Learning Objectives

IMAGING IN IBD: THE MENU [25 MIN]

- Background
- CT-Enterography
- MR-Enterography
- Future Directions
  - PET/CT-MRI Enterography
  - Dual Energy MDCT
- MRI Perianal disease
- Conclusions

SB Imaging in IBD

BACKGROUND

- Small bowel imaging challenging
  - inherent anatomic limitations (long, tortuous, variable)
  - because of pathology (low incidence, subtle early chx)
  - technical constraints (large volume, peristalsis)

- Ideal imaging method
  - displays bowel wall (> mucosal layer)
  - sufficient and reliable distention
  - depicts entire tube
  - information of adjacent structures (mesentery, vessels)

Patak M, Mortele KO, Ros PR. MDCT of the small bowel.
Radiol Clin N Am, 2005;43:1063-1077
SB Imaging in IBD

BACKGROUND

- **Endoscopy & capsule endoscopy**
  - detailed mucosal layer only
  - limited reach and contra-indications
- **Small bowel follow through (SBFT)**
  - < information adjacent structures
- **Enteroclysis**
  - invasive
  - detailed mucosal layer only

- **Helical CT**
- **MDCT-enteroclysis**
  - Thiele J. et al. Rofo 1993
  - utilizing nasojejunal intubation
  - methylcellulose or high density agents
- **MDCT-enterography**
  - Raptopoulos V. Am J Roentgenol (AJR) 1997
  - cross-sectional imaging technique optimized to imaging the small bowel including ORAL contrast, IV contrast and high resolution CT imaging
Koenraad Mortele, MD


CT-enteroclysis

CT-enteroclysis

MDCT-Enterography

BRI GHAM & WOMEN’S HOSP ITAL

![Graph showing Nr. CTE from 2003 to 2007](chart.png)
MDCT-Enterography

TECHNIQUE

- Oral contrast agent
  - positive agents
  - neutral agents
  - negative agents
- IV contrast agent
  - non-ionic iodinated contrast
- High resolution CT scan
  - multi-detector capabilities
  - post-processing software

- Oral contrast agent
  - distend lumen to display wall and lumen
  - maximize conspicuity of abnormal wall enhancement
  - minimize side effects
Previous investigators evaluated:
- 12.5% corn oil emulsion
- dilute collagen
- 2% iodine solution
- nonionic solutions
- gastrografin
- whole milk, 2% milk
- methyl cellulose
- iso-osmotic mannitol

significant improvement in GI tract discrimination & mural visualization without significant difference in patient tolerance

High-attenuation (positive) oral contrast:
- conventionally used in abdominal & pelvic CT
- interferes with 2D MPR and 3D rendering
- obscures bowel wall (mucosal enhancement)

Water:
- efficacious neutral contrast agent for evaluation of the upper gastrointestinal tract
- no adequate distention of the distal small bowel

VoLumen®, 0.1% w/v

Olive MR, Erturk SM, Ichikawa T, Rocha T, Ros PR, Silveman SG, Mortele KJ. GI tract wall visualization and distention during abdominal & pelvic MDCT with a neutral barium sulphate suspension: comparison with positive barium sulphate suspension and with water. JBR-BTR. 2012;95(4):257-42
**MDCT-Enterography**

**ORAL CONTRAST**

- **VoLumen - Dosing Algorithm**
  - total of 1350cc (3 bottles)
  - 450 cc at 45 minutes prior to scan
  - 450 cc at 30 minutes prior to scan
  - 450 cc at 15 minutes prior to scan

![Image of MDCT scan with contrast](image)
MDCT-Enterography
CROHN’S DISEASE

MDCT-Enterography findings
✓ mural or **mucosal hyperenhancement**
✓ mural thickening
✓ mural stratification
✓ mesenteric fat stranding
✓ “comb sign”
✓ sinus, fistula, abscess
✓ fibrofatty proliferation
✓ submucosal fat replacement

