MRI findings in complicated Crohn's disease

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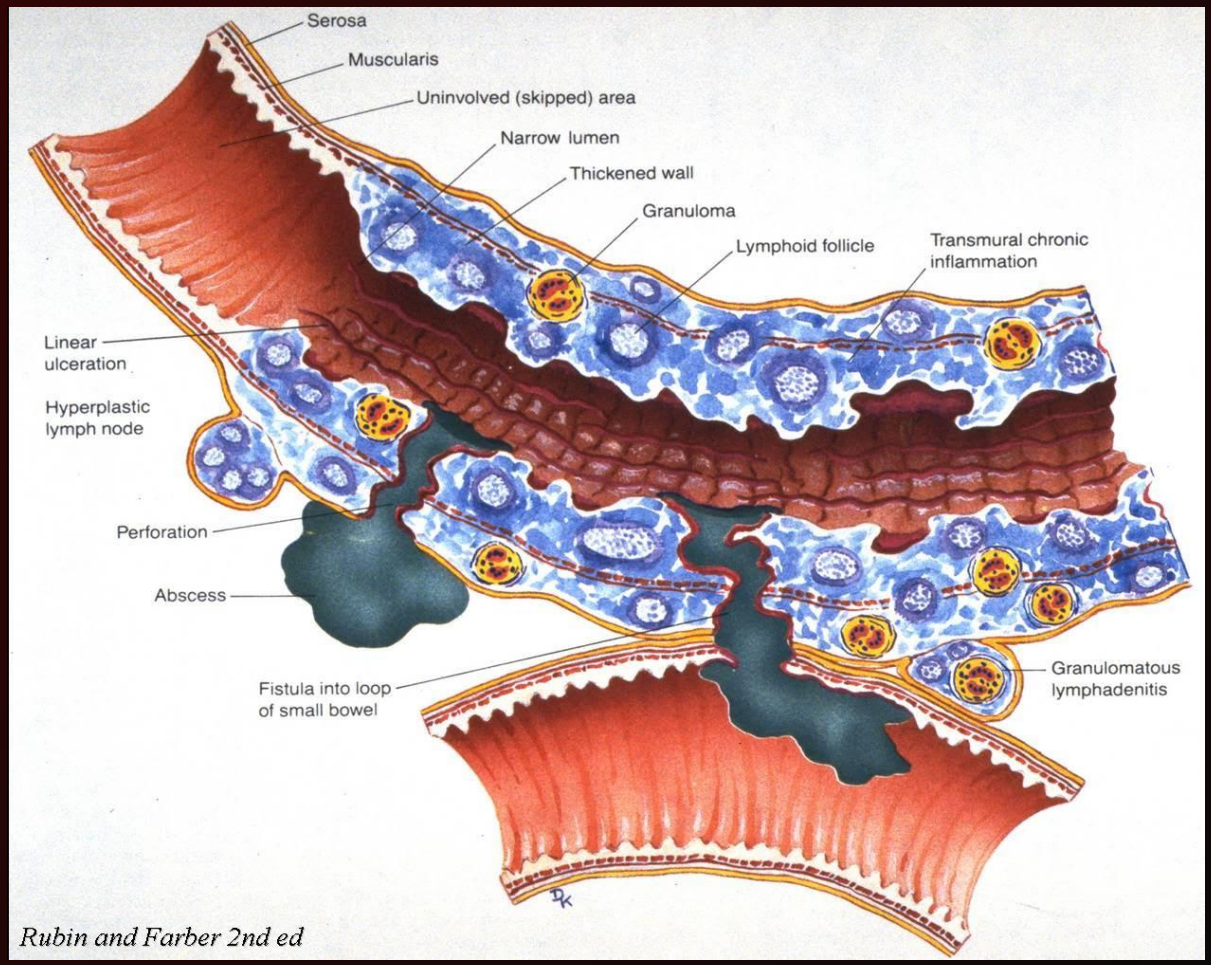
Learning objectives

- To understand the basic inflammatory changes in Crohn's disease (CD) with pathological correlations
- To describe effective MRI protocols to identify intestinal disease and its complications
- To recognize MRI findings relative to different CD complications
- To be aware of the clinical role of MRI in selecting different treatment options

Background – Definition and Classification

- Crohn's disease is a chronic, relapsing, inflammatory disease characterized by transmural granulomatous inflammation of the intestinal wall.
- **The Montreal** and pediatric **Paris classifications** sub-classify phenotypes of Crohn's disease into:
  - **Non-stricturing and non-penetrating inflammatory disease**
  - **Stricturing disease**
  - **Penetrating disease**
  - **Perianal fistula**

