Imaging in Crohn's Disease: 
MR Enterography 

SCBT/MR 
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Disclosure

- Advisory boards of Bayer, GE Healthcare
- UW receives support from GE and Bracco
- Spouse is an employee of GE
Off-Label Uses of Gadolinium

- Off-label uses of Gadolinium contrast
- Investigational Pulse Sequences
Outline

• Need for cross sectional imaging of small bowel
  – Challenges in the diagnosis & treatment monitoring of Crohns disease

• Increasing concerns over radiation

• CT vs MR Enterography

• MR Enterography Protocol at UW

• Examples
Crohn’s Disease

- Inflammatory bowel disease (autoimmune)
- 700,000 Americans afflicted
- Young adults (20’s and 30’s)
- Any part of GI tract, esp. distal ileum
  - Complete small bowel coverage needed
  - Colon and esophagus accessible by other means
- Features
  - Transmural inflammation
  - strictures
  - Fistulas, abscesses, etc
- Key question: active vs quiescent disease
Crohns Disease

• Active disease treated with "biologics"
  – eg. infliximab (remicade)
  – Effective
  – Very expensive
  – Serious side effects, including lymphoma

• Burned out disease with strictures: surgery

• Imaging plays a central role
  – Small bowel follow through
  – CT enterography
  – MR enterography

New opportunities: distinguish active from chronic disease
952,420 non-elderly adults followed for three years
655,613 underwent one or more imaging procedures
2.4 ± 6.0mSv (3mSv = background dose)
82% from outpatient facilities (CT, nuclear scintigraphy)
2.5 year old boy for neck CT scan after falling off bed
Inadvertent exposure to 151x normal dose
CTE Enterography:

Findings of Active Disease

- Bowel wall thickening
  - > 3mm
  - Asymmetric involvement
    - mesenteric > antimesenteric
- Perienteric stranding
- Engorged vasa recta
  - “comb” sign
- Perienteric fibrofatty proliferation
  - Remains present in clinically quiescent disease
MRE Enterography: Findings of Active Disease

- Bowel wall thickening
  - > 3mm
  - Asymmetric involvement
    - mesenteric > antimesenteric
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  - “comb” sign
- Perienteric fibrofatty proliferation
  - Remains present in clinically quiescent disease
- High signal on T2 weighted imaging
- Decreased peristalsis on “real-time” imaging
In 2010, MRE and CTE have equivalent performance
Accuracy of MRI

Accurate markers of acute inflammation:

- increasing mural thickness
- high signal on T2
- mural enhancement NOT a feature
- layered enhancement
Complications

• Fistula
  – Enteroenteric
  – Enterocystic
  – Enterocutaneous (perianal fistulas common)
  – Enterovaginal

• Abscess

• Strictures (fibrostenosis)

• Small bowel obstruction
Protocol: Patient Preparation

- Drink
- Prone position
  - minimize respiratory motion
  - Better co-localization between sequences
  - Splay out loops of small bowel
- Spasmolytic
  - Buscopan (Europe)
  - Glucagon (IM or IV)
Drink

- Goal: distend small bowel, terminal ileum
- Variability in the literature
- Hyperosmolar agent to distend bowel
  - Mannitol
  - Locus bean gum
  - Sorbitol + Barium (Volumen)
- Volume
  - 1000-1500ml
- UW protocol
  - 900-1250ml Volumen in 2-3 boluses over 30-60 minutes
  - 300 ml of water on table
Glucagon: **IM or IV?**

- **1mg IM**
  - Onset 1-3 min, 10-20 min duration
  - Efficacy is good but variable

- **0.3-0.5mg IV**
  - Immediate onset, 5-7 minutes duration
  - Reliable cessation of peristalsis
  - Occasional nausea: *push slowly*

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**No glucagon**  
**1 minute after glucagon**
Protocol: Overview