Wold PB et al., Radiology 2003;229:275-281
since all strictures have mucosal hyper-enhancement it is hard to determine the “fixed” nature of the stricture.
Mural attenuation & thickness at MDCT-enterography:
- 96 patients
- Quantitative measures of attenuation correlated significantly with active disease (127HU)
- Wall thickness was not a significant factor after attenuation was taken into account
- Semi-automated software: sensitivity 90%, specificity 69%
- Experienced GI radiologist: sensitivity 80%, specificity 82%

Bodily K, et al. Radiology 2006;238:505-516
### MDCT-Enterography

**CROHN’S DISEASE**

- **CT-enterography performance**

<table>
<thead>
<tr>
<th>TI DISEASE</th>
<th>Extra-luminal DISEASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>sensitivity:</strong></td>
<td><strong>fistulas or abscess</strong></td>
</tr>
<tr>
<td>✓ 78% CT enterography</td>
<td>✓ 10 CT enterography</td>
</tr>
<tr>
<td>✓ 62% SBFT</td>
<td>✓ 5 SBFT</td>
</tr>
<tr>
<td><strong>accuracy</strong></td>
<td></td>
</tr>
<tr>
<td>✓ 80% CT enterography</td>
<td></td>
</tr>
<tr>
<td>✓ 74% SBFT</td>
<td></td>
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</tbody>
</table>

*Boediy K, et al. ABRS 2004*

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**[Image: CT scan examples]**
**MDCT-Enterography**

**CROHN’S DISEASE**

- MDCT-enterography performance (n=26 pts)

<table>
<thead>
<tr>
<th>ACTIVE TERMINAL ILEUM DISEASE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>sensitivity</td>
<td>40-90%</td>
</tr>
<tr>
<td>specificity</td>
<td>88-100%</td>
</tr>
<tr>
<td>accuracy</td>
<td>69-96%</td>
</tr>
<tr>
<td>negative predictive value</td>
<td>70-94%</td>
</tr>
<tr>
<td>positive predictive value</td>
<td>44-100%</td>
</tr>
</tbody>
</table>

*Vandenbroucke F, Mortele IJ et al. Acta Radiol 2007*
**MDCT-Enterography**

**SB CROHN’S DISEASE**

- **CTE vs CE vs SBFT vs Endoscopy (n=17 pts)**
  - non-obstructive Crohn disease
  - capsule endoscopy most sensitive
  - CT enterography: no false positive findings
  - CTE demonstrated important extra-enteric findings
  - SBFT only depicted CD in 24% of patients
  - The diagnostic algorithm with non-obstructive CD may change to incorporate capsule endoscopy and/or CT enterography rather than small bowel follow through...

  *Hara AK, et al. Radiology 2006;238:128-134*

**Imaging in IBD**

**FUTURE DIRECTIONS**

- **PET/CT-enterography**
  - 18F-fluorodeoxyglucose (FDG)
  - glucose transporters overexpressed in inflamed segments - “Hot Segments”
  - possible impact
    - improved detection of lesions
    - stratification of disease severity
    - therapy monitoring

Imaging in IBD

FUTURE DIRECTIONS

- **Dual source CT-enterography**
  - CT with 2 rows of detectors, dual energy
  - same amount of radiation
  - maximizes “iodine” identification
  - possible impact
    - improved detection of lesions
    - stratification of severity

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Small Bowel Imaging  
"THE NEWER KID ON THE BLOCK"

- **MR-Enterography**  
  - longer exam, more expensive, less availability
  - steeper learning curve, less agreement
  - no significant difference in detection of moderate and marked disease and extraluminal abnormalities
  - motion...

...harder to do a good MRI than a bad CT...

**SO WHY MRI ?**
Koenraad Mortele, MD

**MR-Enterography**

WHY MRI?