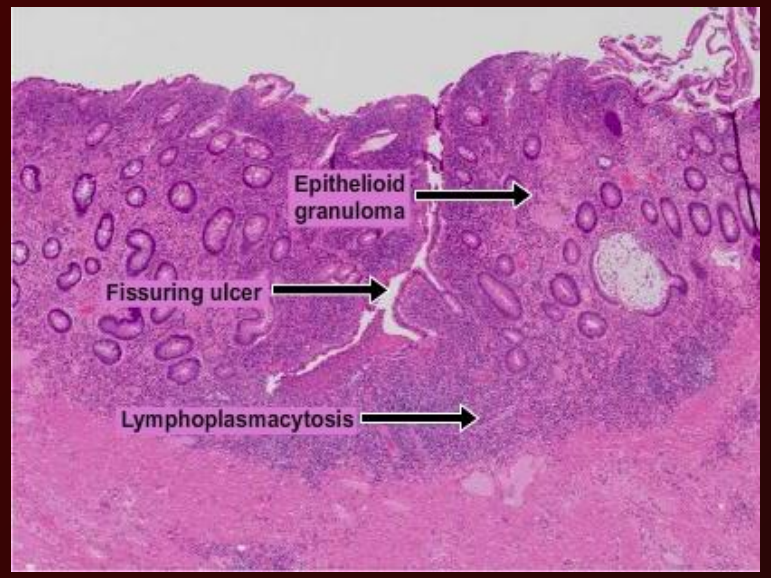


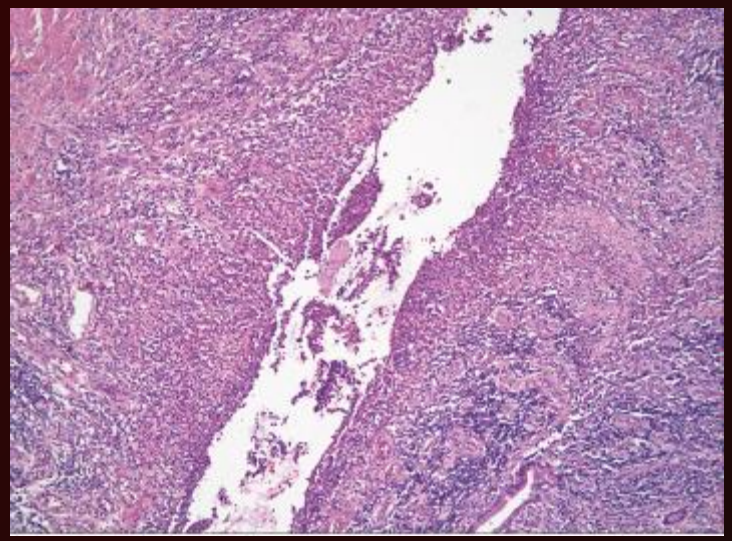
Background – Inflammatory Changes

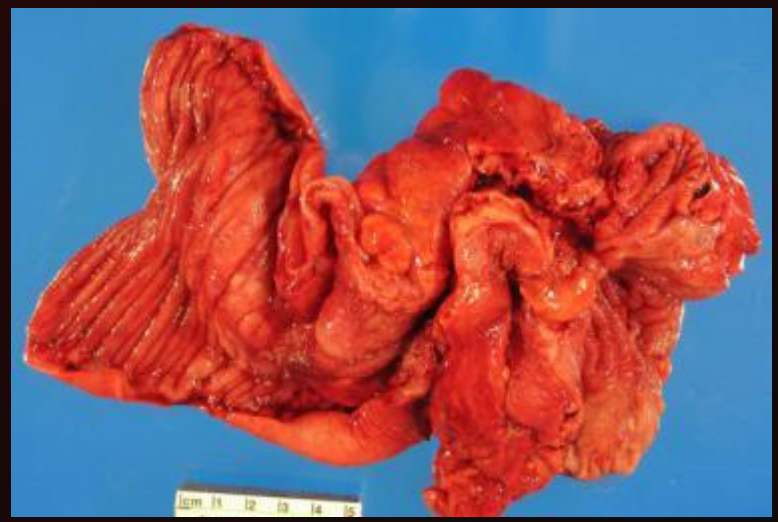
Early inflammatory changes include lymphoid hyperplasia and lymphoedema in the submucosa with aphtoid ulcerations

As inflammation progresses, it extends transmurally to the serosa, also involving the mesenteric fat and adjacent organs. Deep transmural ulcers are produced in this phase

Chronic inflammation leads to fibrotic changes with bowel wall thickening, lumen narrowing and strictures



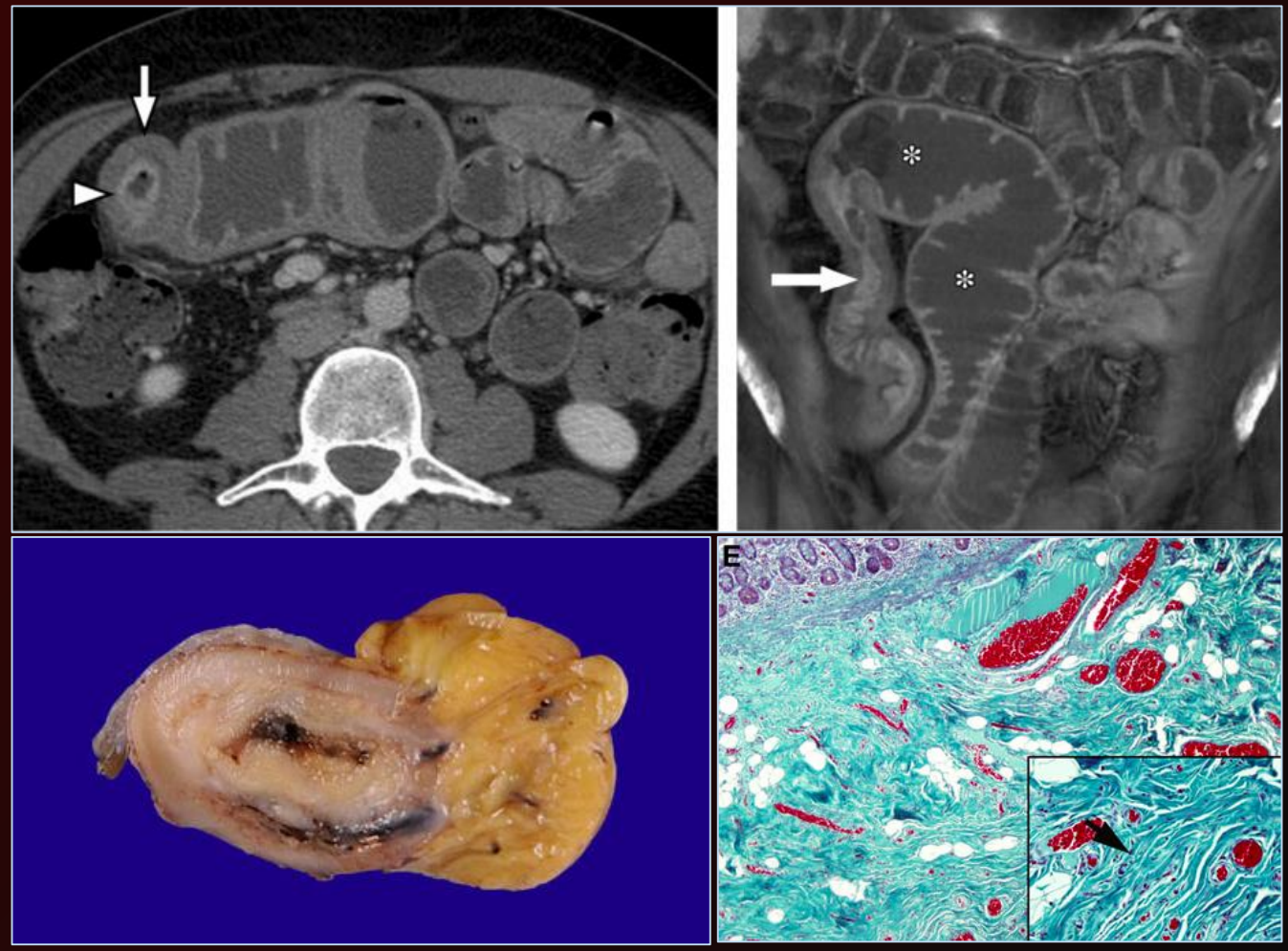




Background – Intestinal Complications 1

Stricturing Disease

- Characterized by bowel segments with severe luminal narrowing due to parietal thickening.
- Aphtoid and deep ulcerations in the acute phases are substituted by granulation tissue, which is subsequently replaced by fibrosis.
- Progressive fibrous tissue deposition during repetitive cycles of damage and repair leads to thickening and stiffness of the bowel wall.
- The most reliable sign of functional obstruction is pre-stenotic dilatation.



