Small Bowel Imaging: What’s New, What’s Best

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Objectives

• Review endoscopic diagnostic/therapeutic tools

• Distinguish different type of enteroscopes

• Techniques in how to use them

• Review of the Evidence
“A man who is a master of patience is master of everything else”

-George Savile
Not Any More....
Figure 1. Suggested diagnostic approach to overt obscure GI bleeding. Dashed arrows indicate less-preferred options. Positive test results should direct specific therapy. Because diagnostic tests can be complementary, more than one test may be needed, and the first-line test may be based upon institutional expertise and availability. PE, push enteroscopy; OGIB, obscure GI bleeding.
Figure 2. Suggested diagnostic approach to occult obscure GI bleeding. Dashed arrows indicate less-preferred options. Positive test results should direct specific therapy. Because diagnostic tests can be complementary, more than one test may be needed, and the first-line test may be based upon institutional expense and availability. Hb, hemoglobin.
Capsule Endoscopy

– Obscure bleeding (either overt or occult) not detected by upper and lower endoscopy

– Identify causes of iron deficiency anemia (IDA) not detected by upper and lower endoscopy

– Crohn’s disease not detected by upper and lower endoscopy
The system consists of the following components, each designed to work together:

- Capsule
- Software
- Recorder
- Sensor belt
Patency Proven
(Capsule not detected in patient’s body)

Patency NOT Proven
(Capsule detected in patient’s body)

Day 0: Liquid Diet from Noon NPO at 10 pm

Day 1: Morning ingestion

Day 2: Scanning*
(Close to But Not Later Than 30 Hours)

Capsule Disintegrates
After 30 Hours

Day 0: Liquid Diet from Noon NPO at 10 pm

Day 1: Morning ingestion

Day 2: Scanning*
(Close to But Not Later Than 30 Hours)

Patency Proven
(Capsule not detected in patient’s body)

Patency NOT Proven
(Capsule detected in patient’s body)
Retention: How Do We Treat It?

**Medical Therapy**
- Purges
- Stop NSAIDs
- Steroids / Remicade

**Endoscopic Retrieval**
- Double-balloon endoscopy (DBE) if necessary and available

**Surgical Therapy**
- Strictureplasty
- Resection
Improved Image Detail

- A 30% improvement in resolution over PillCam SB 2

- Minimal detectable object with PillCam SB 3 is 0.07 mm versus 0.1 mm with PillCam SB 2
Exceptional Image Detail
Increased Frame Rate: More Coverage

- SB2 Mode: 2 FPS
- SB3 Mode: AFR 2-6 FPS

~ 1 second
Three studies (n=88 patients) showed a yield for CE of 67% compared to 8% for small bowel radiography.

CE is superior to push endoscopy and SB barium radiography for diagnosis clinically significant pathology in patients with OGIB.

The incremental yield of CE over these methods is >30% due to visualization of additional vascular and inflammatory lesions.
• 138 patients were included

• CE revealed one or more gastric or small bowel lesions considered to be the cause of IDA in 66%

• Complete resolution of IDA was achieved in 76%

• CE enables visualization of the entire small bowel, permitting a diagnosis in unexplained IDA and therefore leading to a more targeted treatment
• The diagnostic yield of capsule endoscopy increases when it is placed within 3 days of the bleeding event
• This leads to an increased therapeutic intervention rate and decreased length of hospital stay
• The mean cost of a positive diagnosis with CE was 2090.8 Euros and that of other procedures was 3828.8 Euros, with a mean cost savings of 1738.07 Euros
Adult Detection and Retention Rates

- Retrospective review of 22,840 capsule studies

**Detection Rates of CE**
- OGIB: 60.5%
- Crohn’s disease: 55.3%
- Neoplastic lesions: 55.9%
- Pooled: 59.4%

OGIB is the most common indication for CE, with a high detection rate.

**Retention Rates of CE**
- OGIB: 1.2%
- Crohn’s disease: 2.6%
- Neoplastic lesions: 2.1%
- Pooled: 1.4%

This data proves that CE is a safe tool for evaluating the small bowel, and has few adverse events.

Crohn’s Disease Algorithm

Fig. 6 Algorithm for the approach to diagnosing suspected small-bowel Crohn’s disease. The absence of any mucosal lesions demonstrated by a complete assessment of the small bowel by capsule endoscopy excludes active Crohn’s disease of the small bowel. Patients with symptoms suggestive of obstruction or known to have a stenosis should either undergo a patency capsule exam or evaluation by CT enterography (CTE) or MR enterography (MRE) prior to capsule endoscopy. SBFT, small-bowel follow-through.

