Colon Endoscopic Mucosal Resection: State of the Art in 2014

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Gastrointestinal Neoplasms

Role of the Endoscopist

- Colon Neoplasia
  - Diagnosis
  - Staging
  - Palliation
  - Treatment
Concept

- Removal of the mucosa and part of the submucosa without disruption of the muscularis propria
Outline

- Science Behind EMR
- Equipment Needed
- Techniques
- Outcomes
- Complications
- Barriers
THE SCIENCE
Layers of the Gastrointestinal Tract
Colorectal Neoplasia
Staging and Risk of Lymph Nodes

<table>
<thead>
<tr>
<th>T Stage</th>
<th>Depth</th>
<th>Lymph Node Mets (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tis</strong></td>
<td>Neoplastic cells in epithelium (High Grade Dysplasia, Carcinoma In Situ or Intraepithelial Neoplasia)</td>
<td>&lt;1%</td>
</tr>
<tr>
<td></td>
<td>Neoplastic cells into lamina propria (Intramucosal Carcinoma)</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>T1</strong></td>
<td>Neoplastic cells into submucosa</td>
<td>8.22%¹</td>
</tr>
</tbody>
</table>

- Risk of lymph node disease in T1 carcinomas is low (~1%¹,², even with deep submucosal invasion, if:
  - Well-differentiated, low-grade tumor
  - No lymphovascular invasion

¹ Nakadoi K et al, *Journal Gastroenterology and Hepatology*, 2014
² Yoshi S et al, *Clin Gastroenterology and Hepatology*, 2014
THE TOOLS
Colon Endoscopic Resection Tools

Choice of Endoscopes

- Consider use of alternate endoscopes to facilitate visualization
  - Upper endoscope may allow retroflexion and greater maneuverability in the distal colon
  - Pediatric colonoscope is more flexible, but has a smaller working channel
Colon Endoscopic Resection Tools

**Injectate**

- A submucosal injection is performed for two reasons
  - To lift the polyp up, away, from the muscle and serosal layers
  - To define the deep layer after polypectomy
Colon Endoscopic Resection Tools

**Injectate**

- Components of injection solution
  - Solution for cushion
    - Normal Saline
    - 3% Normal Saline
    - Artificial Tears
    - Hydropropyl Methylcellulose
    - Hyaluronic Acid

- Definition of deeper resection margins
  - Methylene blue
  - Indigo Carmine
Colon Endoscopic Resection Tools

Snares

- Variety of snare types each with own utility
  - Shapes (Oval, Crescent, Hexagonal)
  - Specialty Characteristics (i.e. barbed, needle tip, rotatable)
  - Combination with injector needle
What Determines the Risk?

Electrosurgical Considerations

- Electrosurgical units produce their desired effect through the use of high frequency alternating currents.

- In the setting of snare polypectomy, two conceptual modes are present:
  - Cutting (High current density): Cells rapidly “burst” which thus results in cutting effect
    - Increased immediate bleeding risk
  - Coagulation (Lower current density): Cells desiccate, resulting in coagulation effect
    - Increased thermal injury

- In practice, settings can be manipulated to produce varying ratios of cutting and coagulation.

Endoscopic Clips

- Clips may reduce postpolypectomy bleeding
- Can endoscopically close perforations
Over the Scope Clip

- Allows for closure of larger perforations and bleeding sites.
- Clip is positioned over a cap on the endoscope to allow the endoscopist to suction mucosa into the cap and capture more tissue.
- Clips come in a variety of sizes for different locations.
Hemostasis Devices

- **APC**
  - Therapy applied to rim of polypectomy site and visible tissue
  - Shown in a randomized trial to reduce recurrence after piecemeal resection

- **Monopolar forceps using soft coagulation current**
THE TECHNIQUES
Consent

- Appropriate to consent patients regarding the risks of perforation, bleeding, and incomplete resection
  - Perforation risk may be as high as 2% for colon EMR
  - Bleeding risk may be as high as 20%
- Patients should understand that they will likely need to come back for surveillance exams

Walsh RM, GIE, 1992
Binmoeller KF, GIE, 1996
The Dos and Don’ts

- **DO**
  - Have needed equipment available for both the resection and any potential complications
  - Try to utilize carbon dioxide insufflation
  - Allot enough time to complete the resection