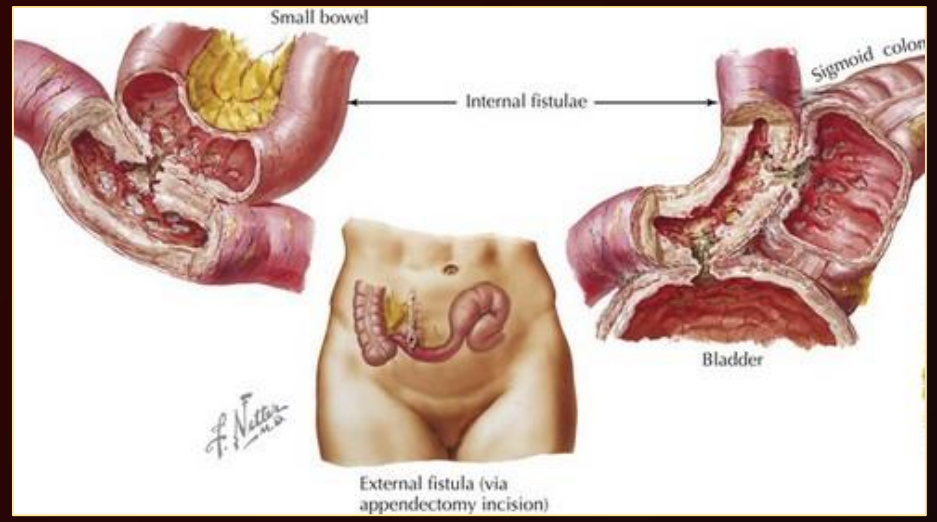
Images from Rimola et al. Abdom Imaging 2012

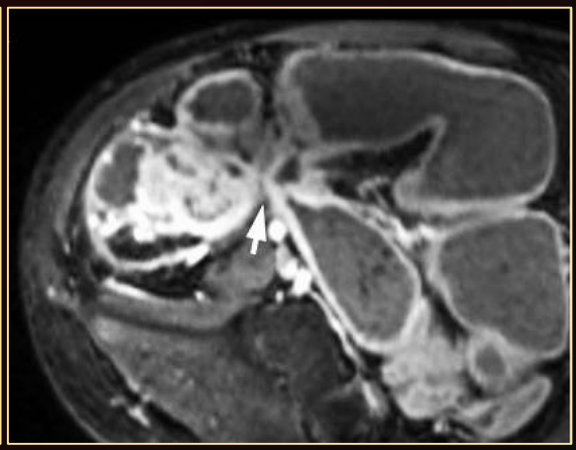
Background – Intestinal Complications 2

Penetrating Disease

Fissures and ulcerations penetrating the bowel wall can lead to:

- **Sinus tracts** – *these are precursors of fistulizing disease, consisting of a tract from the bowel with a blind end.*
- **Fistulas** – *Progression with perforation into adjacient bowel loops (entero-enteric fistulas) or other abdominal structures (entero - vescical, entero - cutaneous fistulas)*
- **Abscesses and adhesions** – *Fistula tracts may be complicated by inflammatory collections, phlegmon and fibrous adhesions to adjacent bowel segments*



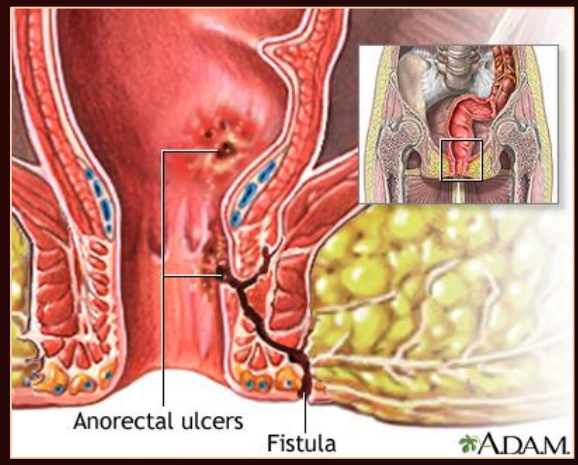


Images from Rimola et al. Abdom Imaging 2012

Background – Intestinal Complications 3

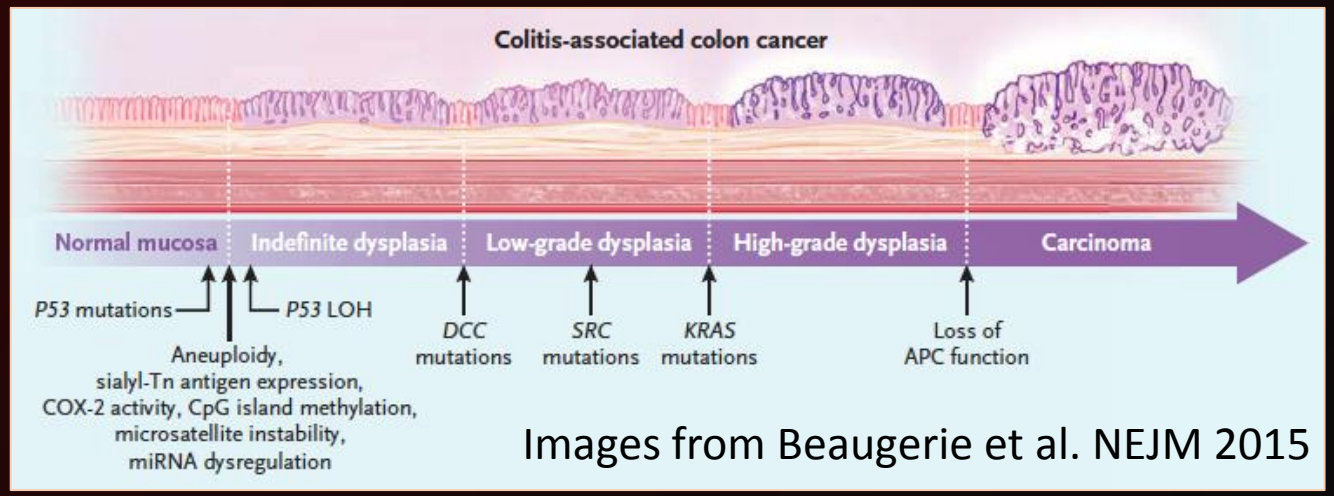
Perianal Disease

- Perianal Fistulas - *Arise from the rectum or anus and extend to the skin of the perineal region or vagina*
- **Perianal Abscesses-** *inflammatory fluid collections along fistula tracts*



Malignant Complications

- **Adenocarcinoma** - *significantly increased risk of colorectal carcinoma in patients with Crohn's disease.*
- ***Lymphoma*** - *Immunomodulators and anti-TNF agents are associated with a small, but measurable, increased cancer risk*



Images from Beaugerie et al. NEJM 2015

Background – Extra Intestinal Complications

- Cutaneous (pyoderma gangrenosum, erythema nodosum)
- Ophthalmic (uveitis, etc)
- Amyloidosis, thrombo-embolic complications
- Renal (calculosis)
- Articular (ankylosing spondilytis, arthritis)
- Primary sclerosing cholangitis