Diagnostic Accuracy of CE in Crohn’s Disease Compared to CTE and MRE

- Prospective, blinded, multicenter study comparing the accuracy of CE, CTE and MRE in patients with newly diagnosed Crohn’s disease

- CE could be a new gold standard for detection of small bowel CD beyond the reach of the colonoscope

- 93 Patients evaluated:

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>100%</td>
<td>91%</td>
</tr>
<tr>
<td>CTE</td>
<td>76%</td>
<td>85%</td>
</tr>
<tr>
<td>MRE</td>
<td>81%</td>
<td>86%</td>
</tr>
</tbody>
</table>

Indications for Deep Enteroscopy

- GI Bleeding, AVM
- Suspected Crohn’s disease
- Erythema or erosion on capsule endoscopy
- Stricture or mass
  - Refractory celiac sprue
  - Protein-losing enteropathy
- Foreign body (retained pillcam)
- Polyposis syndromes
- Carcinoid search
- Inspect bypassed stomach or intestine (gastric bypass)
- ERCP via Roux-Y limb
- Incomplete colonoscopy in redundant colon
“Deep Enteroscopy”
Tube or Balloon Assisted Enteroscopy

Double-Balloon Enteroscopy (DBE)
- Fujinon

Single-Balloon Enteroscopy (SBE)
- Olympus

Spiral Overtube Enteroscopy (SE)
- Spirus
BAE Technique

- The scope is advanced through the small bowel by inflating and deflating balloons
- Pleating of intestine using a “push and pull” technique over an overtube
Preparation

• Anterograde:
  – 12 hour fast should be enough
  – Partial bowel prep

• Retrograde:
  – Standard colonoscopy bowel preparation
Sedation:
- Anterograde Approach:
  General anesthesia

- Retrograde Approach:
  Monitored Anesthesia Care (MAC)

Insufflation:
- Carbon dioxide (CO$_2$)
  A randomized trial showed CO2 is safe, reduces patient discomfort, and significantly improves intubation depth.

Fluoroscopy:
- Can be helpful to observe the advancement and reduction of the enteroscope for the initial 10-20 cases.
- Surgically modified anatomy or therapeutic procedures such as dilations, fluoroscopic guidance is suggested.
- However, the data does not show clinical impact.
Depth of Insertion:

- For each advancement of the enteroscope, the distance is added, usually ranging between 20 cm and 40 cm.

- Any portion of an advancement that is lost during a reduction maneuver is then subtracted.

- When advancement is no longer possible, it is recommended to place a tattoo.

- However, identifying the target lesion has clinical impact, but depth does not.

Clinical Applications

• DBE allow for deep intubation
  Oral: 240 to 360 cm
  Anal: 102 to 140 cm

• Total enteroscopy
  Not feasible in all cases
  Combined approach
  Rate from 16 to 86%
Clinical Applications

- DBE allow for deep intubation
  Oral: 240 to 360 cm
  Anal: 102 to 140 cm

- Total enteroscopy
  Not feasible in all cases
  Combined approach
  Rate from 16 to 86%
Learning Curve for DBE
Complications

- Pancreatitis
- Perforation
- Aspiration
- Bleeding
- Abdominal pain from air insufflations and distention
- Diagnostic about 1% vs Therapeutic 4%

Why Pancreatitis?

- 50 cases reported in the literature to date
- Incidence is 0.3%

- The causal mechanism of post-DBE acute pancreatitis is uncertain

- Most probable cause is mechanical straining of the endoscope with over-tube on the pancreas or in the papillary area

Kapacova et al. WJG 2010; 16:2331-2340
Should Combined Anterograde-Retrograde be done the same day?

• Retrograde DBE is more challenging then anterograde approach

• Failure to intubate T.I. as high as 21%

• Study has shown better to do on different days then combined approach

• Estimated retrograde alone 112cm compared to 95cm when combined with anterograde DBE

Teshima et al. SCJ 2011;46:220-226
Double-Balloon Enteroscopy and Capsule Endoscopy Have Comparable Diagnostic Yield in Small-Bowel Disease: A Meta-Analysis

SHABANA F. PASHA, JONATHAN A. LEIGHTON, ANANYA DAS, M. EDWYN HARRISON, G. ANTON DECKER, DAVID E. FLEISCHER, and VIRENDER K. SHARMA

Division of Gastroenterology & Hepatology, Department of Internal Medicine, Mayo Clinic, Scottsdale, Arizona
• VCE and DBE with similar diagnostic yield

• VCE as an initial test is noninvasive and can dictate initial DBE approach

• However, DBE maybe an initial approach for a patient actively bleeding

• Another study by Teshima et al. also concluded yield of DBE higher in the setting of positive VCE
Emergent DBE is there a role?