- **Do NOT**
  - Start a resection you do not intend to complete
  - Inject tattoo (e.g., Spot) underneath the polyp
Injection Technique

- Two equally acceptable techniques for injection
  - Poke and inject
  - Inject and poke
Improving Adenoma Detection

Flat Polyps

- Flat lesions are difficult to detect as they may not be well differentiated from the surrounding mucosa
Injection Facilitates Recognition of Polyp Borders
Ascending Colon Polyp

Endoscopic Mucosal Resection
Rectal Polyp
*Endoscopic Mucosal Resection*
Cecal Retroflexion Facilitates Complex Right Colon Polyp Removal
THE OUTCOMES
Endoscopic Mucosal Resection

Risk Factors for Unsuccessful EMR

- Of 479 referred polyps in a prospective multicenter study, endoscopic resection was successful in 84%

<table>
<thead>
<tr>
<th>Risk Factors for Failed EMR</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Intervention</td>
<td>3.75</td>
<td>1.77-7.94</td>
<td>0.001</td>
</tr>
<tr>
<td>IC valve involvement</td>
<td>3.38</td>
<td>1.20-9.52</td>
<td>0.021</td>
</tr>
<tr>
<td>Difficult Position</td>
<td>2.17</td>
<td>1.14-4.12</td>
<td>0.019</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Factors for Adenoma Recurrence</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion size &gt; 40 mm</td>
<td>4.37</td>
<td>2.43-7.88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>APC Use</td>
<td>3.51</td>
<td>1.69-7.27</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Moss A et al, Gastroenterology, 2010
Long-Term Outcomes of EMR

- Risk factors for recurrent adenoma were lesion > 40 mm, use of APC, and intra-procedural bleeding
- 93% of endoscopic recurrences managed endoscopically
Cost Savings of Colon EMR

<table>
<thead>
<tr>
<th>Cost and Length of Stay of EMR Compared to Surgery (Hypothetical), n=174</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMR Cost</strong></td>
</tr>
<tr>
<td>Total Cost for Cohort</td>
</tr>
<tr>
<td>Total Cost per Patient</td>
</tr>
<tr>
<td>Total Length of Stay for Cohort (days)</td>
</tr>
<tr>
<td>Total Length of Stay per Patient (days)</td>
</tr>
</tbody>
</table>

Of 174 consecutive patients, 90% treated successfully endoscopically - 95% of adenomas successfully treated

Swan MP, GIE, 2009
OOPS!
Is a Surgery for a Benign Polyp Really Benign?

<table>
<thead>
<tr>
<th>Table 2. Surgical Outcomes of Benign Colon Polyps (n=359)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Hospitalization</strong></td>
</tr>
<tr>
<td>Length of Stay, Mean (SD)</td>
</tr>
<tr>
<td>Charges, median (IQR)</td>
</tr>
<tr>
<td>Costs, median (IQR)</td>
</tr>
<tr>
<td>Adverse Events Delaying Discharge</td>
</tr>
<tr>
<td><strong>12-Month Outcomes</strong></td>
</tr>
<tr>
<td>Readmissions for adverse events</td>
</tr>
<tr>
<td>Adverse events at initial hospitalization and/or resulting in readmission</td>
</tr>
<tr>
<td>Mortality</td>
</tr>
<tr>
<td>Total days hospitalized*, mean (SD)</td>
</tr>
<tr>
<td>Total hospital charges*, median (IQR)</td>
</tr>
<tr>
<td>Total hospital costs*, median (IQR)</td>
</tr>
</tbody>
</table>

Keswani RN et al, DDW, 2015
### Complications from Removal of Large Colon Polyps (n=479)

<table>
<thead>
<tr>
<th>Complications</th>
<th>n</th>
<th>% of Total Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Procedural Pain</td>
<td>10</td>
<td>2.1%</td>
</tr>
<tr>
<td>Post-Polypectomy Syndrome</td>
<td>7</td>
<td>1.5%</td>
</tr>
<tr>
<td>Bleeding</td>
<td>14</td>
<td>2.9%</td>
</tr>
<tr>
<td>Perforation</td>
<td>6</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