→ **MRI findings**

Background – CT vs MRI in detecting CD complications

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CONSENSUS/GUIDELINES

Imaging techniques for assessment of inflammatory bowel disease: Joint ECCO and ESGAR evidence-based consensus guidelines

einisch [c], J. Stoker [d], S
Halligan [h], B. Marincel
G. Rogler [m], G. van As
Bellini [r], L. Biancone
harzik [w], F. Maccioni [x],

Consensus Recommendations for Evaluation, Interpretation, and Utilization of Computed Tomography and Magnetic Resonance Enterography in Patients With Small Bowel Crohn's Disease[1]

Radiology

David H. Bruining
Ellen M. Zimmermann
Edward V. Loftus Jr
William J. Sandborn
Cary G. Sauer
Scott A. Strong
Society of Abdominal Radiology Crohn's Disease-Focused Panel

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. CTE and MRE have similar and moderately high accuracy for penetrating Crohn's disease (fistulas, inflammatory mass, abscess) (53,76,94–97). (Moderate)

. Penetrating complications detected at CTE and MRE may occur in unsuspected patients (94,98,99). (Low)

Prospective Comparison of Computed Tomography Enterography and Magnetic Resonance Enterography for Assessment of Disease Activity and Complications in Ileocolonic Crohn's Disease

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*W. Fries, MD,** L. Balzarini, MD,† M. Montorsi, MD,¶ A. Malesci, MD,*†† and S. Danese, PhD**

Conclusions: MR and CT are equally accurate to assess disease activity and bowel damage in CD. MR may be superior to CT in detecting intestinal strictures and ileal wall enhancement. MR may represent an alternative technique to CT in assessing ileocolonic CD.

(Inflamm Bowel Dis 2011;17:1073–1080)

Imaging technique
MR-Enterography protocol (1.5 and 3 Tesla magnet)

Type of sequence	1.5T (Siemens)	3T (GE)
Ultra fast T2 w SE	HASTE with/without Fat suppression (Half-Fourier Acquisition Single Shot Turbo SE)	SS-FSE with/without Fat suppression (Single-shot fast spin echo)
High resolution T2 w	Blade	PROPELLER Periodically Rotated Overalapping Parallel Lines with Enhanced Reconstruction)
Balanced	TrueFISP (True Fast Imaging with Steady-state Free Precession)	FIESTA (Fast Imaging Employing Steady State Acquisition)
DWI (Diffusion-Weighted Imaging)	b values: 50-500-800	b values: 50-500-1000
Ultra fast GE T1 w post Gadolinium –chelate injection	VIBE T1-weighted (Volumetric Interpolated Breath-hold Examination) *Dynamic arterial, portal, 3-7 min delayed acquisitions*	LAVA (Liver Acquisition with Volume Acceleration) *Dynamic arterial, portal, 3-7 min delayed acquisitions*

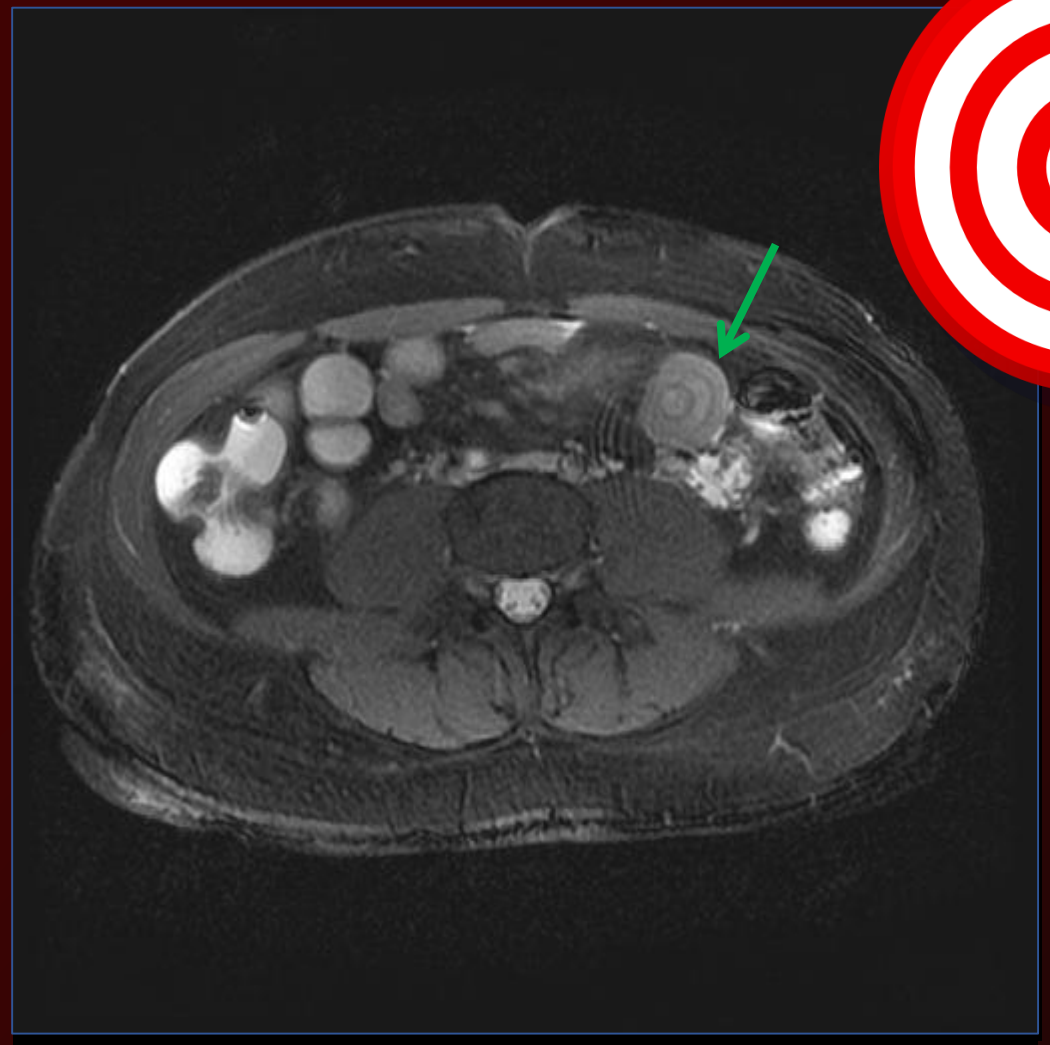
- MR enterography protocol : 1500-2500 ml oral contrast solution (Macrogol), administered 30-40 min before the exam