- Over 4 years 152 DBE were performed

- 17 emergent DBE were done for overt bleeding in 10 patients

- Findings: Dieulafoy, tumors bleeding, AVMs, ulcer

- Endoscopic therapy was done in to control bleeding: (APC, epinephrine, fibrin glue)

- Emergent DBE was felt to be feasible, allowing management of massive overt GI bleeds
Xray after oral insertion

Cecum
Spiral Enteroscopy
Discovery Small Bowel Overtube (DSB)

• Helps to advance beyond the Ligament of Treitz

• Rotating allows the spiral to pleat the small bowel in a rapid and controlled manner
Diagnostic Yield of Deep Enteroscopy

- **SE**: 33%-65% $^{1,2}$

- **DBE**: 45%-75% $^{1,3,4}$

- **SBE**: 42%-61% $^{5,6}$

Enteroscopy Findings

- Multiple AVM
- Meckel’s diverticulum
- Peutz Jeghers
- Lymphoma
- Eosinophilic enteritis
SBE vs. DBE

• **SINGLE-01: RCT comparing the efficacy and depth of insertion of SBE and DBE**

<table>
<thead>
<tr>
<th>TABLE 7. Insertion depth per method of enteroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>Antegrade Procedures No. of folds</td>
</tr>
<tr>
<td>SBE</td>
</tr>
<tr>
<td>DBE</td>
</tr>
<tr>
<td>Estimated distance, cm</td>
</tr>
<tr>
<td>SBE</td>
</tr>
<tr>
<td>DBE</td>
</tr>
</tbody>
</table>

SBE vs. DBE

- **SINGLE-01:** RCT comparing the efficacy and depth of insertion of SBE and DBE
  
  - Diagnostic yield: 57% SBE vs. 53% DBE (p=0.697)
  - Therapeutic yield: 32% SBE vs. 26% DBE (p=0.490)

  - Similar enteroscopy times, 60 minutes
  - No differences in retrograde depth of insertion, 72 vs. 75 cm (p=0.835)

Comparison between double-balloon and single-balloon enteroscopy in therapeutic ERC after Roux-en-Y entero-enteric anastomosis

Tom G Moreels, Paul A Pelckmans

- Aim: to compare DBE vs SBE with ERCP for patients s/p Roux-en-Y
- Retrospective cohort

- 38 ERCPs in 25 patients
  - DBE in 29 and SBE in 9 pts
  - DBE and SBE were equally successful in this cohort
DBE vs. SE

- Prospective, randomized, single-center trial comparing DBE and SE in patients with suspected small bowel disorders

  - Total enteroscopy:
    - 13% (1/13) for SE
    - 92% (12/13) for DBE, p=0.002

  - Procedure time:
    - Antegrade: 43 min for SE vs. 60 min for DBE (p<0.007)
    - Retrograde: 52 min for SE vs. 76 min for DBE (p=0.009)

DBE vs. SE

- Prosp ective, randomized, single-center trial comparing DBE and SE in patients with suspected small bowel disorders

  - No differences in diagnostic yield
  - No differences in therapeutic yield

  - Conclusion: “SE does not represent an alternative to DBE with regard to the depth of insertion or the rate of complete enteroscopies achieved...improvements will be necessary before SE can compete with DBE...”

Messer I et al. Gastrointest Endosc 2012
Long-Term Outcomes

- Long-term outcome of patients treated with DBE for small bowel vascular lesions
  
  - Single-center, retrospective cohort study
  - 261 DBE procedures for obscure GI bleeding
  - 133 patients with vascular lesions treated endoscopically

  - Follow-up period was 22.6 ± 13.9 months (range=1-52)

Long-Term Outcomes

• Long-term outcome of patients treated with DBE for small bowel vascular lesions \(^1\)

  – 129/133 patients (97%) were treated successfully
    • APC ablation (98.5%)
    • Clips (1.5%)

  – Re-bleeding rate = 46% at 36 months of follow-up

Long-Term Outcomes

- Long-term outcome of patients treated with DBE for small bowel vascular lesions

SE: Long-Term Outcomes

• Prospective evaluation of the long-term outcomes after deep small bowel SE in patients with obscure GI bleeding

- Two-center, retrospective cohort study
- 78 SE procedures for obscure GI bleeding
- Long-term follow-up data available in 68 patients (78%)

- Follow-up period was 25.3 ± 7.5 months (range=13-39)

SE: Long-Term Outcomes

- Prospective evaluation of the long-term outcomes after deep small bowel SE in patients with obscure GI bleeding
  
  - Overt bleeding before SE: 62%
  - Overt bleeding after SE: 26% (p<0.0001)

SE: Long-Term Outcomes

- Prospective evaluation of the long-term outcomes after deep small bowel SE in patients with obscure GI bleeding

