



MR Enterography in Crohn's Disease

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**Mount
Sinai**

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Burrill Crohn (1884 –1983)

- Trained in pathology and gastroenterology at Mount Sinai
- Named Chief of Mount Sinai's Gastroenterology Clinic in 1923
- Associated with Mount Sinai for over 60y
- One of the first to describe CD as “Regional ileitis; a pathologic and clinical entity”. JAMA 1932 (14 cases of granulomatous inflammation of the distal ileum)

JAMA The Journal of the American Medical Association

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October 15, 1932, Vol 99, No. 16 >

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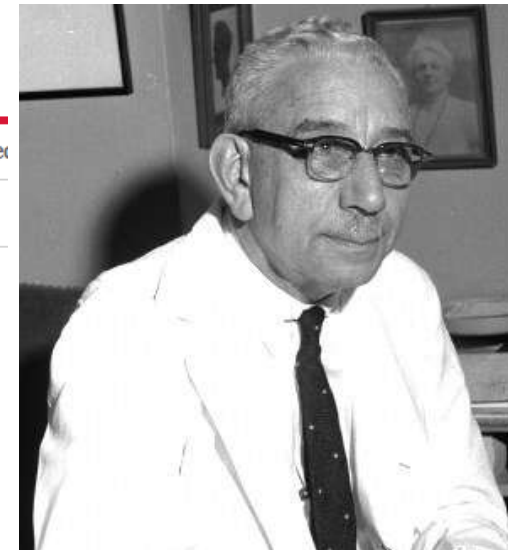
ARTICLE | October 15, 1932

**REGIONAL ILEITIS
A PATHOLOGIC AND CLINICAL ENTITY**

BURRILL B. CROHN, M.D.; LEON GINZBURG, M.D.; GORDON D. OPPENHEIMER, M.D.

JAMA. 1932;99(16):1323-1329. doi:10.1001/jama.1932.02740680019005.

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Crohn's disease (CD)

- Chronic IBD with variable clinical features and disease course
- Can involve any location of the GI tract, frequently affects distal SB
- All bowel layers may be involved, with skip areas
- Fatigue, persistent diarrhea, cramping abdominal pain, fever, rectal bleeding, loss of appetite, weight loss
- Extra-digestive symptoms: joints, eyes, skin, PSC
- Complications: SBO, GI ulcers, perianal fistulas, protein loss, vitamin insufficiency, superinfection
- Increased risk of SB, colorectal cancer, lymphoma and carcinoid tumors

Crohn's disease (CD)

- Disease behavior based on the presence/absence of complications such as stricture, fistula, and abscesses
- Biologic therapy: immune modifiers (azathioprine, 6-MP, methotrexate), antibiotics, anti-TNF (infliximab)
- 2/3 to 3/4 of CD patients require surgery at some point
- Ultimate goal of medical therapy in CD:
 - Achieve clinical response and sustained remission
 - Prevent strictures and penetrating complications that lead to surgery

Advantages of MRI over CT

- Radiation free
- Higher tissue contrast
- Comprehensive examination: Bowel and perianal fistulas
- Functional assessment:
 - ✓ Peristalsis
 - ✓ Diffusion
 - ✓ Enhancement/perfusion

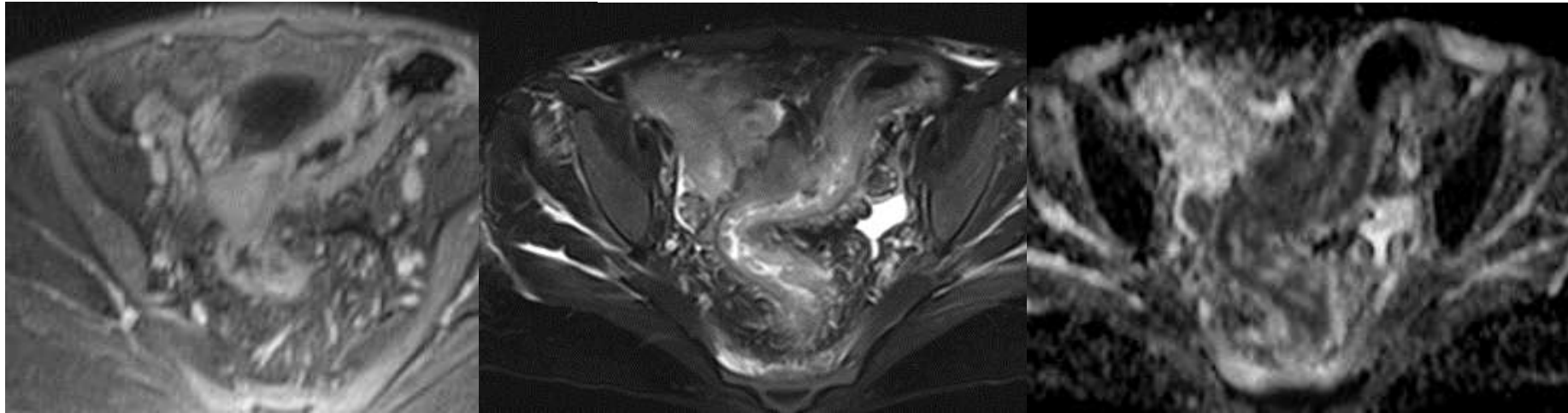
CT related radiation

Diagnostic Procedure	Effective Dose (mSv)	Time Period for Equivalent Effective Dose from Natural Background Radiation
Chest x ray (PA)	0.02	2.4 days
CT abdomen	8 (3.5-25)	2.7 years
CT pelvis	8 (3.3-10)	2.7 years

Note: yearly limit for radiation workers in the US 50 mSv

<http://www.fda.gov/Radiation-EmittingProducts/>

27 year old female with Crohn colitis

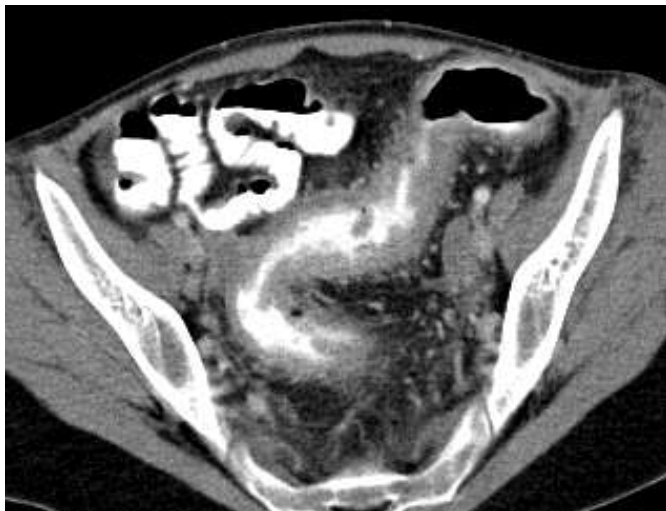


T1 post-contrast

T2 fat sat

ADC

CT



Effective CT dose = 11.4 mSv

kV	mAs	CTDI _w	DLP
120			
120	200	15.20	762

Roles of MRI

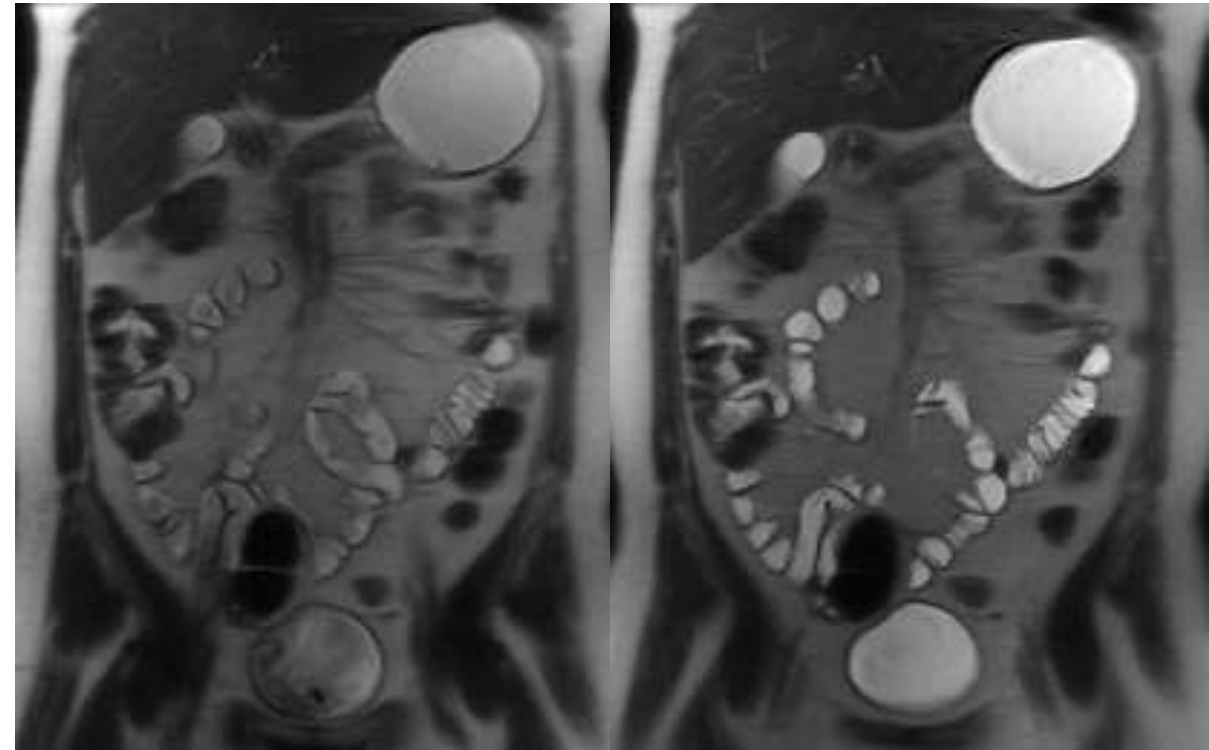
- Diagnose CD
- Assess extent of lesions
- Assess for complications (abscess/phlegmons, fistulas, obstruction, stenotic lesions)
- Assess response to treatment
- Marker of severity (MaRIA and Clermont scores)
 - $\text{MaRIA} = 1.5 \times \text{wall thickening (T1, mm)} + 0.02 \times \text{RCE} + 5 \times \text{edema} + 10 \times \text{ulceration}$
 - $\text{Clermont} = 1.646 \times \text{wall thickening} + 1.321 \times \text{ADC} + 5.613 \times \text{edema} + 8.306 \times \text{ulceration} + 5.039$