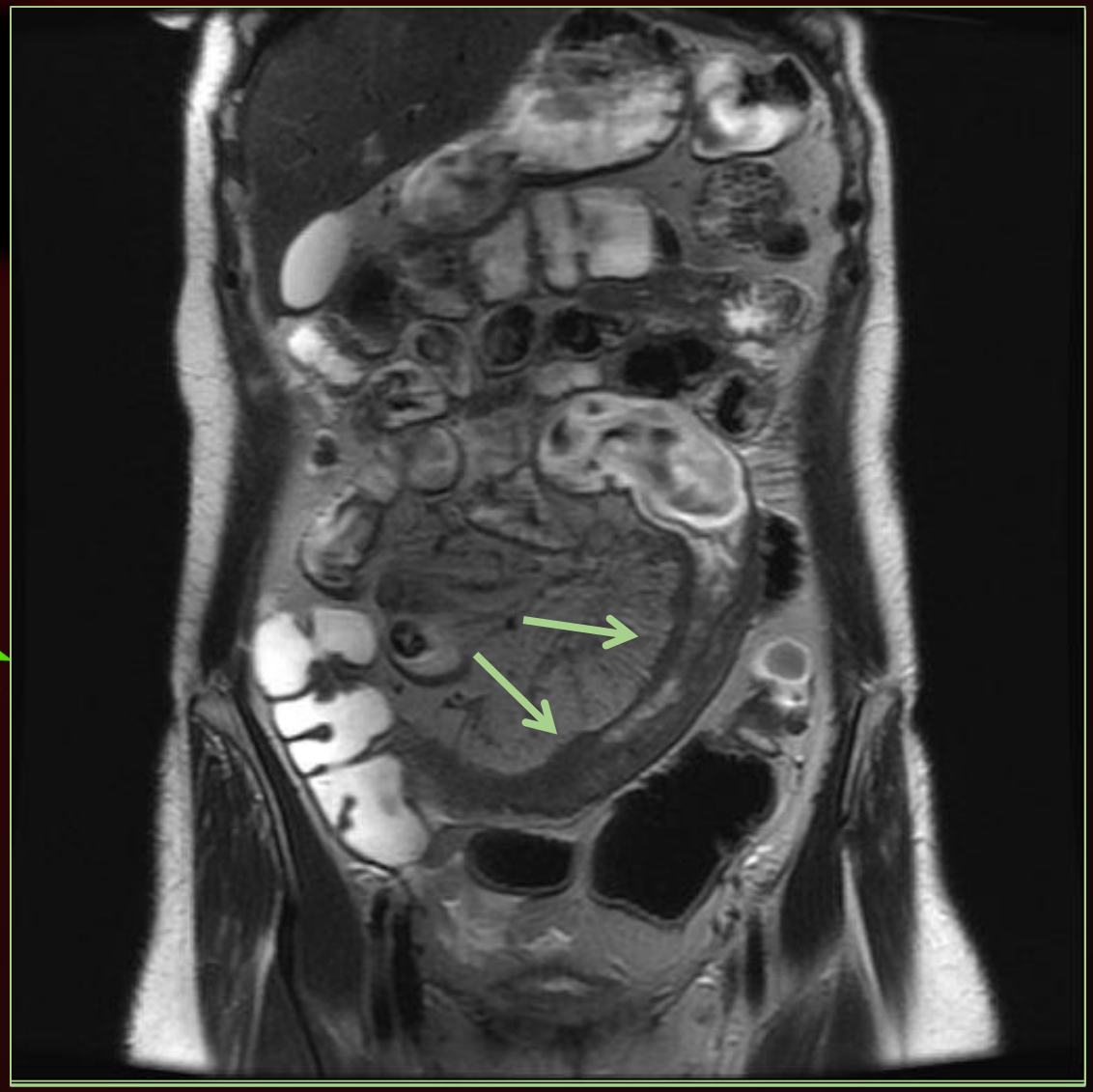
MR Imaging Protocol

Different pulse sequences which complement one another, are employed for demonstrating the intestinal anatomy as well as the intestinal and extraintestinal lesions and their inflammatory activity.

HASTE	True-FISP	Propeller/ Blade	Vibe CE	DWI
Heavily T2-weighted imaging does not suffer from susceptibility or chemical shift artifacts but is prone to motion artifacts such as intraluminal flow void.	Motion-free, high resolution imaging similar to T2-weighted images. Prone to “black boundary” artifacts that can be eliminated through fat suppression	Motion correction technique which samples *k*-space in a rotating fashion using a set of radially directed "blades” containing phase-encoding lines	Allows visualization of the enhancing bowel wall, which contrasts well with the lowsignal-intensity mesenteric fat and negative intraluminal contrast material	Gives information about activity of lesions and aids the detection of lymphnodes and different complications (abcsesses)

Imaging Findings:
Terminal ileum stricture





Ax T2 FS showing marked mural thickening with «target sign».

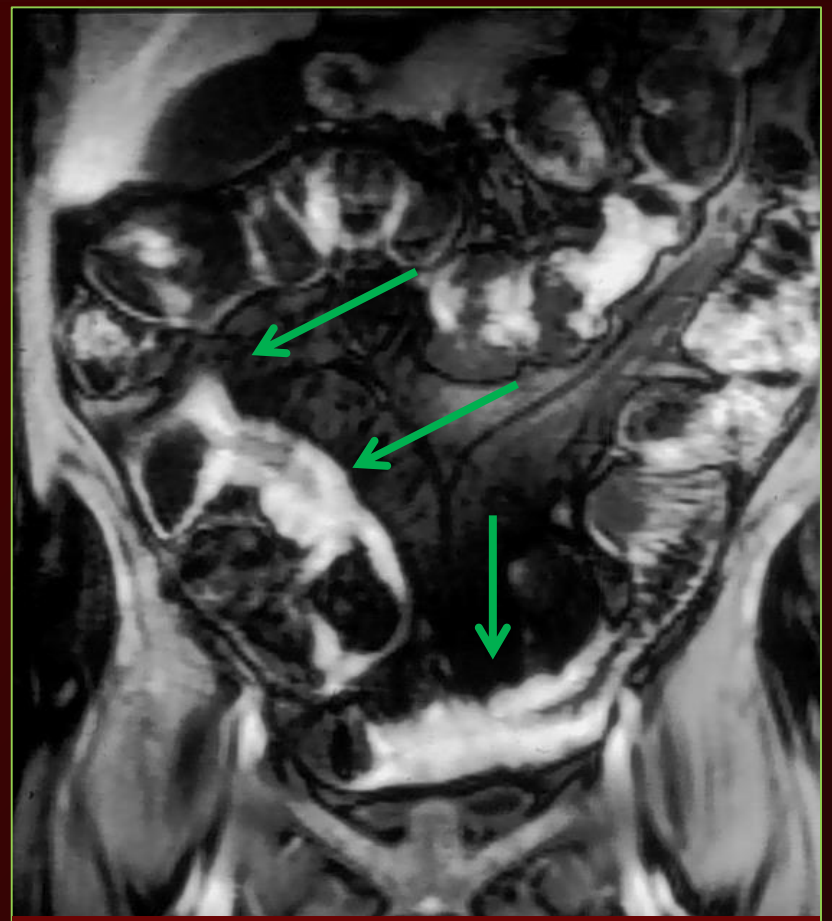
Cor T2 SSFSE showing severe and extensive stenosis of the terminal ileum with upstream dilation.