Hemoglobin Before SE & at Long-term Follow-up

SE: Long-Term Outcomes

- *Prospective evaluation of the long-term outcomes after deep small bowel SE in patients with obscure GI bleeding* ¹

Blood Transfusions Before SE & at Long-term Follow-up

Deep Enteroscopy with a Conventional Colonoscope: Initial Multicenter Study Using the NaviAid Balloon System


1. New York University School of Medicine, New York, NY, United States.
2. Geisinger Health System, Danville, PA, United States.
3. Indiana University, Indianapolis, IN, United States.
4. University of Colorado, Denver, Aurora, CO, United States.
5. University of Chicago, Chicago, IL, United States.
6. Johns Hopkins Medical Institutions, Baltimore, MD, United States.
7. Duke University, Durham, NC, United States.
8. Tel Aviv Sourasky Medical Center, Tel Aviv, Israel.
Clinical Challenges of Deep Enteroscopy in Routine Practice:

- Time consuming
- General anesthesia, might be needed
- Specialized enteroscopes and processors
- Longer accessories
- Not readily available depending on geographic location
NaviAid Balloon Guided Enteroscopy

- No specialized enteroscope or accessories required
  - Can use a colonoscope

- On-demand, single-use balloon, inserted through the working channel

- No overtube

- Anterograde and Retrograde

- Tissue sampling and therapeutic intervention can be done
NaviAid Balloon Advancement Sequence

Step 1

Step 2

Repeat step 1 and step 2
Results

n=98 patients:
- 52% were male
- mean age 55 years (range: 15-94)

<table>
<thead>
<tr>
<th>Enteroscopy</th>
<th># Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterograde</td>
<td>65</td>
</tr>
<tr>
<td>Retrograde</td>
<td>33</td>
</tr>
</tbody>
</table>
Indications

- Abnormal capsule endoscopy
- Abdominal Pain
- Anemia
- Occult gastrointestinal bleed
- Diarrhea

- Weight Loss
- Protein Losing Enteropathy
- Retained Foreign Body
- Altered Anatomy ERCP
- Small Bowel Strictures
Depth of Insertion (DOI)

- Anterograde enteroscopy: 65 cases
  - Average DOI: 156cm (range 50cm-350cm)

- Retrograde enteroscopy: 33 cases
  - Average DOI: 89 cm (range 20cm- 150cm)

Procedure Time

- Average time: 15.5 min (range 10-40 min)

- No adverse events reported
## Results

**Overall Diagnostic Yield: 45%**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Findings</td>
<td>55%</td>
</tr>
<tr>
<td>AVM</td>
<td>12%</td>
</tr>
<tr>
<td>Granular Mucosa</td>
<td>9%</td>
</tr>
<tr>
<td>Non-specific Enteritis/Friability</td>
<td>9%</td>
</tr>
<tr>
<td>Intraepithelial Lymphocytosis</td>
<td>8%</td>
</tr>
<tr>
<td>Lymphovascular ectasia</td>
<td>4%</td>
</tr>
<tr>
<td>Ulceration</td>
<td>3%</td>
</tr>
<tr>
<td>Stricture</td>
<td>3%</td>
</tr>
<tr>
<td>Bleeding (no source)</td>
<td>2%</td>
</tr>
<tr>
<td>Migrated Enteral Stent</td>
<td>2%</td>
</tr>
<tr>
<td>Polyp</td>
<td>2%</td>
</tr>
<tr>
<td>NSAD Enteropathy</td>
<td>2%</td>
</tr>
<tr>
<td>Radiation Enteritis</td>
<td>1%</td>
</tr>
<tr>
<td>Duodenal Scarring</td>
<td>1%</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>1%</td>
</tr>
<tr>
<td>Jejunal Diverticulum</td>
<td>1%</td>
</tr>
<tr>
<td>Small Bowel Crohns</td>
<td>1%</td>
</tr>
<tr>
<td>Giardia</td>
<td>1%</td>
</tr>
<tr>
<td>Ring</td>
<td>1%</td>
</tr>
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</table>
Conclusion

NaviAid Advancing Balloon

- Safe and effective for DSBE
- Conventional colonoscope / no need for overtube
- Shorter procedure times
- Diagnostic yield and DOI are on par with other forms of DSBE
Should you do BAE?

- Personality and Practice Issues
  - Patience and stamina?
  - Appropriate skill set?
    - Reliably intubate terminal ileum?
    - Successful with long, loopy colons? (gathering and shortening skills)
  - Practice situation
    - Allow flexibility of your time?
    - Financial viability?
Final Thoughts

• Capsule endoscopy remains an important tool to investigate small bowel diseases

• Deep enteroscopy expands our ability for the diagnosis and therapy of small bowel diseases