Limitations of MRI

- Longer exam
- Not as sensitive to air
- Limited availability
- Quality can be suboptimal (poor breath-holding, limited bowel distention)

Patient preparation

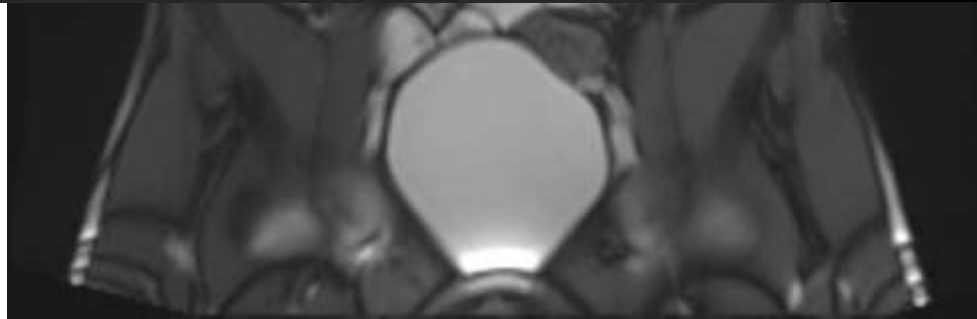
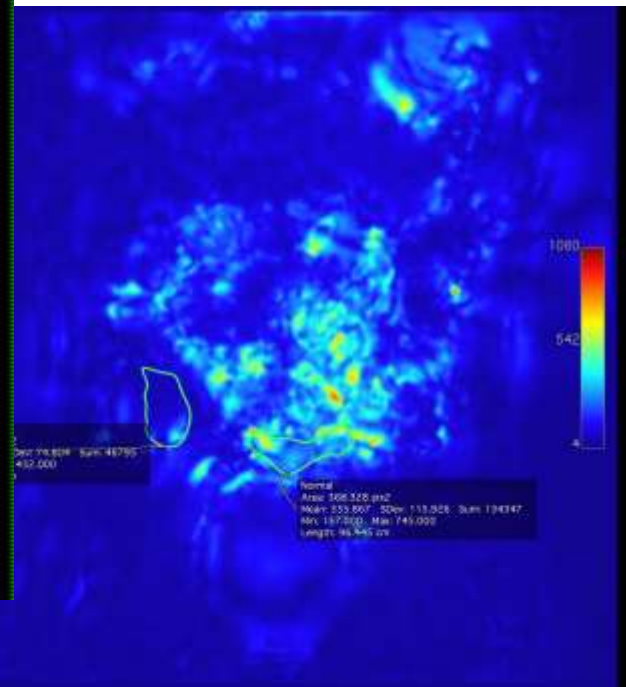
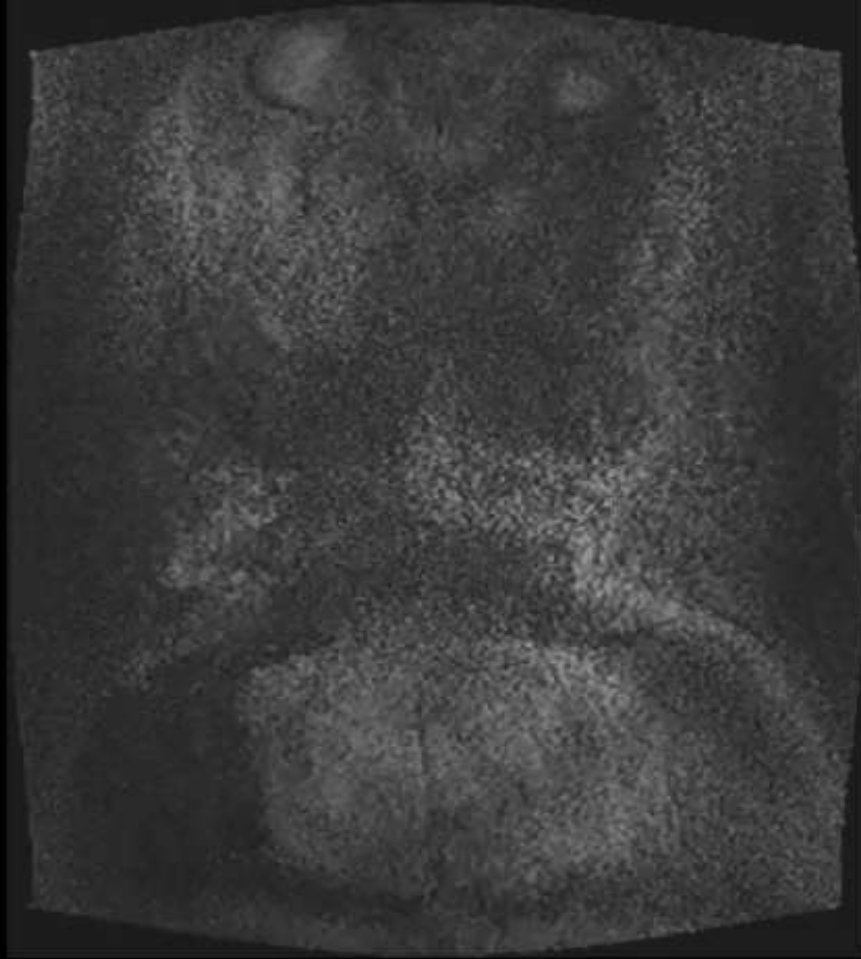
- 6 hours of fasting
- Check contra-indications to MRI
- Glucagon (1 mg IM)



Before

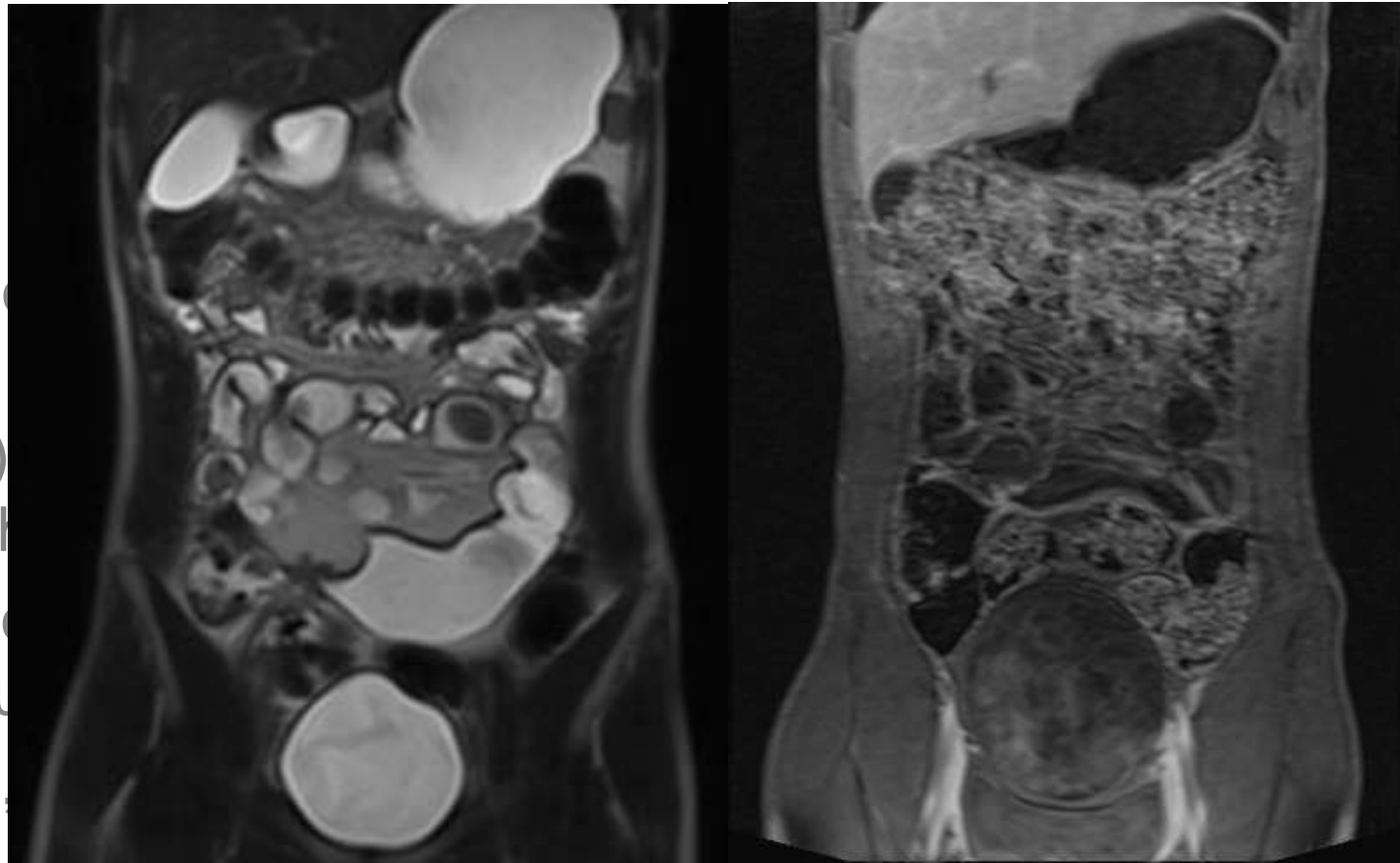
After

Courtesy, Jeff Fiddler, Mayo Clinic



Oral contrast agents

- ▶ Need neutral biphasic non-absorbable contrast agent with minimal water absorption by the bowel
- ▶ VoLumen (Bracco Diagnostics): barium sulfate suspension (0.1% weight/volume)
- ▶ Breeza (Beekley medical): lemon and xanthan gum without barium
- ▶ Performs similarly to VoLumen, but requires repeat drinking (Kolbe. AJR 2016; Dinnman, Radiology 2016)
- ▶ Mannitol, PEG, sorbitol and lactulose, methylcellulose, metamucil
- ▶ Ingestion of up to 1000 ml 45-60 min prior to scanning