**Other Outcomes**

<table>
<thead>
<tr>
<th>Other Outcomes</th>
<th>n</th>
<th>% of Total Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submucosal Invasion</td>
<td>33</td>
<td>6.9%</td>
</tr>
<tr>
<td>EMR Not Attempted</td>
<td>15</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

*Moss A et al, Gastroenterology, 2010*
Case Presentation

- A 55 year old female presented for surveillance colonoscopy to her primary gastroenterologist. A 25 mm nonpolypoid (Paris O-Ia) lesion was seen in the mid-ascending colon and was biopsied to be a tubular adenoma.
Colon Polyp
Colon Polyp in Retroflexion
Colon Perforation Noted
Clip Closure
Case Presentation

- Admitted to hospital
- Made NPO with intravenous antibiotics
Perforation Management

- Prevent oxygenation/ventilatory problems
- Needle decompression
- Carbon dioxide
Needle Decompression

- Rapidly accumulating peritoneal air results in decreased lung capacity and patient discomfort
- Needle decompression allows reduction of pneumoperitoneum which would also allow for completion of endoscopic procedure
Needle Decompression

- What do you need?
  - Betadine to sterilize skin
  - Angiocath or other similar needle attached to saline syringe
Carbon Dioxide

- Consider carbon dioxide insufflation to decrease risk of pneumoperitoneum after perforation has occurred in procedure high risk for perforation
Ask for Help if you Need It

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Post Perforation Management

- NPO
- Appropriate antibiotics
- Choose your surgeon wisely – they need to be “on board” with nonsurgical management and their team should manage as a postoperative patient (frequent checks)
- Consider needle decompression if not done previously
Case Presentation

- 56 year old male referred for sigmoid polyp seen on screening colonoscopy
Post-Polypectomy Bleeding

What Determines the Risk

- Polyp Factors
  - Polyp Location
  - Polyp Size

- Patient Factors
  - Medications
  - Medical Comorbidities

- Procedure Factors
  - Electrocautery Settings
  - Prophylactic Measures

- How bleeding is defined
## Post-Polypectomy Bleeding

### Overall Risk in **Routine** Colonoscopy

<table>
<thead>
<tr>
<th>Study</th>
<th>Intra-procedural</th>
<th>Post-procedural</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ko CW et al (2010)$^1$</td>
<td>0.06%</td>
<td>0.159%</td>
<td>• ~ 50% of patients underwent polypectomy</td>
</tr>
<tr>
<td>N=21,375 (Prospective)</td>
<td></td>
<td></td>
<td>[CORI Database]</td>
</tr>
<tr>
<td>Levin TR et al (2006)$^2$</td>
<td></td>
<td>0.32%</td>
<td>• 0.48% in patients who underwent biopsy/polypectomy</td>
</tr>
<tr>
<td>N=16,318 (Retrospective Cohort)</td>
<td></td>
<td></td>
<td>[Kaiser System]</td>
</tr>
<tr>
<td>Warren JL et al (2010)$^3$</td>
<td></td>
<td>0.87%</td>
<td>• (Only for those with polypectomy)</td>
</tr>
<tr>
<td>N=29,988 (Administrative) (Medicare)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabeneck L et al (2008)$^4$</td>
<td></td>
<td>0.16%</td>
<td>• Odd’s Ratio for Bleeding if polypectomy performed 10.32</td>
</tr>
<tr>
<td>N=97,091 (Administrative) (Canadian Institute for Health Information)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This translates into approximately 20,000 occurrences of clinically significant post-polypectomy bleeding after colonoscopy **annually** in the U.S.

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1 Ko CW et al, *Clin Gastro and Hepatology*, 2010
What Determines the Risk?

*Location (in the colon) Matters*

- Case control study at 4 centers (2 academic, 2 community) - 39 events and 117 controls
- Right vs. left bleeding
  - Odds’ ratio was 4.67 (1.88-11.61)\(^1\)
  - OR 3.65 (0.72-18.64)
  - OR 13.82 (2.66-71.73) \(P=0.002\)
  - OR 2.19 (0.32-15.00)
  - OR 2.00 (0.39-10.36)
  - OR 1.00

- Similar findings in a prospective study of large polyps (n=1172)\(^2\) with an Odds’ ratio for right vs. left of 3.72 (2.08-6.67)

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What Determines the Risk?