Imaging Findings
Bowel Obstruction

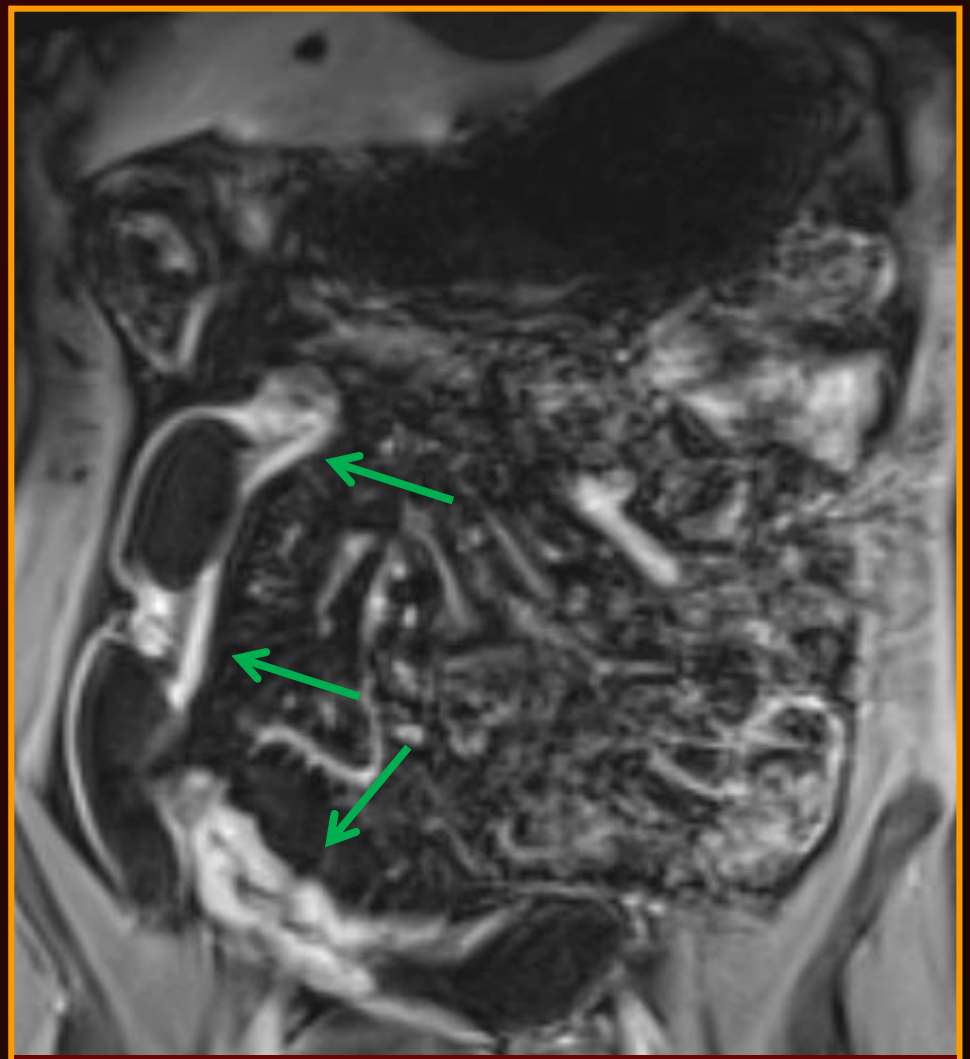
T1Cor LAVA early phase showing mucosal enhancement with submucosal and muscular parietal fibrosis.

Intraoperative findings: notice the transition from normal to pathological mucosa.

Imaging Findings:
Multiple segmental Strictures



T1 Cor VIBE after mdc showing multiple recurrent strictures following ileocecal resection

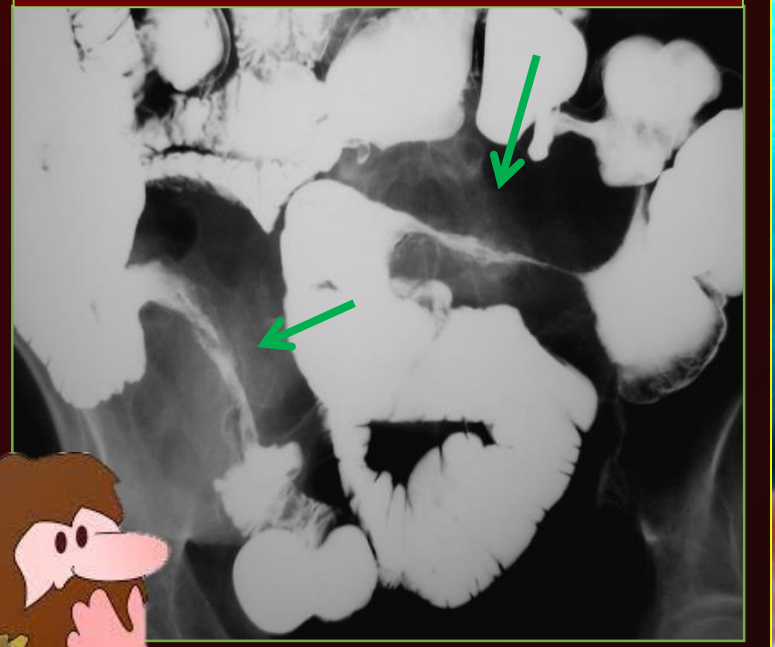


T1Cor VIBE after mdc showing multiple strictures of the ascending trasverse colon and terminal ileum with interposition of dilated segments.