- Position prone on table
- Drink 300cc water on table
- Localizers
- Real time 2D-SSFP *before* Glucagon
- 0.3-0.5mg IV Glucagon
- Axial T2-SSFSE with fat-sat
- Coronal T2-SSFSE without fat-sat
- 3D-SSFP
- 0.3-0.5mg IV Glucagon
- T1W 3D-SPGR with fat-suppression
  - Pre-contrast (can perform before 2\textsuperscript{nd} dose of glucagon)
  - Inject 0.1mmol/kg GBCA at 2.0ml/s, 25-50ml saline flush
  - 40 seconds (later arterial)
  - 2 minutes
- T1W 2D-SPGR with fat-suppression

*$Money Shot*$

Total table time is 30 minutes
Protocol: Localizers

• 3-plane SSFSE no fat-saturation
• Large FOV body phased array
• Not critical to cover to dome of liver
• It is critical to cover through perineum
• Check coil sensitivity after this step
• Check bowel distension
Protocol: *Real Time bSSFP*

- Balanced steady-state free precession (SSFP, FIESTA, trueFISP, BFFE)
- Bright fluid
- “India-ink” artifact at water-fat interfaces
- 10-20 phases at each slice in 2D stack
- Free-breathing
- Fast, high SNR, available on all systems
- Perform *before* glucagon
- *Diseased segments have reduced motility*
Protocol: *Real Time bSSFP*
Protocol: *T2* weighted imaging

- SSFSE (HASTE): rapid, insensitive to motion
- Coronal T2-SSFSE *without* fat-sat: *anatomy*
- Axial T2-SSFSE *with* fat-sat: *disease activity*
Protocol: 3D-bSSFP

- Anatomical overview with high resolution
- Isotropic spatial resolution for 3D reformats
- Bright fluid
- Water-fat interfaces black – etched appearance
- Banding artifacts
- Single breath-hold
Protocol: Contrast Enhanced Imaging

• T1 weighted 3D-SPGR with fat-saturation (LAVA, VIBE)
• 2D parallel imaging (ARC, GRAPPA) essential
  – Complete coverage of all small bowel
  – 1.5 x 1.9 x 2.0mm³ (0.9 x 0.9 x 1.0mm³)
2D-ARC: Increased Coverage

Lum et al JMRI 2009
Protocol: *Axial 2D T1W-SPGR*

- Second look with contrast
- Peri-anal fistulas
- Adenopathy
Case: 16yo Girl with Crohns

Coronal T₁ Weighted SPGR  Coronal T₂ Weighted SSFSE  Axial T₂ Weighted SSFSE  Axial Reformat T₁ Weighted SPGR
Case:
9yo M with Crohn Dz
Case: *Follow-up 1 year later*

New lesions, high T2 signal: *Active Disease*
Case: 24y woman with Crohn's
Case: 27yo with abdominal pain
3D Multiplanar Reformats

Pearl: useful for referring surgeons - surgical planning
Case: 33yo M with known h/o Crohns

Multiple Lesions of Varying Acuity
Case: 33yo M with known h/o Crohns

Perianal Fistulas
Case: 30yo F, known Crohns Disease

Active disease with perienteric stranding and fistula formation
Case: 37 yo M with chronic disease and acute abdominal pain

Perienteric fatty proliferation (chronic)
Enteroenteric fistula (active disease?)
**Case:** 69yo F with histology proven Crohn’s of the rectum

- Active on chronic disease
  - Bright T2 signal
  - Perirectal fatty proliferation
- Rectal labial fistula
Case: 40yo M with long history of Crohns, presents with PSBO
Summary MR Enterography

• In 2010, MRE = CTE
• Moving target, with improved technology performance of MRE will exceed CTE
• MRE is an excellent modality to assess disease status and complications
• Additional information in the future …
  – Assessment of active inflammation
  – Role for DWI, MT, DCE, BOLD, others?
  – Advanced real time applications
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