Update on GI Imaging

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Disclosure of Conflicts of Interest

• I have no affiliations with commercial interests to disclose.

Overview

• GI bleeding evaluation
  • Chronic/obscure versus Active
  • Diagnostic Imaging Modalities
• Evaluation of Crohn’s Disease
  • SBFT/Enteroclysis
  • CT Enterography
  • MR Enterography
Obscure GI bleeding (OGIB)

- Recurrent or persistent bleeding with no source found at initial (upper and lower) endoscopy nor with radiologic evaluation of the small bowel (SBFT, enteroclysis)
- UGI: Cameron’s erosions in HH, Fundic varices, PUD, angioectasias, Dieulafoy’s lesion, gastric antral vascular ectasia
- Colon: angioectasia/neoplasm

Obscure GI bleeding (OGIB): Small Bowel

- Younger patients (<40 yo)
  - Small intestinal tumors
  - Meckel’s diverticulum
  - Dieulafoy’s lesion
  - Crohn’s Disease
- Older patients (>40 yo)
  - Vascular lesions (40%)
  - NSAID-induced small bowel disease
  - Tumors
Obscure GI bleeding

- Upper GI Bleeding $\rightarrow$ EGD
- Mid GI Bleeding $\rightarrow$ capsule endoscopy and double-balloon enteroscopy
- Colonic Bleeding $\rightarrow$ colonoscopy

- Still no etiology?....
  - CT Angiography (Active)
  - CT Enterography

Active GI Bleeding:
Diagnostic Imaging Options

- Nuclear Medicine GI Bleed Study
- CT Angiography GI Bleed Study
- Conventional Angiography

0.1 mL/min 0.3 mL/min 0.5 mL/min
Nuclear Medicine: **Advantages**

- Image over time
- Can use if IV contrast allergy
- Can use with elevated GFR
- Active arterial or venous bleeding rates as low as 0.1 mL/min
  - 93% sensitive
  - 95% specific

Nuclear Medicine: **Limitations**

- Limited resolution
- Limited availability
- Length of time required to perform study
CT: Advantages

- Availability
- Noninvasive
- Rapid Acquisition
- Etiology of Bleed
- Evaluation of vasculature
  - Reduce angio time / # of runs
  - Reduce angio contrast dose
  - Reduce angio radiation
- Sensitivity - 91%  Specificity - 99%

CT: Limitations

- Renal failure
- IV contrast allergies
- Residual oral contrast in bowel
CT Angiography for Active Bleed

• No oral contrast
• Triple Phase CT Abdomen and Pelvis
  • Unenhanced (Low dose)
  • Arterial Phase - 30 sec
    100-150 cc contrast at 4 cc/sec
  • Venous Phase - 70 sec delay

*Alternatively: arterial/venous/delayed

Diagnosis of Active Bleeding
(look for something bright)

• High attenuation material in bowel lumen at CTA, not present at unenhanced CT performed immediately prior
• Linear, jetlike, pooled or swirled or ellipsoid focal collection of arterial density contrast material within bowel lumen

False Positives for GI Bleeding

- Residual contrast in bowel/diverticula
- Foreign bodies
- Sutures
False positives:
Oral Contrast

• Unchanged between phases
• Often with sharp edges
• Density often brighter than vascular structures

Medication

Evaluation of Occult/Chronic GI Bleeding

• CT Enterography
  • Noninvasive, easy to perform
  • View extra-enteric structures as well as bowel wall
  • Detect small bowel tumors
  • Detect occult GI bleeding--hemodynamically stable
  • KEY: Negative oral contrast AND IV contrast
Negative oral contrast vs Positive oral contrast

CT Enterography: Contrast

- **ORAL:**
  - Volumen® (low density barium)
    - 3 bottles, 450 cc each = 1.35 L total
    - 60, 45, 30 minutes prior
- **IV:** ~ 150 cc @ 4cc/sec
  - Triphasic Acquisition
    - Arterial phase: ~ 20 seconds
    - Enteric phase: 50 seconds after start
    - Delayed phase: 90 seconds after start
CT Enterography: What to look for…