Imaging Findings
Strictures

T1 Cor VIBE after mdc showing multiple recurrent strictures following ileocecal resection

Follow through barium study



Intraoperative findings

Imaging Findings:

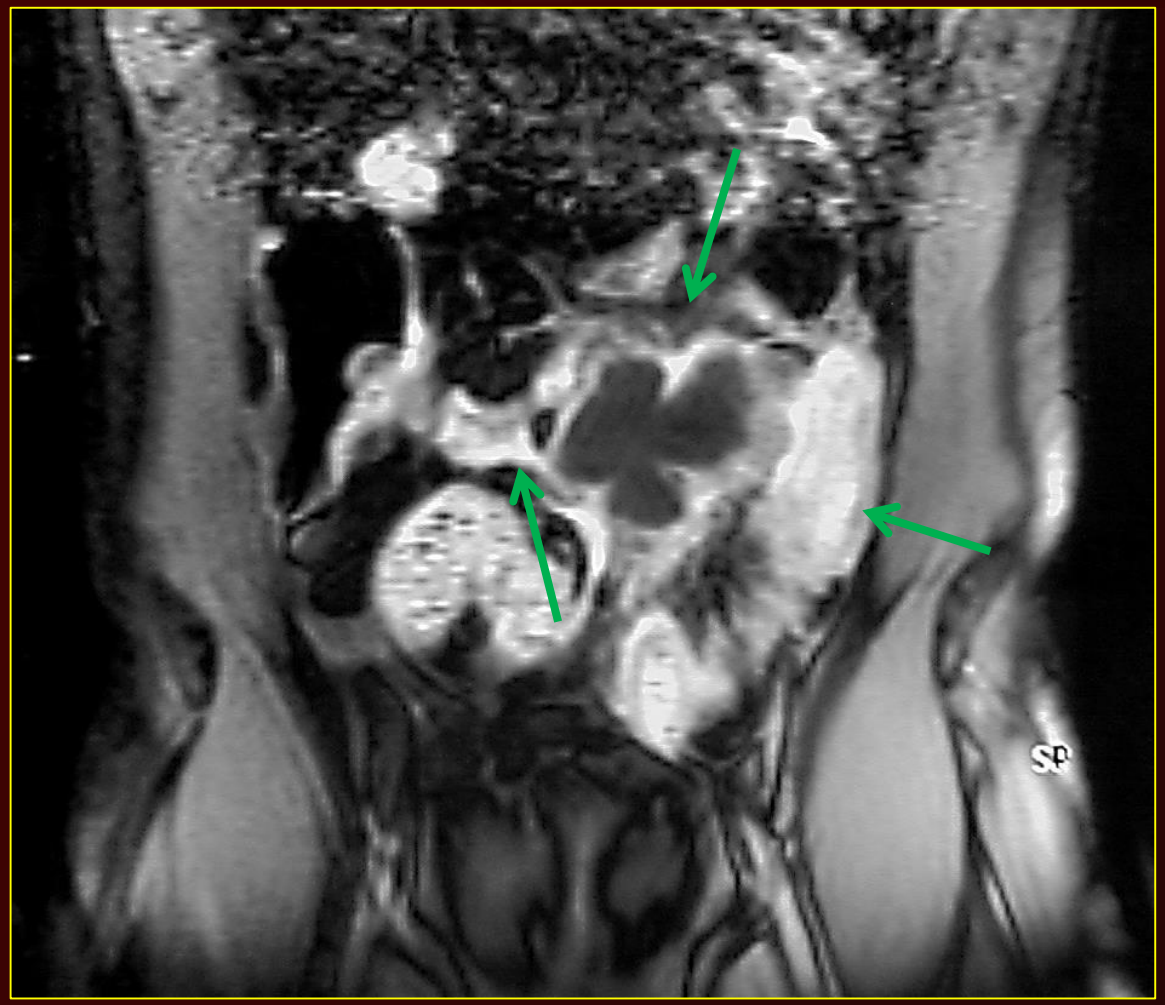
Severe stricture with Marked Bowel Obstruction

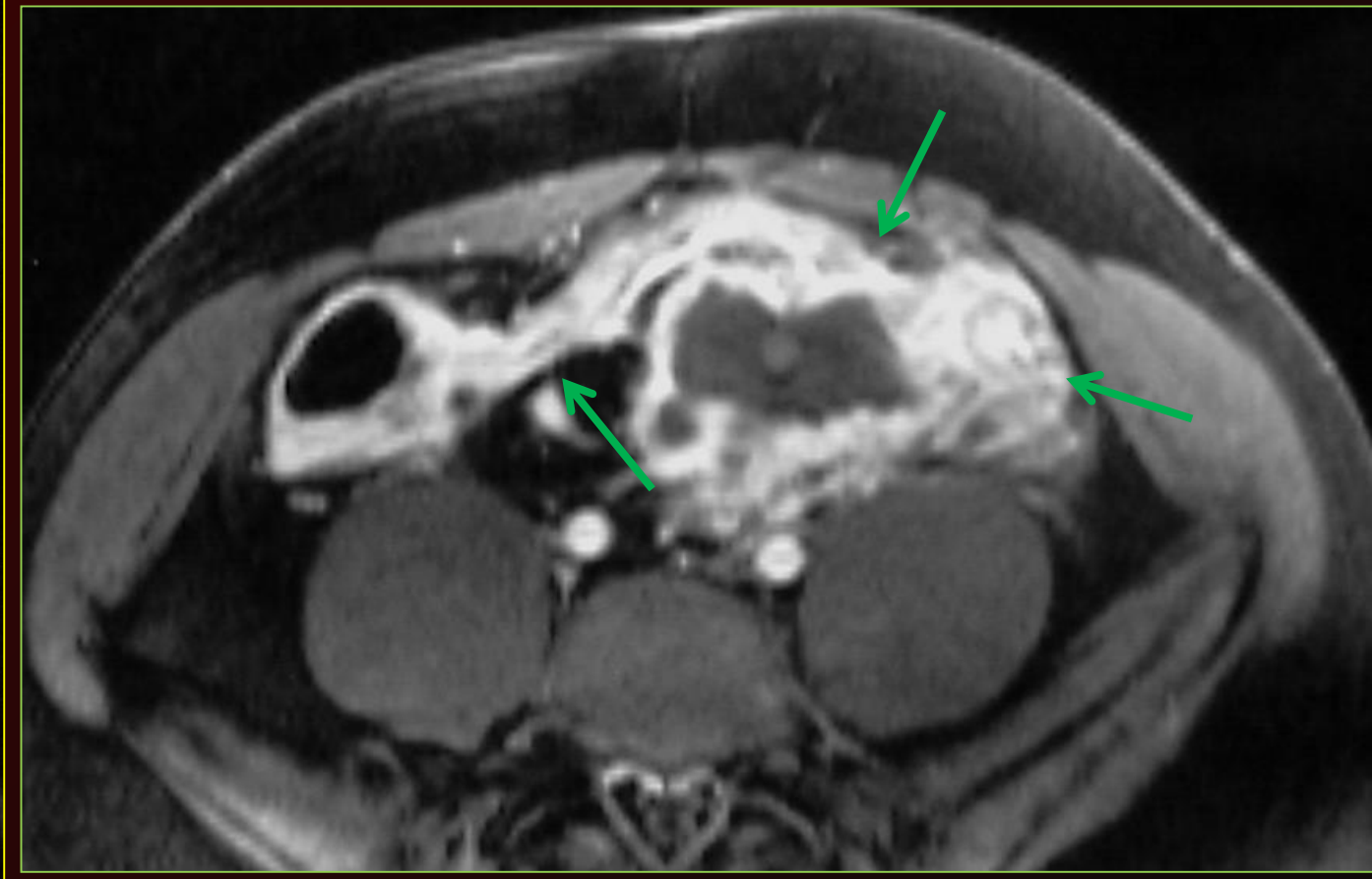
12-year-old boy

Coronal T2 FS SSFSE showing severe bowel obstruction caused by a Crohn’s disease stenosing lesion of the terminal ileum wih marked small bowel upstream dilation and stasis of ingested material.