Imaging findings associated with SB CD inflammation

Segmental mural hyperenhancement

- Asymmetric
- Stratified (bi-or tri-laminar)
- Homogeneous, symmetric

Wall thickening

- Normal
- Mild (3-5 mm)
- Moderate (>5 - 9 mm)
- Severe (≥ 10 mm)

Intramural edema

Stricture

- Possible stricture without upstream dilation (< 3 cm)
- Stricture with mild upstream dilation (3 - 4 cm)
- Stricture with moderate/severe upstream dilation (>4 cm)

Ulcerations

Sacculations

Restricted Diffusion

Diminished Motility

Imaging Findings of Penetrating CD

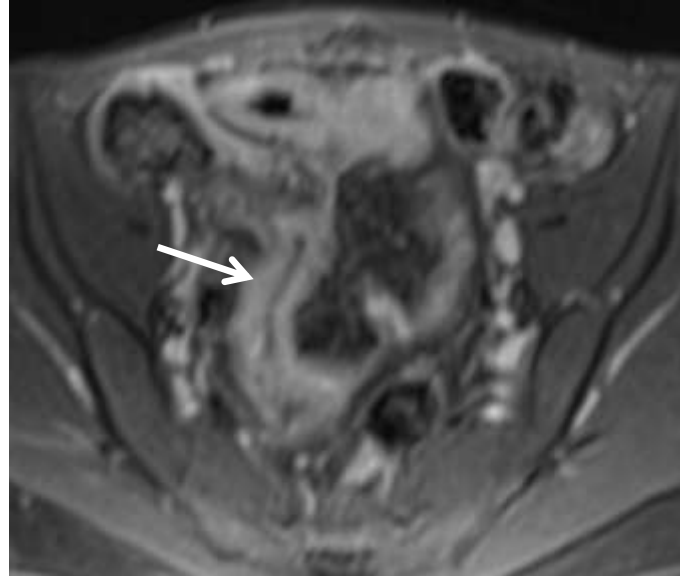
Fistulas

- Sinus tract
- Simple fistula
- Complex fistulas
- Inflammatory mass
- Abscess

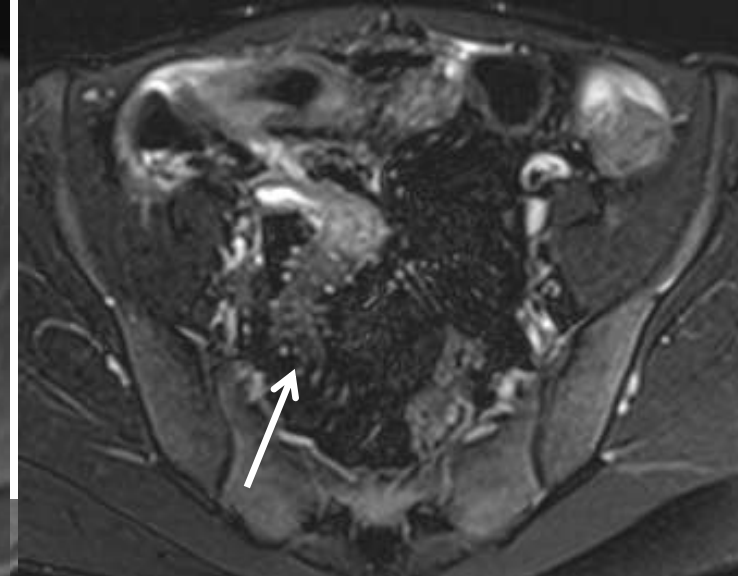
CD changes in the mesentery

Perienteric edema/inflammation
Engorged vasa recta
Fibrofatty proliferation
Mesenteric venous
thrombus/occlusion
Adenopathy