- High attenuation structure
  - Tumors (carcinoid)/angiodysplasia
- Intraluminal filling defects/masses
  - polyps
- Focal bowel wall thickening
  - Neoplasm/vascular
- Dilated feeding artery or early draining vein
  - Sign of vascular malformation
- Progressive accumulation of intraluminal contrast
  - Bleeding

<table>
<thead>
<tr>
<th>Intraluminal Masses:</th>
<th>High attenuation Mass:</th>
</tr>
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<tbody>
<tr>
<td>Peutz Jeghers Polyps</td>
<td>Carcinoid</td>
</tr>
</tbody>
</table>
High Attenuation Structure: Angiodysplasia

Half time quiz....
Crohn’s Disease

- Endoscopy/Capsule Endoscopy
- Small bowel follow through
- Peroral pneumocolon
- SB enteroclysis
- CT Enterography/Enteroclysis
- MR Enterography/Enteroclysis
Capsule Endoscopy

- Excellent depiction of mucosa
- Limited ability to localize disease
- Limited submucosal evaluation
- No extraluminal evaluation
- Cannot use with bowel stenosis

35 yo female history of Crohn’s Disease:
3 weeks S/P capsule endoscopy
Role of CTE in Crohn’s Disease

• Differentiate active inflammatory strictures from fibrotic strictures to guide therapy
  • Active bowel disease \( \rightarrow \) medical therapy
  • Fibrotic strictures \( \rightarrow \) surgery, strictureplasty

CTE findings of active mucosal and mural inflammation

• Mural hyperenhancement
• Mural stratification
• Bowel wall thickening
• Soft-tissue stranding in perienteric fat
• Engorged vasa recta
Mural Hyperenhancement

- Segmental: relative to nearby normal loops
- Correlates with histologic findings of active Crohn’s disease

39 yo with Crohn’s Disease, presents with vomiting

- Mucosal hyperenhancement → active inflammatory disease
Potential Pitfalls

- In late arterial phase:
  jejenum enhances > ileum
- Collapsed bowel loops - denser than distended ones
  - Compare SB loops with increased attenuation with normal-appearing distended loops in same bowel segment
Mural Stratification on CTE

- Visualization of layers of bowel wall
- Mucosa and serosa enhance avidly, intervening bowel wall: variable
  - fat: indicates past or chronic inflammation
  - edema (water): active inflammation
  - soft-tissue attenuation: may represent an inflammatory infiltrate
Mural Thickening

Comb Sign: Engorged vasa recta

- Vessels penetrate bowel wall -- perpendicular to lumen
- Indicate active inflammation
- Associated with elevated C-reactive protein levels
- Longer hospital stays in patients with severe Crohn’s disease
Fibrofatty Proliferation

- Occurs along mesenteric border of bowel
- Considered surgically pathognomonic for Crohn’s disease
- Perienteric fat in patients with Crohn’s disease not simply result of inflammation
  - Is hormonally active
  - May help drive inflammatory process

Fistulas

- Hyperenhancing tracts originating from bowel loops that exhibit signs of active inflammation
  - Exception: perianal fistula, often isodense to anorectum
• **Enterovesical fistula** in 61 yo man with CD, recurrent UTI’s and pneumaturia

• **Ileoileal fistula** arising from ileal loop with acute asymmetric bowel inflammation with wall thickening and enhancement
MRI

- MR Enterography, MR Enteroclysis
- No ionizing radiation
- Excellent tissue contrast
  - Intrinsic bowel disease
  - Surrounding edema
- Real-time functional imaging
- Evaluation of intra and extra-luminal pathology

MR Enteroclysis/Enterography

True FISP

T1 fat sat post contrast
### MRE Technique

- **Glucagon**: Reduce peristalsis
- **VoLumen**: Oral Contrast
  - 1-2 liters
  - (PEG, methylcellulose, water)
- **Gadolinium**: IV Contrast
  - Active inflammation, Fistulas, Abscesses
- **MR Protocol**:
  - Multiple pulse sequences, pre & post contrast

