite the polyp (right-lateral or supine)
- Consider retroflexed position and upper endoscopy scope
- Consider use of a cap
- Aspirate gas in lumen and use CO₂
- Align the resection area to be at 5-6 o’clock
- Begin submucosal dynamic injection
- Apply snare to capture a rim of normal tissue
- Use deliberate snare closure technique

Dynamic positioning

Koksal AS. Can J Gastroenterol 2013; 509-512.
Snare closure technique

- Close snare until target tissue is seated within the snare and loop of snare just entering the snare sheath
- Aspirate gas again while pushing down firmly (up/down wheel) and closing the snare to resistance
- Re-insufflate and confirm proper ensnaring
- Move sheath back and forth to assess mobility (snared tissue should move independently of colon wall)
- If snare capture optimal, close snare until tight
- With full snare closure use minimal electrocautery to completely resect tissue (typically 1-2 seconds)
- After resection, irrigate the defect and carefully inspect for evidence of deep injury and complete resection

Injection assisted polypectomy-1
Injection assisted polypectomy-2

Injection assisted polypectomy-3
Injection assisted polypectomy-4

Residual polyp during EMR

- Saline lift can be used for remaining tissue, even through the mucosal defect
- Remove 1-2 mm of normal tissue from polyp edge to avoid residual polyp
- APC to fulgurate remaining tissue may increase the adenoma eradication rate
- Consider changing to a micro snare which opens completely in a tighter space

Hurlstone DP. *Endoscopy* 2006;38:945-6
Regula J. *Endoscopy* 2003;35:212-8
Zlatanic J. *Gastrointest Endosc* 1999;49:731-5
The problem of incomplete resection

- Prospective study of 346 polyps in 1427 patients who had at least one sessile polyp 5 – 20 mm in size
- Biopsies taken at the margin after endoscopic resection was deemed complete
  - 10% incomplete resection
    - Size >10 mm RR 2.1
    - Sessile serrated RR 3.7

Pohl H. Gastroenterology 2013;144:74-80

Avulsion is superior to APC

- Retrospective analysis of 223 EMR cases

- Conclude recurrence rate for avulsion much less than for APC post piecemeal EMR

Holmes I. Gastrointest Endosc 2016; in press
Adverse events

- Perforation: 0 - 0.3%
- Bleeding: 1.4 – 11%
- Multiple procedures: 40-55%

Iishi H. Gastrointest Endosc 2000;51:697-700

Post polypectomy bleeding
Delayed bleeding

- Occurs in about 2% of polypectomies
  - 1% for polyps < 1.0 cm
  - 6.5% for polyps > 2.0 cm
- Develops average of 2-7 days after
- Two general causes:
  - Sloughing of eschar covering a blood vessel
  - Excavation of zone of thermal necrosis
    induced by electro-thermal cautery

Risk factors for delayed bleeding

- **Definite**
  - Increasing polyp size
  - Proximal colon location
  - Anticoagulation
  - Anti-platelet agents
- **Probable**
  - Coagulation current
  - Endoscopist experience

Choung BS. *J Clin Gastro* 2014;48:784-789
Prevention of bleeding principles

- Optimize coagulation status
- Use cold snare to remove polyps <1 cm
- Large polyps especially on right side of colon lift first with saline injection
- Consider detachable loop for large pedunculated polyps
- Consider hemoclips

Removal of colorectal polyps (<1 cm) in anticoagulated patients

Immediate Bleeding

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Delayed Bleeding

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<td>$P = 0.027$</td>
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Horiuchi A. Gastrointest Endosc 2014;79(3):417-23
Hemoclips for polyps >2 cm

Prophylactic hemoclips

- 184 patients who received polypectomies and hemoclips
- 184 matched controls who received polypectomies without clips
  - Matched by size, morphology, technique, number of polyps and anticoagulants
- Average of 3.8 polyps/pt with clips vs. 3.3 polyps/pt in controls
- Delayed post polypectomy bleeding:
  - 3 patients receiving hemoclips (1.6%), 2 with polyps <1 cm on coumadin and thienopyridine
  - 1 control patient (0.05%, \( P = .62 \))
- Cost $64,000/year at study center for prophylactic hemoclips
- Prophylactic hemoclip placement may not decrease the rate of post polypectomy bleeding and is not cost effective

Liaquat H. Gastrointest Endosc 2013:77:401-7
Prophylactic hemoclips after polypectomy: systemic review and meta-analysis

• Systematic search of literature
• Initial search 1217 studies of which 38 studies reviewed
• 12,108 patients with 8,354 polypectomies
• Delayed post polypectomy bleeding:
  – 1.1% patients receiving hemoclips
  – 0.82% control patients ($P = .84$)
• No publication bias noted
• “Use of prophylactic clip placement after any snare polypectomy is probably not warranted.”