Active CD



Enhancing T1

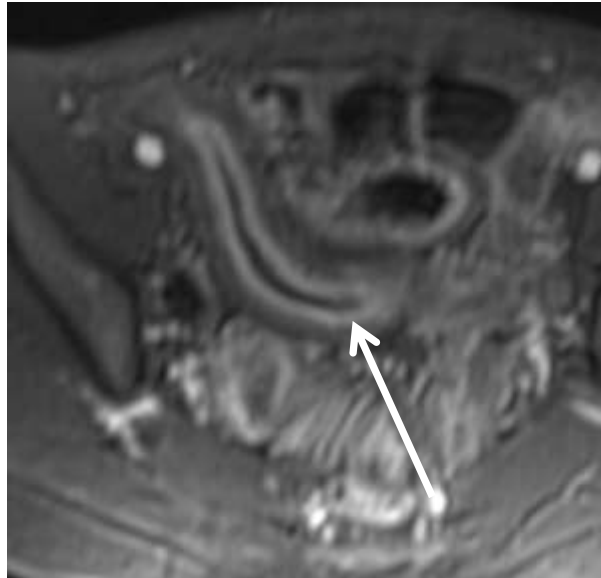


Comb sign

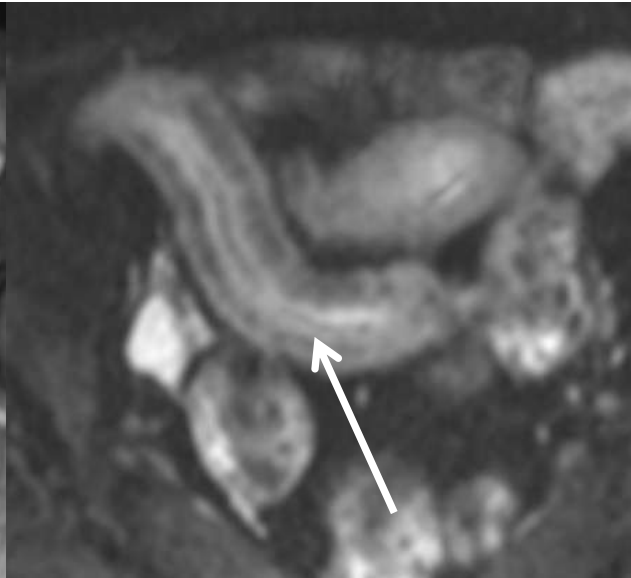


Nodes

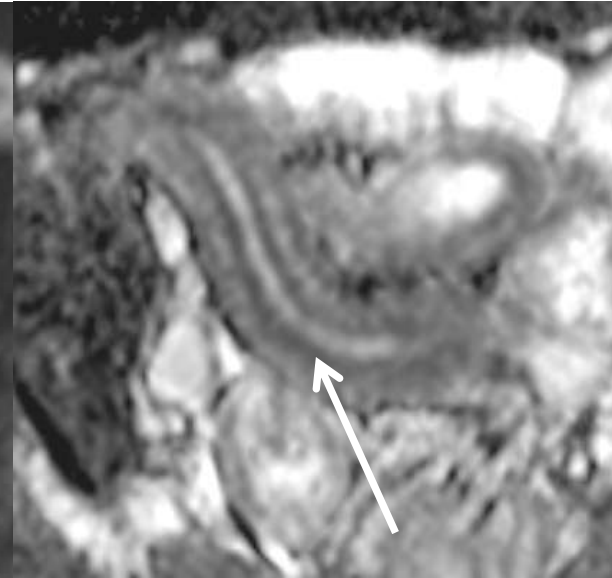
Active CD in TI and perianal fistula



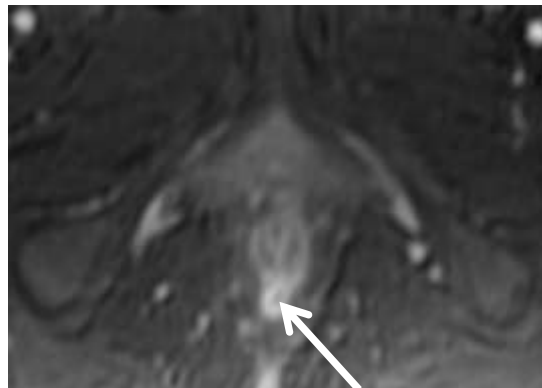
Post-contrast T1



DWI b800



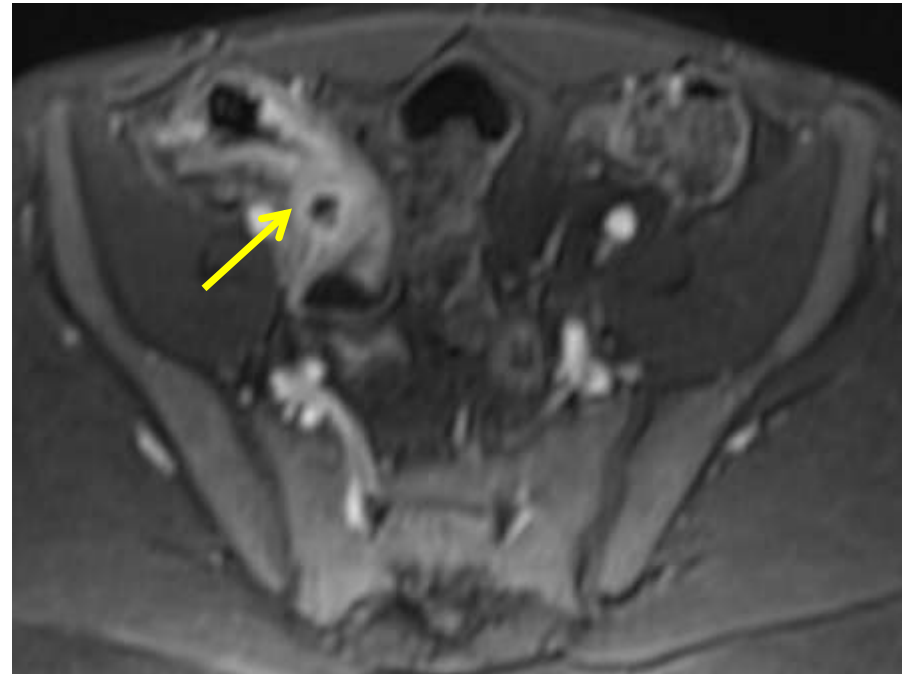
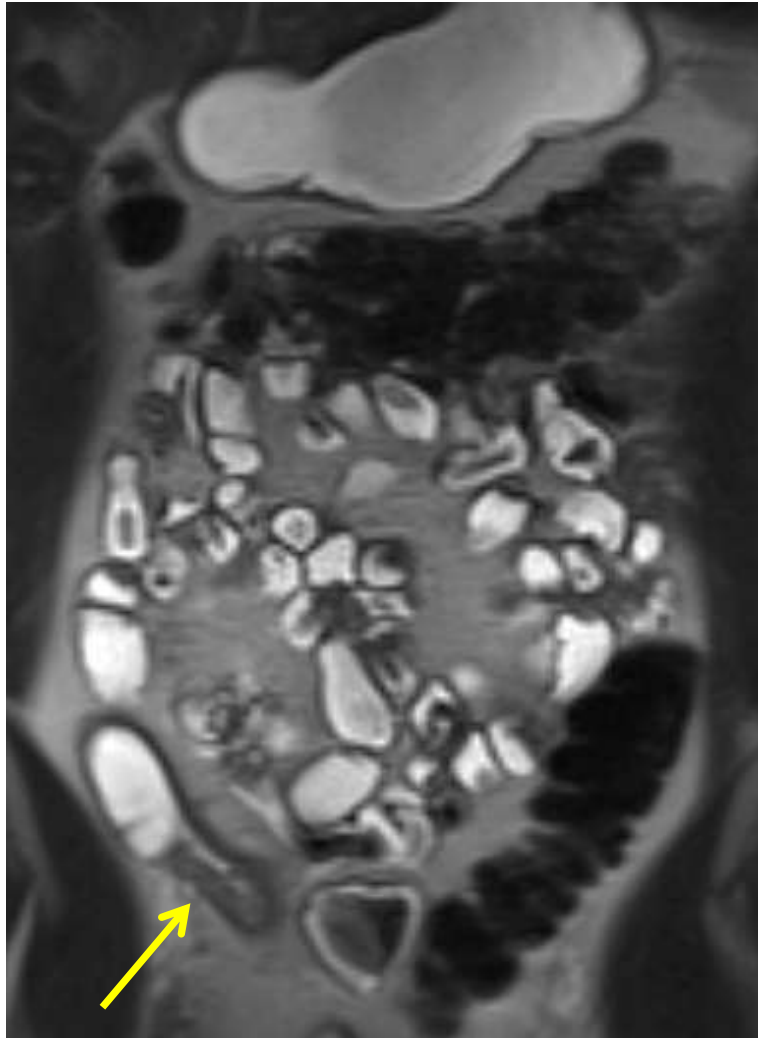
ADC



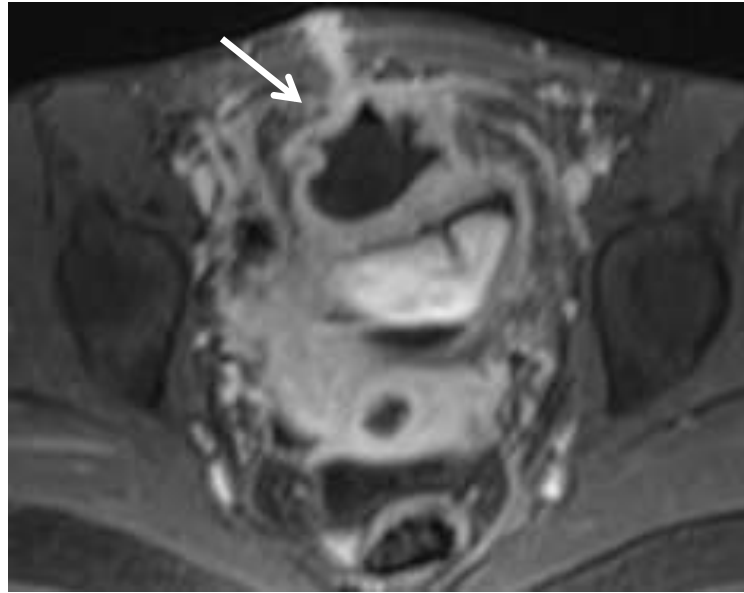
CD with complex internal fistulas



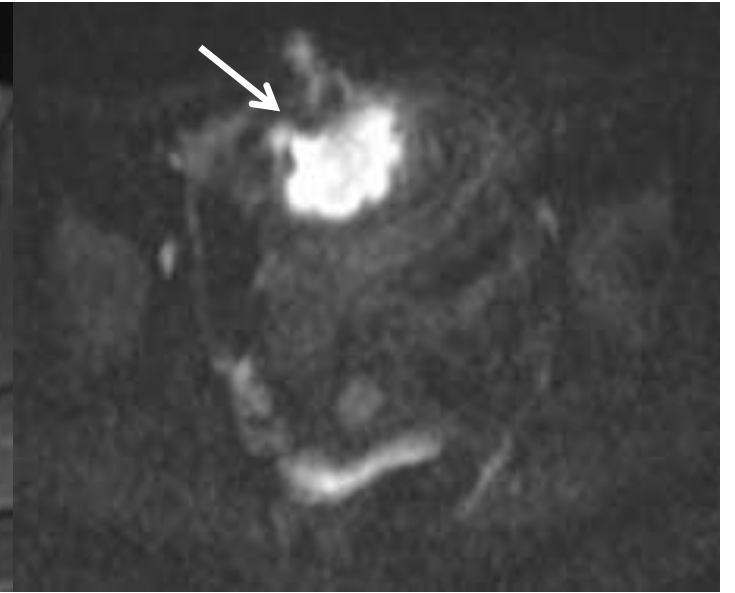
CD, TI Involvement and small abscess



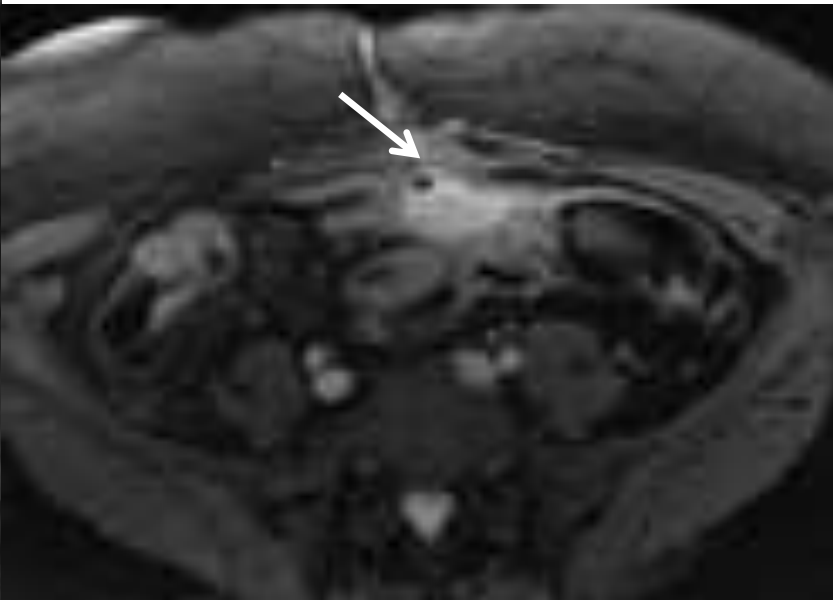
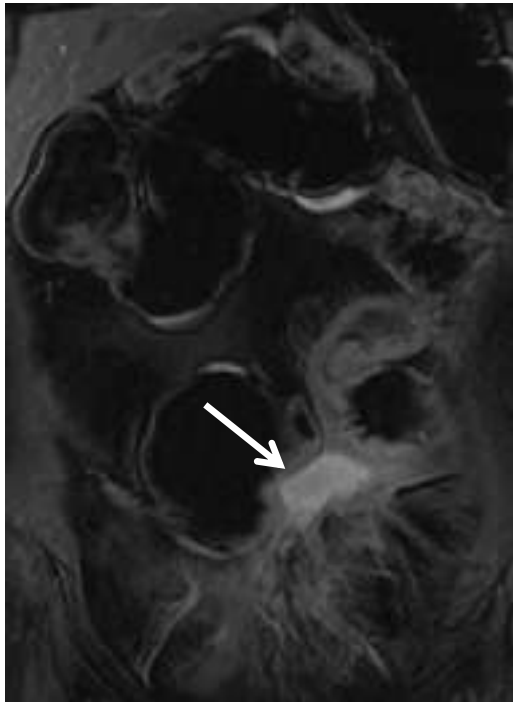
Abscesses in CD