Medications

Rate of Bleeding Is Increased with Antiplatelet and Anticoagulation Therapy

- Post-Polypectomy Bleeding Rate
- No antiplatelet/anticoagulation: 0.64%
- Antiplatelet therapy (nonaspirin): 2.50%
- Anticoagulation Therapy: 3.40%

1 Parikh ND et al, Clin Gastro and Hepatology, 2013
What Determines the Risk?

Electrosurgical Considerations

- Electrosurgical units produce their desired effect through the use of high frequency alternating currents
- In the setting of snare polypectomy, two conceptual modes are present
  - Cutting (High current density): Cells rapidly “burst” which thus results in cutting effect
    - Increased immediate bleeding risk
  - Coagulation (Lower current density): Cells desiccate, resulting in coagulation effect
    - Increased thermal injury
- In practice, settings can be manipulated to produce varying ratios of cutting and coagulation

Morris ML et al, American Journal of Gastroenterology, 2009
What Determines the Risk?

Electrosurgical Considerations

- A “smart” electrosurgical unit has a microprocessor which accounts for the varying tissue impedance during polypectomy and limits peak voltage.
- A microprocessor-controlled electrosurgical unit may reduce the risk of clinically significant post-procedure bleeding.

<table>
<thead>
<tr>
<th>Electrosurgical Current</th>
<th>Intra-procedural Bleeding</th>
<th>Clinically Significant Post-procedural Bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microprocessor-controlled</strong></td>
<td>11.6%</td>
<td>5.8%</td>
</tr>
<tr>
<td>“Blended”</td>
<td>15.3%</td>
<td>8.5%</td>
</tr>
<tr>
<td><strong>Pure Coagulation</strong></td>
<td>4.3%*</td>
<td>15.2%**</td>
</tr>
</tbody>
</table>

* p=0.21; ** p=0.033

Burgess NG et al, Clin Gastro and Hepatology, 2013
Reducing the Risk  
Avoidance of Electrocautery

- A large body of literature has demonstrated the safety and efficacy of snare polypectomy without the use of any electrocautery

- Associated with a very low risk of post-polypectomy bleeding

- This reduction was also present in anticoagulated patients in a recent randomized study of 70 patients with significantly lower delayed bleeding in cold vs. hot snare polypectomy groups (0% vs. 14%, p=0.027)

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1 Repici A et, *Endoscopy*, 2012  
What Determines the Risk?

Injectate Considerations

- Dilute epinephrine within the injection solution has a likely advantage of reducing immediate bleeding though this has not been clearly shown\(^1\),\(^2\).

- It is unclear whether reducing immediate bleeding is beneficial as it may obscure a window for potential intervention prior to procedure termination.

\(^1\) Hsieh YH et al, *Hepatogastroenterology*, 2001
Post-Polypectomy Bleeding Prophylaxis

Clipping After Large Polypectomy

- Fully Clipped
- Partially Clipped
- Not Clipped
Case Presentation - Continued

- Presents two days later
Post-Polypectomy Bleeding Prophylaxis

Clipping After Large Polypectomy

- Retrospective study of 524 polyps (mean size 31 mm) in 463 patients. Clipping *not standardized*. Use of coagulation current.

<table>
<thead>
<tr>
<th>Clipping</th>
<th>Bleeding Rate (Univariate)</th>
<th>Odd’s Ratio (Multivariate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Clipped</td>
<td>9.7%</td>
<td>6.1 (2.0-18.6)**</td>
</tr>
<tr>
<td>Partially Clipped</td>
<td>5.8%</td>
<td></td>
</tr>
<tr>
<td>Completely Clipped</td>
<td>1.8%*</td>
<td></td>
</tr>
</tbody>
</table>

* p=0.001; ** p=0.01

1Liaquat H et al, *Gastrointestinal Endoscopy*, 2013
Post-Polypectomy Bleeding Prophylaxis