- **NO RADIATION!!**
  - **young** patients with **numerous** imaging studies over lifetime
  - superior soft tissue contrast: **significant** improved detection of **mild** disease
  - cinematic **“functional”** evaluation
    - peristalsis, inflammatory stenosis, stricture
  - **comprehensive** evaluation perianal region

*Low, JMRI 2000 and Schmidt, Eur Radiol 2003*
MR-Enterography

BETH ISRAEL DEACONESS MED CTR

**TECHNIQUE**

- **Oral contrast agent**
  - positive agents
  - negative agents
  - biphasic agents
- **IV contrast agent**
  - gadolinum-chelates
- **Optimized MRI scan**
  - breath-hold sequences
  - thin-section and thick-slab
  - controlled bowel motion

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**Oral contrast agents**

- uniform & homogenous opacification
- adequate distension of the lumen
- high contrast between lumen and bowel wall
- low cost
- absence of significant side effects

MR-Enterography
PULSE SEQUENCES

- **Patient preparation**
  - fluids only 12 hrs & 4 hrs of fasting

- **Patient positioning**
  - **prone** positioning: better distention, decreased imaging volume, separates loops
  - **supine** positioning: greater patient comfort, indicated in patients with stomas, fistulas, pain, and post surgery


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**WHEN TO PUT PATIENT ON THE TABLE?**
- average SB transit time = 45 minutes
- we aren’t all equal !!!
1.5 Tesla (3T shorter bore)
torso coil (minimum 8 channels)
max z-coverage (48 cm): duodenal bulb-symphisis pubis

1 mg IM glucagon

25 minutes scan time

**MR-Enterography**

**PULSE SEQUENCES**

- **SS FSE or half-Fourier RARE (COR)**
  - evaluates **distention**, defines **coverage**
  - allows **functional** evaluation (15 images/TP)
  - poor information on mesentery

- **Balanced GRE (AXIAL & CORONAL)**
  - **FIESTA, true FI SP, balanced SSFP**
  - mural and extra-intestinal abnormalities
  - chemical shift artifact detects submucosal fat

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**MR-Enterography**

**PULSE SEQUENCES**

- **SS FSE FS ASPI R (COR)**
  - mural characterization
- **3-D FS GRE (CORONAL & AXIAL)**
  - LAVA, VI BE, THRI VE, 3D QUI CK
  - 0.2 mmol/kg gadolinium - flow rate 2mL/sec
  - timing formula + 6 seconds: "**enteric phase**"
  - second coronal after 70 sec, axial after 90 sec
  - signal variation reflects tissue microcirculation

Inflammatory Stenoses

Since most strictures have mucosal or mural hyper-enhancement it is hard to determine the activity of the stricture.

Fibrotic Stenosis

Since most strictures have mucosal or mural hyper-enhancement it is hard to determine the activity of the stricture.
**MR-Enterography**

**CROHN’S DISEASE**

- **MR-Enterography Indications**
  - Identify presence of Crohn’s disease
    - Sensitivity 88-98%, specificity 78-100%
  - Differentiate from other SB diseases
  - Number, length, locations of involved segments
  - Characterization stenosis
  - Determine severity of inflammatory activity
  - Assess presence of mesenteric changes

MR-Enterography
CROHN'S DISEASE

- Features Chronic Inflammation
  - mural thickening
  - fibrofatty proliferation
  - submucosal fat replacement
  - strictures
    - if inactive: can assess fixed or not
    - if active: could be spasm...
  - inflammatory pseudopolyps
  - sacculations

Wold PB et al., Radiology 2003;229-275-281

Stratification with Fat + Edema = Acute on chronic
MR-colonography: same prep but monitor contrast transit

Imaging in IBD

CONCLUSIONS

- SB imaging in IBD has changed
  - SBFT is pretty much “dead”
  - CT-E is new and accurate technique
  - MR-E is technique of the future/ present?
- What to expect?
  - PET/CT & Dual energy CT enterography
- MRI perianal disease
  - most superior technique
  - expanding applications