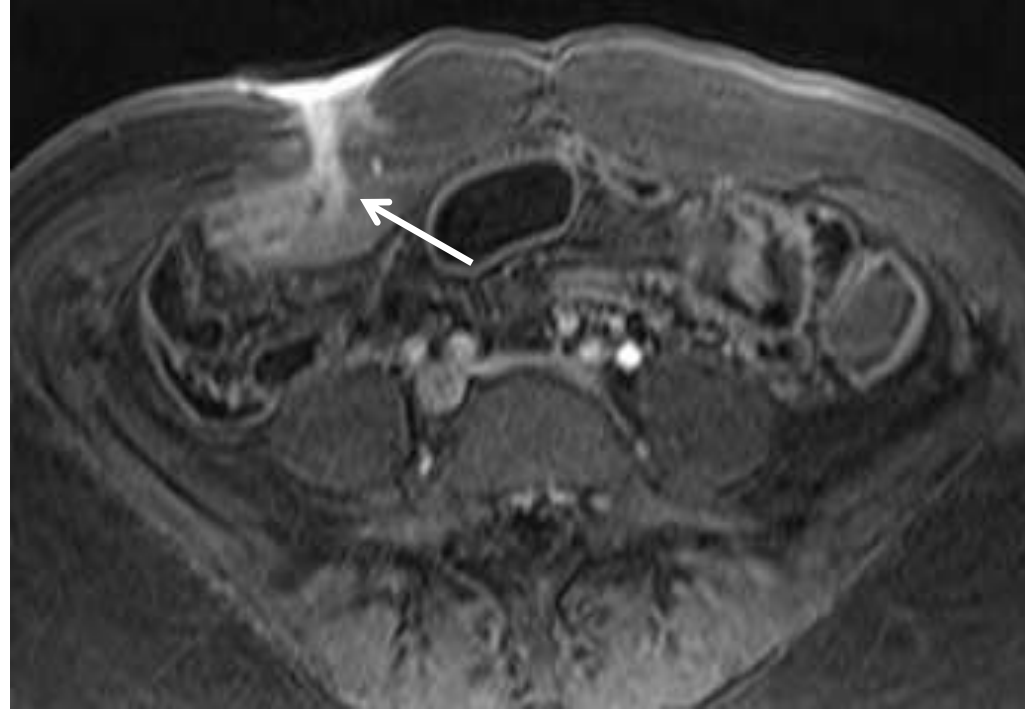
Post-contrast T1



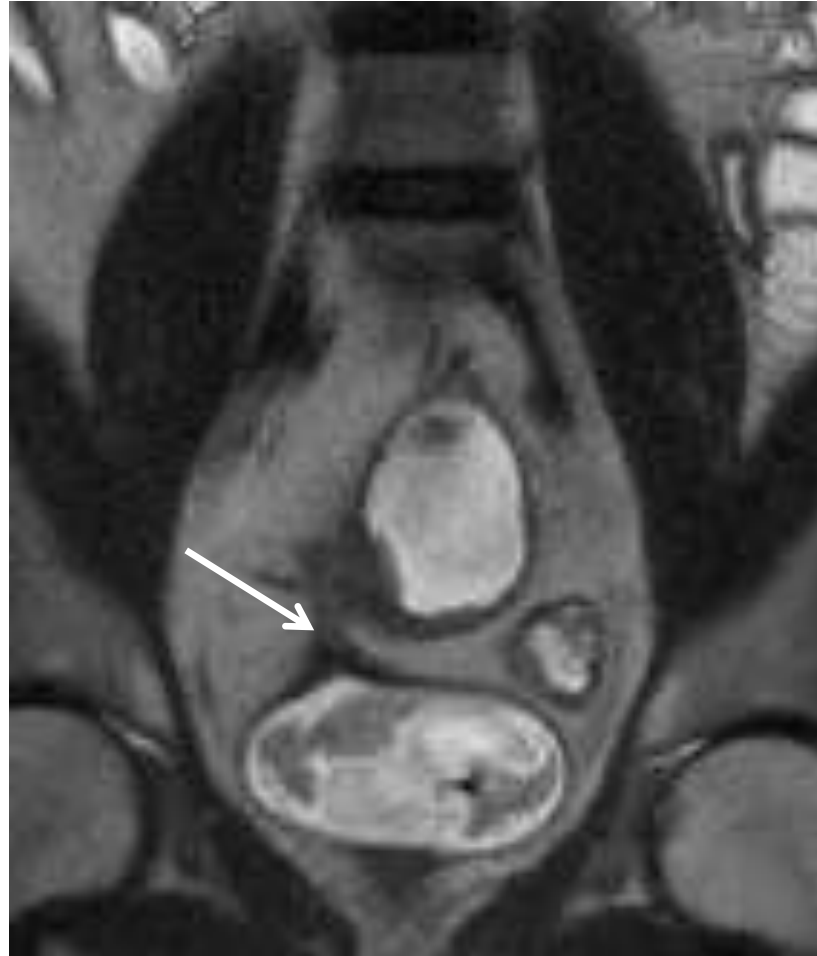
DWI b1000



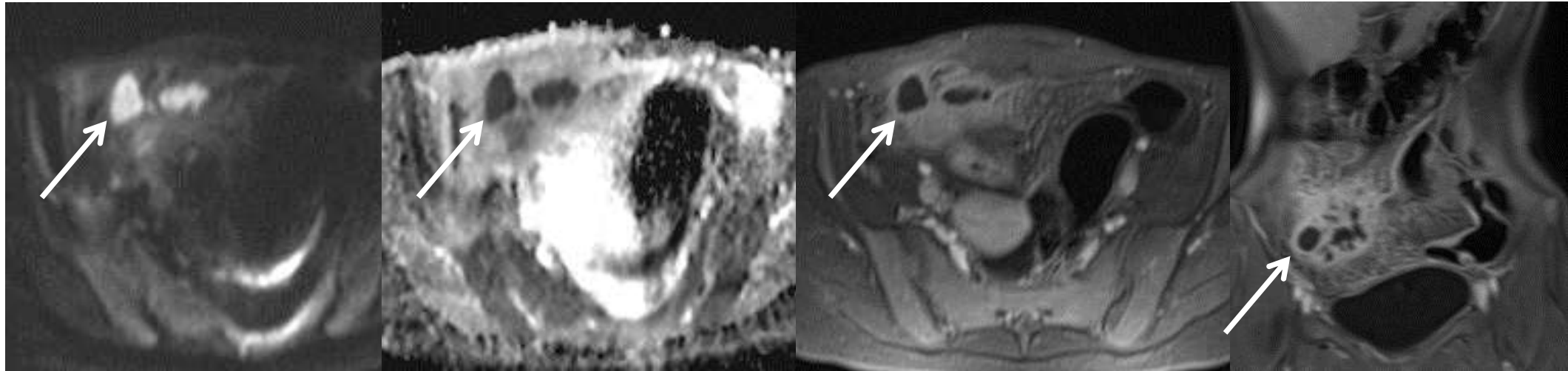
CD-Enterocutaneous fistula



CD-Fistula between sigmoid colon and bladder



14 year old female with CD and large complex abscess



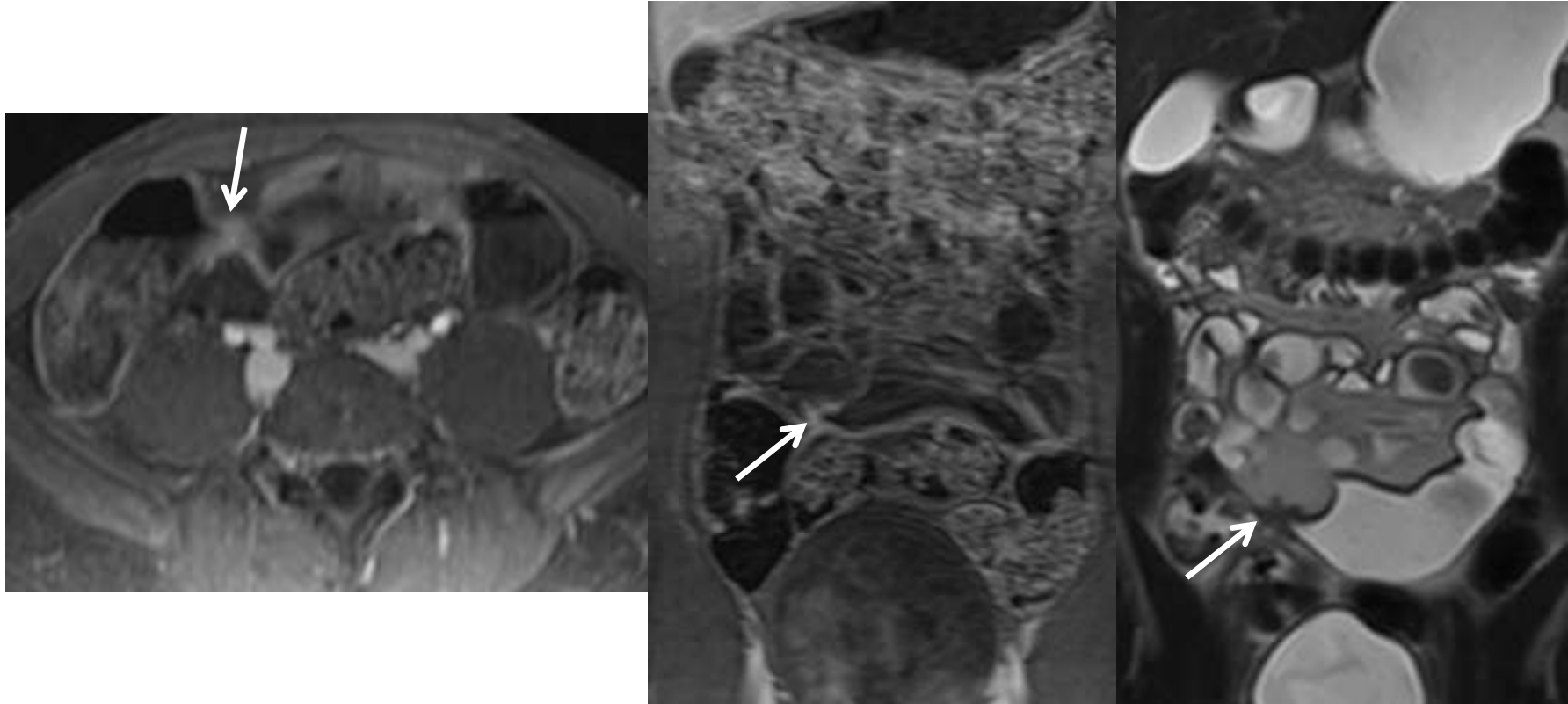
DWI

ADC