### MR Findings and Disease Subtypes

<table>
<thead>
<tr>
<th>Disease Stage</th>
<th>Balanced GRE</th>
<th>T2 FSE</th>
<th>Post contrast T1</th>
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</thead>
<tbody>
<tr>
<td>Active</td>
<td>Fold thickening, mural ulcers, comb sign, mesenteric lymphadenopathy</td>
<td>Fold thickening, mural ulcers, mural edema</td>
<td>Mucosal hyperemia, mural thickening, mural edema, comb sign, mesenteric lymph nodes</td>
</tr>
<tr>
<td>Fibrostenotic</td>
<td>Stricture</td>
<td>Stricture, mural fibrosis</td>
<td>Stricture, mural fibrosis</td>
</tr>
<tr>
<td>Penetrating</td>
<td>Deep fissuring ulcers, fistulas, abscess</td>
<td>Deep fissuring ulcers, fistulas, abscess</td>
<td>Fistulas, abscess</td>
</tr>
<tr>
<td>Regenerative</td>
<td>Regenerative polyps, decreased luminal diameter</td>
<td>Regenerative polyps, decreased luminal diameter</td>
<td>Decreased luminal diameter</td>
</tr>
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</table>

*More than one process may be in a segment or multiple adjacent segments in the same patient*
Active Inflammation in Crohn’s Disease

SSFP
Wall thickening

Post-Contrast T1
Enhancement, comb sign

DWI
Restricted diffusion

Ulcerations in terminal ileum

Fibrofatty mesentery
Ileal wall thickening
Stratified enhancement

Potential Pitfall

Transient bowel collapse mimicking active inflammation
Penetrating Disease in CD

- Transmural extension of inflammatory process
- Deep fissuring ulcers
  - Longitudinal or transverse thin high intensity lines in bowel wall
- Sinus tracts
- Fistulæ
  - Thicker than adhesions
  - Enhance earlier than adhesions
- Abscesses
- Extraintestinal involvement

![Image of medical scans showing enteroenteric and enterovesicle fistulas]
Fibrostenotic

- Fixed mural thickening and luminal narrowing
  - Mural fibrosis \(\rightarrow\) Strictures \(\rightarrow\) Bowel obstruction
- Aperistaltic on cine
- Prestenotic dilatation
  - Less likely to respond to medical therapy
- Lack mural inflammation and edema
  - Usually little to no increased T2 signal
- Reduced enhancement
  - Homogenous, not stratified

Fibrostenosing strictures
ACR Appropriateness Criteria...

- Evidence-based guidelines
- Developed to help referring clinicians
- Choose appropriate diagnostic imaging test
- ACR.org
- FREE!!!
American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: Crohn's Disease
Variant 1: Adult; initial presentation (abdominal pain, fever, or diarrhea); Crohn's disease suspected.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
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<tbody>
<tr>
<td>CT abdomen and pelvis with contrast (CT enterography)</td>
<td>9</td>
<td></td>
<td>☢ ☢ ☢</td>
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<tr>
<td>X-ray small-bowel follow-through</td>
<td>7</td>
<td></td>
<td>☢ ☢ ☢</td>
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<tr>
<td>CT abdomen and pelvis with contrast (routine)</td>
<td>6</td>
<td></td>
<td>☢ ☢ ☢</td>
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<tr>
<td>X-ray contrast enema</td>
<td>6</td>
<td></td>
<td>☢ ☢ ☢</td>
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<tr>
<td>MRI abdomen and pelvis without and with contrast (MR enterography)</td>
<td>6</td>
<td>MR enterography may have sensitivity and specificity similar to CT enterography and avoids radiation risks. However, the choice of examination depends on institutional preferences and resources. MRI is the preferred modality for investigating perianal disease. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>☢ ☢ ☢</td>
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<tr>
<td>X-ray abdomen</td>
<td>5</td>
<td>May be useful to exclude free air if perforated hollow viscus is suspected.</td>
<td>☢ ☢ ☢</td>
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<tr>
<td>US abdomen and pelvis</td>
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<td>☢ ☢ ☢</td>
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<tr>
<td>US pelvis endorectal</td>
<td>3</td>
<td></td>
<td>☢ ☢ ☢</td>
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<tr>
<td>Te-99m HMPAO scintigraphy</td>
<td>3</td>
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*Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level
Final Quiz: Name that foreign body:

Thank you!

Questions?