Preventing adverse events

• EndoLoop
  – Detachable ligation snare for thick stalked polyps

• Epinephrine injection into the stalk can shrink the polyp to facilitate removal

Underwater EMR (UEMR)

Traditional EMR with distension of the wall with air flattens out lesions and thus requires injection of submucosal fluid. Water immersion polypectomy allows for the mucosa to fold and take on a polypoid shape (not the muscularis propria), does not require injection and perforation is unlikely.
**Underwater EMR initial study**

- 62 large polyps (mean 30 mm diameter) in 60 patients
- All underwent mini-probe EUS and water immersion (0.5 – 1.0 L) EMR using a cap without sub-mucosal injection
- All completed in one procedure
- No perforations, 3 (5%) patients had delayed hemorrhage but no intervention needed
- One patient had a distant, small adenoma on 3 month follow-up

Binmoeller KF. *Gastrointest Endosc* 2012;75:1086-91

**Water immersion technique polypectomy: large sessile colorectal polyps**

- Retrospective analysis of 72 patients with 139 polyps removed, 72 done using WEMR technique
- Mean size of biggest polyp 21.2 + 9.2 mm
- Prophylactic clipping in 71% and rebleeding in 9.7% (7 patients)
- No perforations and all polyps completely removed
- Conclude: water immersion polypectomy for large sessile polyps is a safe and effective technique

Overall, the limitations of the technique are that the non-lifting sign for submucosal invasive cancer is lost, there may be more delayed post polypectomy bleeding and the outcomes of perforation with a water-filled bowel are unknown.

**Laparoscopic colonic resection**

- Sometimes necessary for cecal polyps or those at turns, folds or endo unresectable
- Need to clearly mark during colonoscopy
- Can be combined endoscopic:
  - Laparoscopy-assisted endoscopic resection (LAER)
  - Endoscopy-assisted laparoscopic wedge resection (EAWR)
  - Endoscopy-assisted laparoscopic transluminal resection (EATR)
  - Endoscopy-assisted laparoscopic segment resection (EASR)
- Very low conversion rate (3.7%) to open laparotomy

Mönkemüller K. *Clin Gastro Hepatol* 2009;7:641-52

**EMR vs. surgery outcomes**

- 186 large sessile polyps in 167 patients
- Median size 30 mm (up to 80 mm)
- 90% avoided the need for surgery
- 95% procedural success (excluding those with invasive cancer)
- Adverse events:
  - No perforations
  - 10 (5.4%) immediate hemorrhage
  - 7 delayed (3.7%) hemorrhage
- $6990 per patient savings compared to if they had been sent for surgical resection

Swan MP. *Gastrointest Endosc* 2009;70:1128-36
Endoscopic submucosal dissection: ESD definition

ESD is a technique pioneered in Japan for the treatment of early gastric cancer. It involves the use of specially engineered electrosurgical needles or knives, injection to infiltrate the submucosal space, allowing concurrent lifting and dissection of the submucosal layer. The technique now has a central role in the management of early esophageal and gastric cancers.

Burgess NG. Gastrointest Endosc 2014;81:813-835

<table>
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<th>Feature</th>
<th>Targeted organ</th>
<th>Tasks</th>
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<td>Stomach (2.0 mm, 1650 mm)</td>
<td>Marking, Incision, Dissection</td>
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<td>IT knife- nano (Olympus)</td>
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<td>Colon, Eso (1.5 mm, 1950 mm)</td>
<td>Incision, Dissection Inside—Outside</td>
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<td>Hook knife (Olympus)</td>
<td></td>
<td>Stomach, Eso (1650 mm)</td>
<td>Incision, Dissection Fibrosis, Narrow submucosal space</td>
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Indications for ESD

1) Large Lesions for which *en bloc* resection with EMR is not feasible
   - laterally spreading tumor (LST)

a, b: LST- granular type

c, d: LST-non granular type
Indications for ESD

2) Mucosal lesions with submucosal fibrosis
   - previous EMR attempt or biopsy
   - sporadic tumor with IBD background

Injection solutions

1. Normal saline
2. 6% hydroxyethyl starch plus saline
3. Carboxymethyl cellulose (CMC)
4. Hydroxypropylmethylcellulose (HPMC)
5. Hetastarch

Plus
- 0.1% Epinephrine (1 mL/100 mL; 1/100,000) to avoid bleeding
- Methylene blue (0.25 mL/100 mL) to distinguish submucosal tissue

Gels available in the US
ESD compared to EMR

(1) More accurate histologic assessment: This may be of benefit with subtle submucosal invasion that could be missed or misinterpreted with multiple piecemeal specimens. In practice, this has not proven to be clinically relevant.

(2) Reduced recurrence: Long-term outcomes from large, prospective, EMR series show that recurrence usually is small and is treated easily in follow-up, with no impact on the likelihood of long-term remission.

(3) The possibility of cure in low-risk submucosal invasive cancer: Low risk assumes <1000 mm depth of invasion from the muscularis mucosa and absence of lymphovascular involvement, tumor budding, or poor differentiation. Such cases are infrequent (6-12% ESDs)

ESD disadvantages

• Need extensive training
• Has a longer procedure time
• Increased risk of perforation
• Mandatory hospitalization (multiday)
• Increased costs (and lack of reimbursement)
• Unclear current indications for colonic ESD over EMR
**Surveillance post EMR/ESD**

- Recurrent or residual adenoma at the first surveillance colonoscopy (typically 3-6 months) is reported in 10% to 30% of large, prospective series of EMR outcomes
- Associated with larger lesions and the use of thermal ablative therapies in which snare resection has been incomplete
- Piecemeal resection warrants 3-6 month surveillance and continue at 3-12 months until completion is documented
- Then follow usual surveillance guidelines based on pathology of original specimen

**Advanced polypectomy summary**

- Large flat or sessile polyps can be safely removed endoscopically with good technique
- Intent should always be for complete removal once EMR is begun
- Injection assisted polypectomy facilitates removal and may increase safety
- Use careful, deliberate polypectomy technique
- ESD should be used rarely and only by experts
- Close surveillance post EMR/ESD is needed