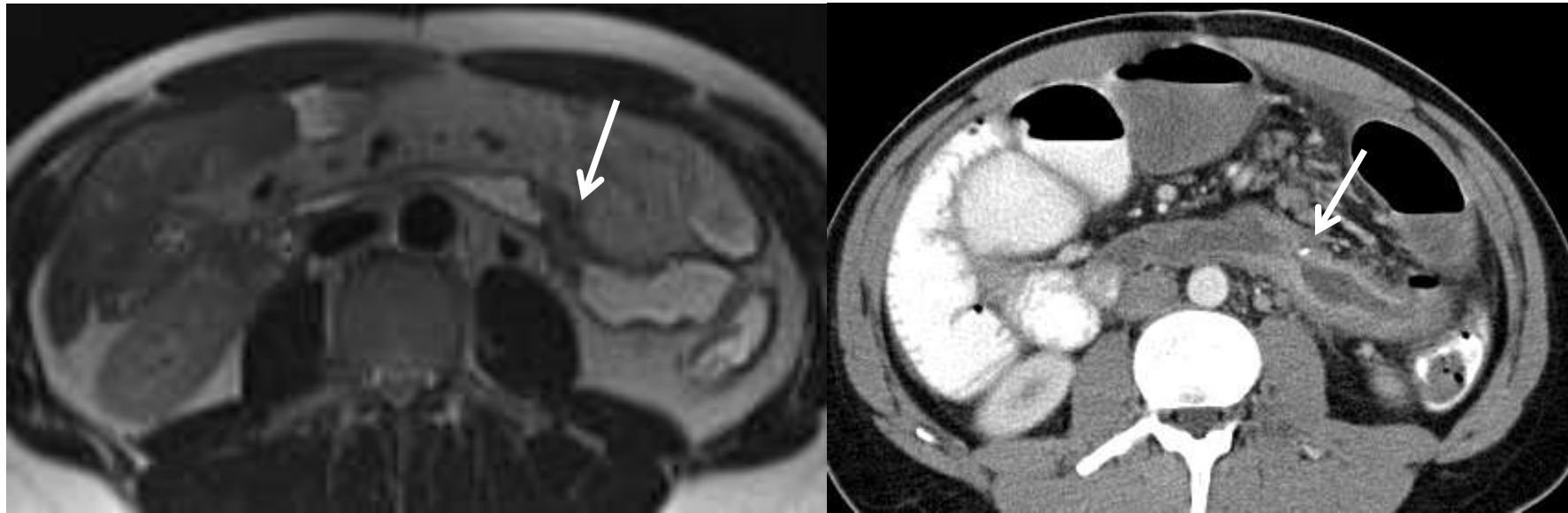
post-contrast T1

T1

CD-Stenotic lesion



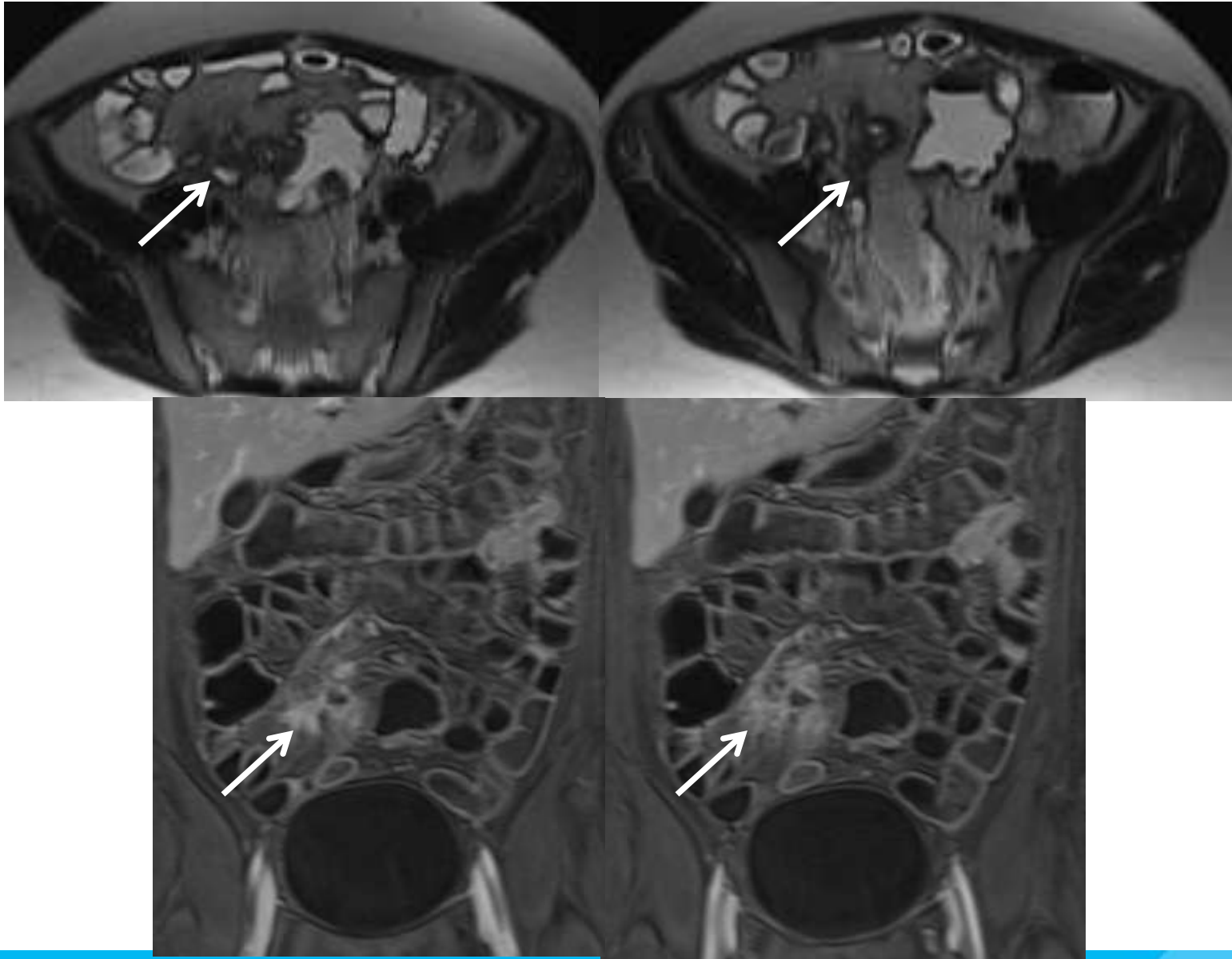
CD-Stenotic lesion



CD with complex internal fistulas



Complex entero-enteric fistulas in CD



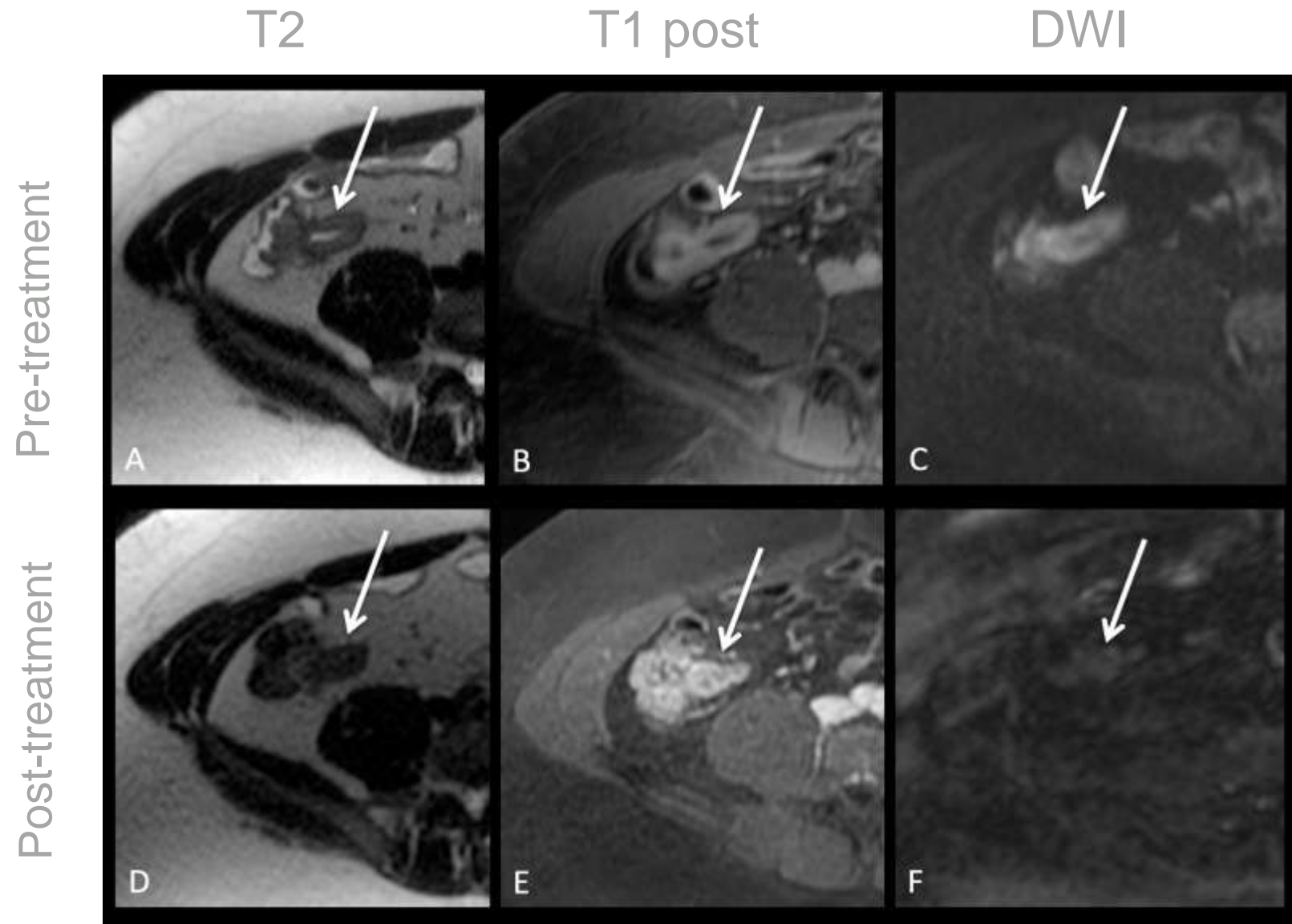
New directions

Diagnostic performance of MRE for prediction of mucosal healing (n=24)