Coagulation of Vessels

- RCT of APC to treat NBVV after polypectomy in 600 patients
  - Rate of delayed bleeding similar in APC (2.5%) and non-APC (4.3%) groups.¹

- Prophylactic evaluation of the polypectomy base and treatment of visible vessels with soft coagulation (either with coagulation forceps or snare tip) is practiced, but no clear randomized data to support

¹Lee CK et al, Gastrointestinal Endoscopy, 2009
Post-Polypectomy Bleeding Treatment

**Endoscopic Options**

- **Tamponade**
  - Saline
  - Dilute epinephrine

- **Mechanical hemostasis**
  - Detachable snare
  - Endoscopic through the scope clip
  - Endoscopic over the scope clip

- **Thermal hemostasis**
  - Argon plasma coagulation
  - Bipolar therapy
  - Snare tip soft coagulation
  - Coagulation grasper forceps soft coagulation

- **Spray hemostasis**

Choice of treatment may vary whether the bleeding occurs during a piecemeal polypectomy, immediately following completion of polypectomy, or in a delayed fashion.

Location of resection may impact choice of device.
Case Presentation

- Immediate bleeding during resection of a 30 mm Paris O-IIa descending colon polyp
Immediate Post-Polypectomy Bleeding

Treatment with Soft Coagulation

- With soft coagulation current, a low **peak voltage** is used.
- After initial tissue desiccation, the tissue resistance quickly increases.
- Due to a fixed peak voltage, no further current can be generated.
- Can be utilized with coagulation forceps or tip of the snare
  - Majority (90.9%) of bleeding controlled with snare tip soft coagulation in single study
- Brisk arterial bleeding likely will require coagulation forceps

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Coagulation Forceps

Video Courtesy of Drs. Sachin Wani and Steve Edmundowicz
THE BARRIERS

CAN YOU BREAK THROUGH?
Physician Assessment and Management of Complex Colon Polyps

- Objective of this study was to determine the accuracy of physician assessment of complex polyps and the factors leading to recommendation for surgery
- An online video-based survey was sent to 317 physicians
  – Gastroenterologists, GI trainees, and surgeons at six tertiary academic centers were sent an invitation to participate

### Complex Colon Polyp Survey

**Accuracy of assigning lesion size**

<table>
<thead>
<tr>
<th>Physician Type</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI</td>
<td>29.1%</td>
</tr>
<tr>
<td>GI - SCP</td>
<td>30.6%</td>
</tr>
<tr>
<td>Surgeon</td>
<td>25.3%</td>
</tr>
<tr>
<td>GI Trainee</td>
<td>28.4%</td>
</tr>
<tr>
<td>Total</td>
<td>28.4% (p=0.74)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>Overall Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypoid</td>
<td>35.1% (p &lt; 0.001)</td>
</tr>
<tr>
<td>Non-polypoid</td>
<td>21.9%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>Overall Accuracy +/− 1 Size Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypoid</td>
<td>79.6% (p &lt; 0.05)</td>
</tr>
<tr>
<td>Non-polypoid</td>
<td>56.9%</td>
</tr>
<tr>
<td>Total</td>
<td>68.3%</td>
</tr>
</tbody>
</table>

Complex Colon Polyps Accurately Identified Malignant Lesion

Can we use the resources we currently have more **efficiently**?

<table>
<thead>
<tr>
<th>Physician Type</th>
<th>Recommend Surgery for Colon Polyp</th>
<th>Recommended Surgery of Correctly Identified Benign Polyp</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI Trainee</td>
<td>11.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Surgeon</td>
<td>17.2%*</td>
<td>16.7%**</td>
</tr>
<tr>
<td>Specialist in Complex Polypectomy</td>
<td>3.1%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Other GI</td>
<td>12.3%</td>
<td>5.1%</td>
</tr>
</tbody>
</table>

* P = 0.009  
** P=0.002

Summary

- Colon endoscopic mucosal resection in expert hands is safe and cost-effective
- Prior to beginning an EMR, ensure your unit stocks all needed equipment
- Be prepared to manage complications of colon EMR which are not uncommon
Thank You!

Northwestern University
Gastrointestinal Endoscopy