	AUC	p	Threshold	Sensitivity (%)	Specificity (%)
Clermont pre- treatment	0.835	0.016	24	100	69
Clermont post- treatment	0.912	0.003	9	71	100
Wall thickness post-treatment	0.938	0.001	6	67	100
MaRIA post-treatment	0.901	0.004	18	100	77
Δ MaRIA	0.813	0.024	-25	71	77

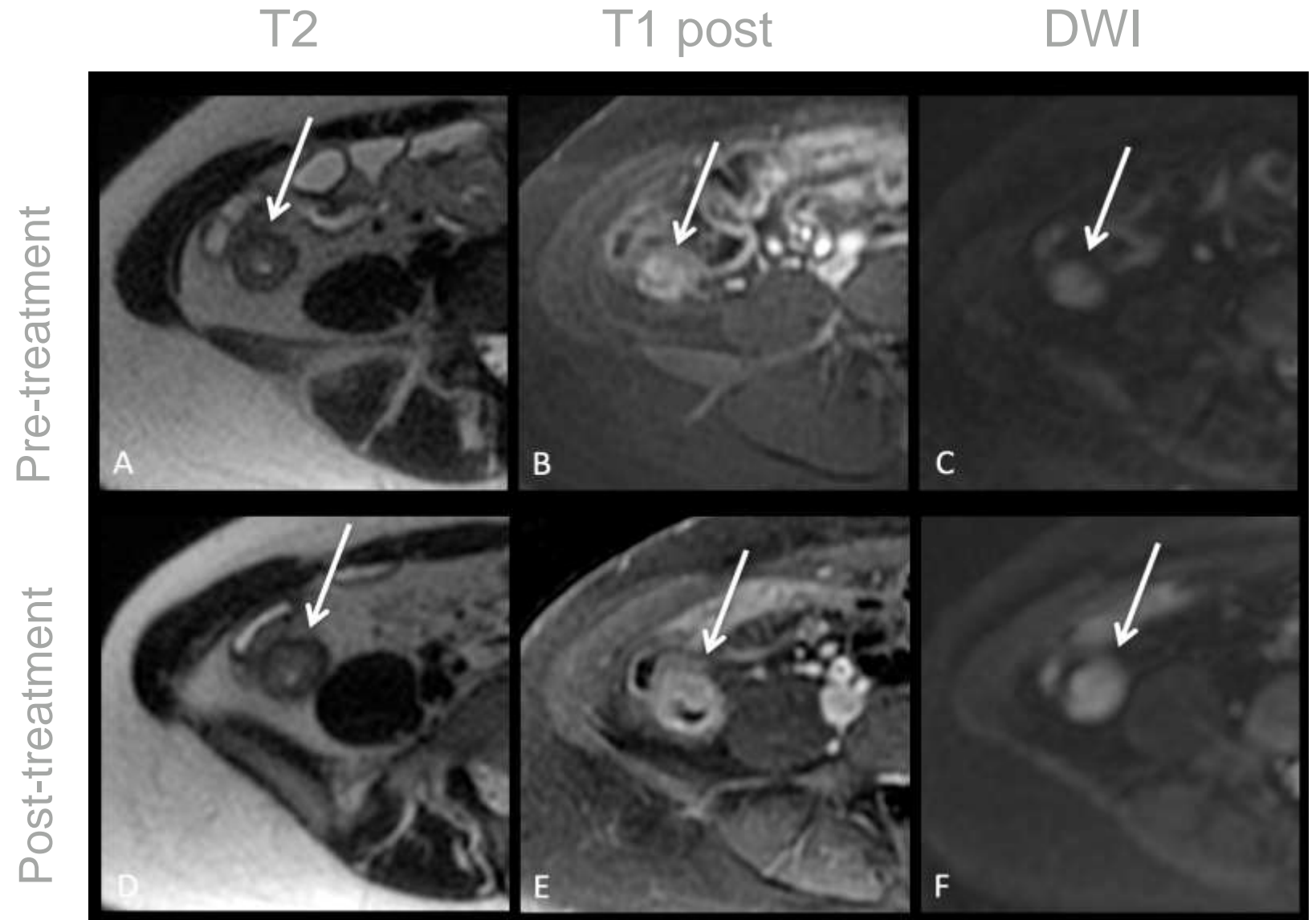
20-yo man with ileal CD with mucosal healing post treatment

Δ MaRIA -86.8%
 Δ Clermont -75.8%



21-yo woman with ileal CD with lack of mucosal healing post treatment

Δ MaRIA 0.1%
 Δ Clermont -2.8%



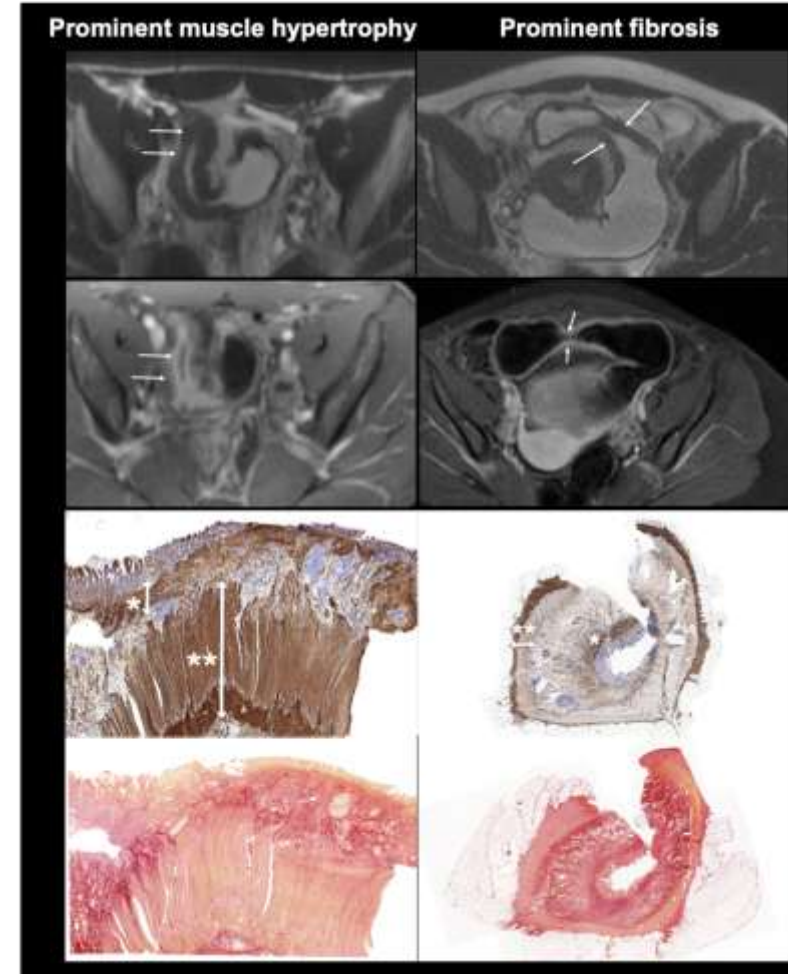
DWI in CD

- DWI may have a role as a quantitative measure of inflammation and fibrosis in CD
- Inflamed bowel segments show restricted diffusion compared with normal bowel (Oto. Academic Radiology 2009, Oto. JMRI 2011)
- Significant negative association between ADC in bowel wall and MRI markers of disease activity (Ream. Pediatric radiology 2013)
- ADC lower in areas of transmural fibrosis compared to inflamed nonstenotic segments and normal bowel (Kovanlikaya. Abdominal imaging 2014)

Prediction of tissue composition of stenotic lesions in CD

- 35 CD patients with SB resection and MRI assessed
- Layered pattern at early post-contrast phase more frequent with marked inflammation
- ADC significantly lower and MaRIA score significantly higher in inflammation grade 2-3 vs. grade 1
- Significant correlations between inflammation grade and ADC/MaRIA score ($r = -0.396/0.376$, $P < 0.02$)

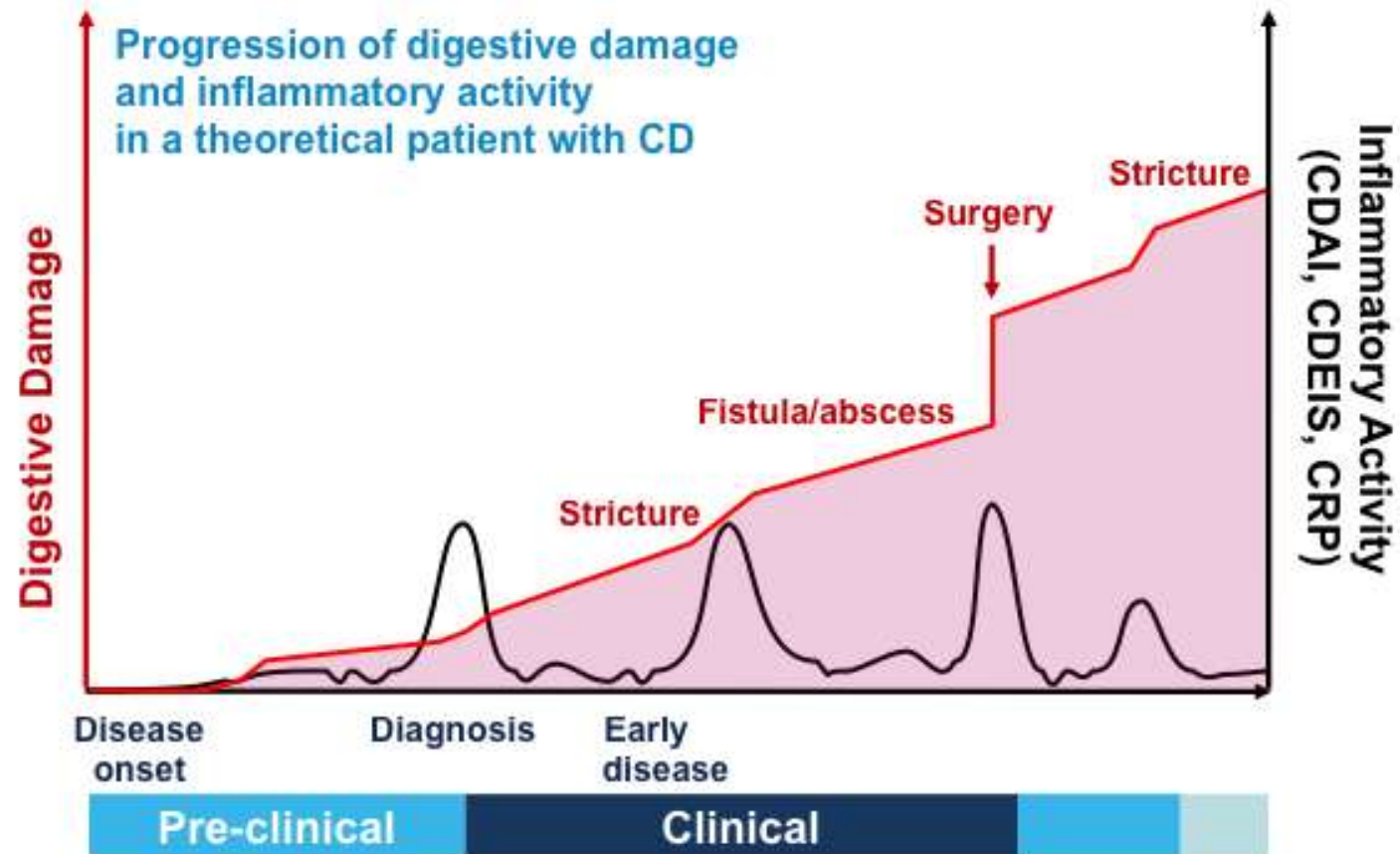
Parameter	Inflammation		Prominent muscle hypertrophy vs. prominent fibrosis	
	AUC	p	AUC	p
Length of involved bowel	0.7	0.036	0.713	0.054
Wall thickness on T2WI	0.64	0.142	0.742	0.029
Wall thickness on T1WI	0.725	0.018	0.711	0.056
ADC	0.728	0.029	0.556	0.637
MaRIA score	0.736	0.013	0.71	0.058
Clermont score	0.667	0.11	0.727	0.054



Summary

- MRI is an excellent modality for SB imaging in IBD
- MR enterography should be used in young patients, preferably to CT
- MRI: best imaging modality for perianal fistulas
- Role of functional imaging (DWI, peristalsis) remains to be determined

Progression of digestive disease damage (Lémann score) and inflammatory activity



CDAI: Crohn's Disease Activity Index; CDEIS: Crohn's Disease Endoscopic Index of Severity; CRP: C-Reactive Protein

Pariente B et al. *Inflamm Bowel Dis* 2011;17(6):1415-22

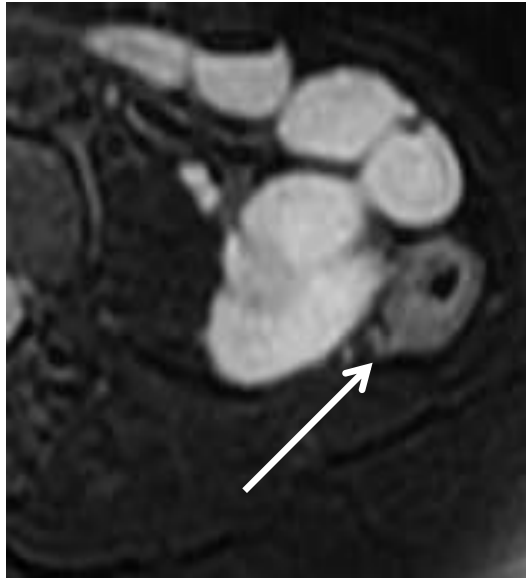
MRI report

- SB: inflammation, extent of lesions, stenosis, fistulas, SBO
- Colon: inflammation, distention
- Rectum-anus: proctitis, perianal fistulae
- Fluid collections, abscesses
- Nodes
- Upper abdomen: biliary system (PSC)

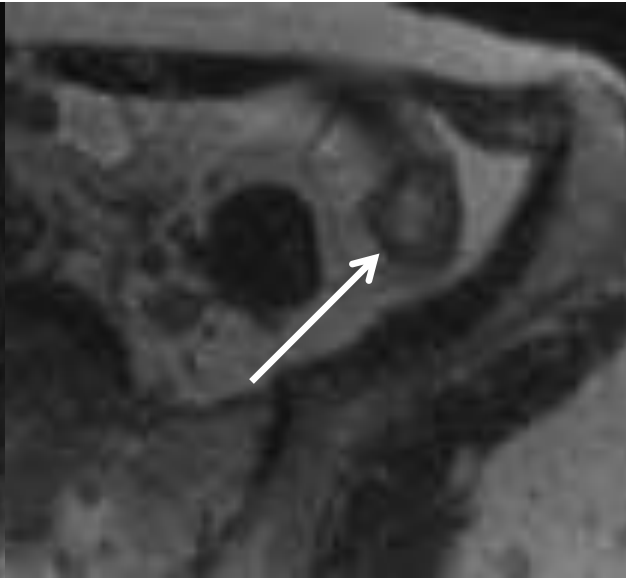
UC findings

- Diffuse colon wall thickening, wall edema
- Ahaustral colon
- No fistula or stenotic lesions
- No skip lesions, no abscess
- Superficial inflammation
- Patients may be imaged after total proctocolectomy (J pouch)
- Risk of CRC

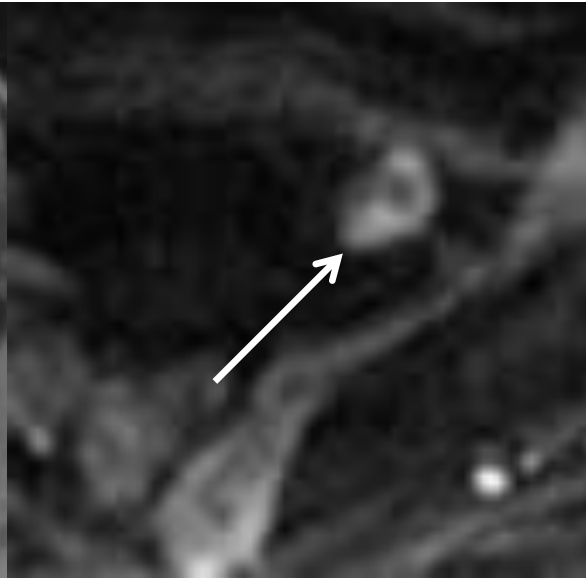
UC



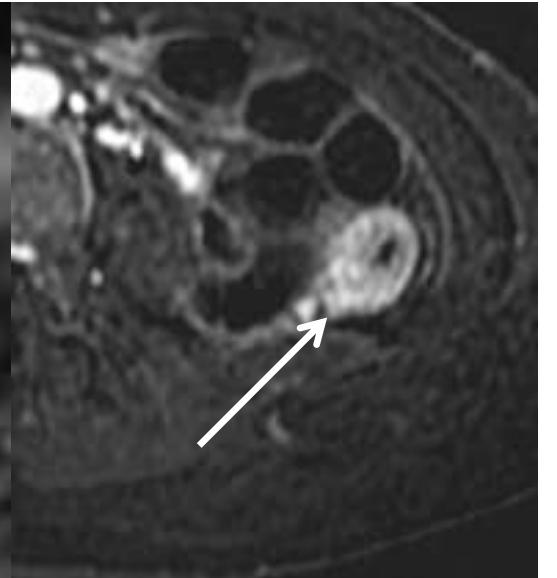
T2 fat sat



HASTE



DWI



Post-contrast T1

Quantitative imaging techniques

- DWI
- DCE-MRI
- Magnetization transfer ratio (potential marker of fibrosis)
- Quantification of bowel peristalsis
- FDG PET-MRI

Fibrostenotic vs. inflammatory lesions

- Direct relationship: Mural enhancement and response to medical therapy (Zappa, 2011)
- Fibrostenotic Subtype: fixed narrowing, wall thickening, surgical therapy
 - Prestenotic dilation (+/-, less likely to respond to medical therapy)
 - Reduced enhancement
 - Decreased T2 signal
 - Decreased FDG Avidity
- Inflammatory Subtype: Stricture responds to medical therapy
 - TTP – Enhancement
 - Increased T2 SI – stratified
 - Increased FDG Avidity (Catalano. Radiology 2016)
 - ? Low ADC