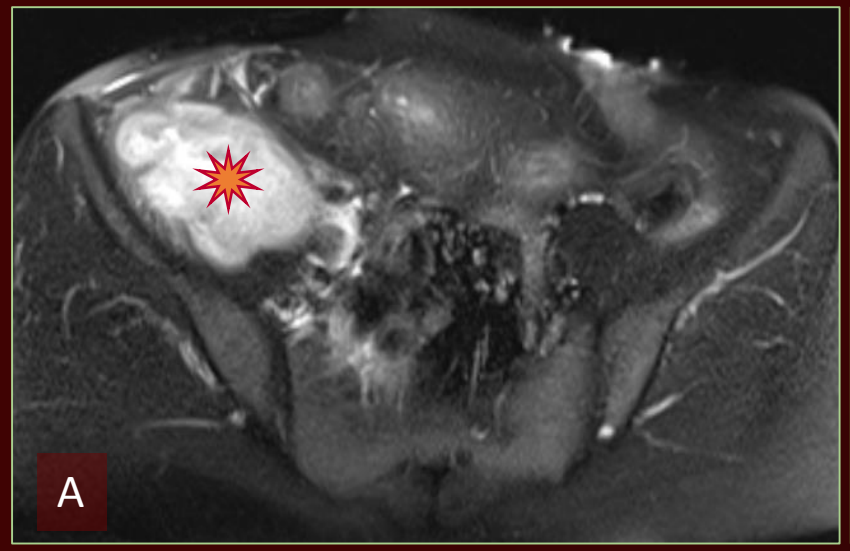
Notice also obstruction of the right ureters due to a peritoneal abscess.

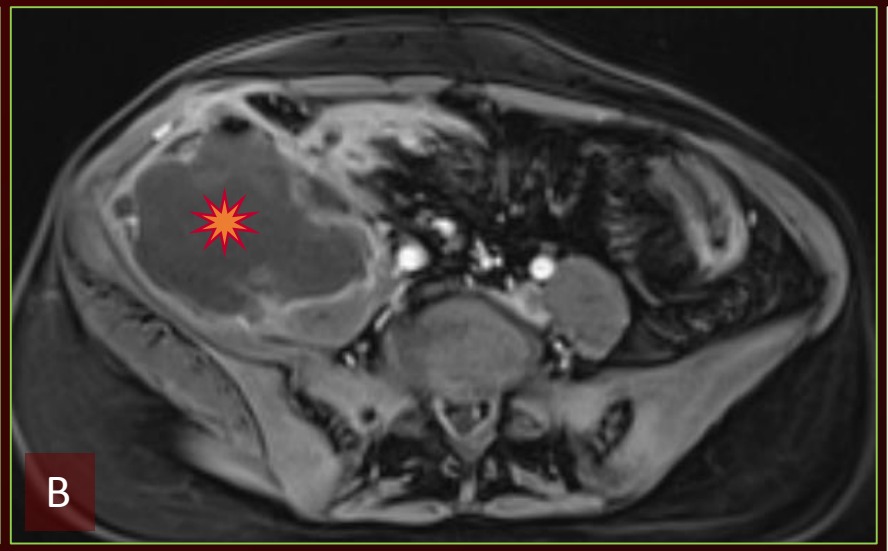
Imaging Findings:
Abdominal Abscess



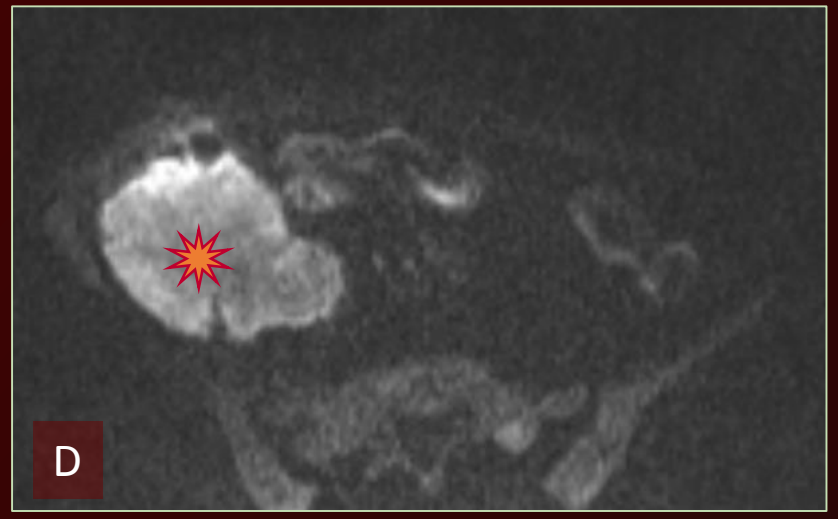


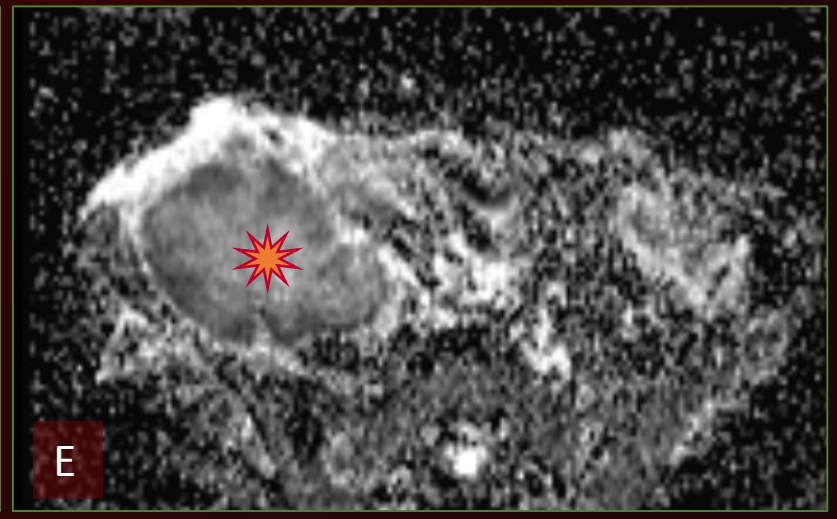
Cor and Ax T1 post Gd: terminal ileum Crohn's disease with abdominal perivisceral abscess invading the sigma. A previous endoscopy showed mild sigmoid colon mucosa inflammation.





Imaging Findings:
Iliac muscle Abscess





Terminal ileum disease with iliac muscle abscess

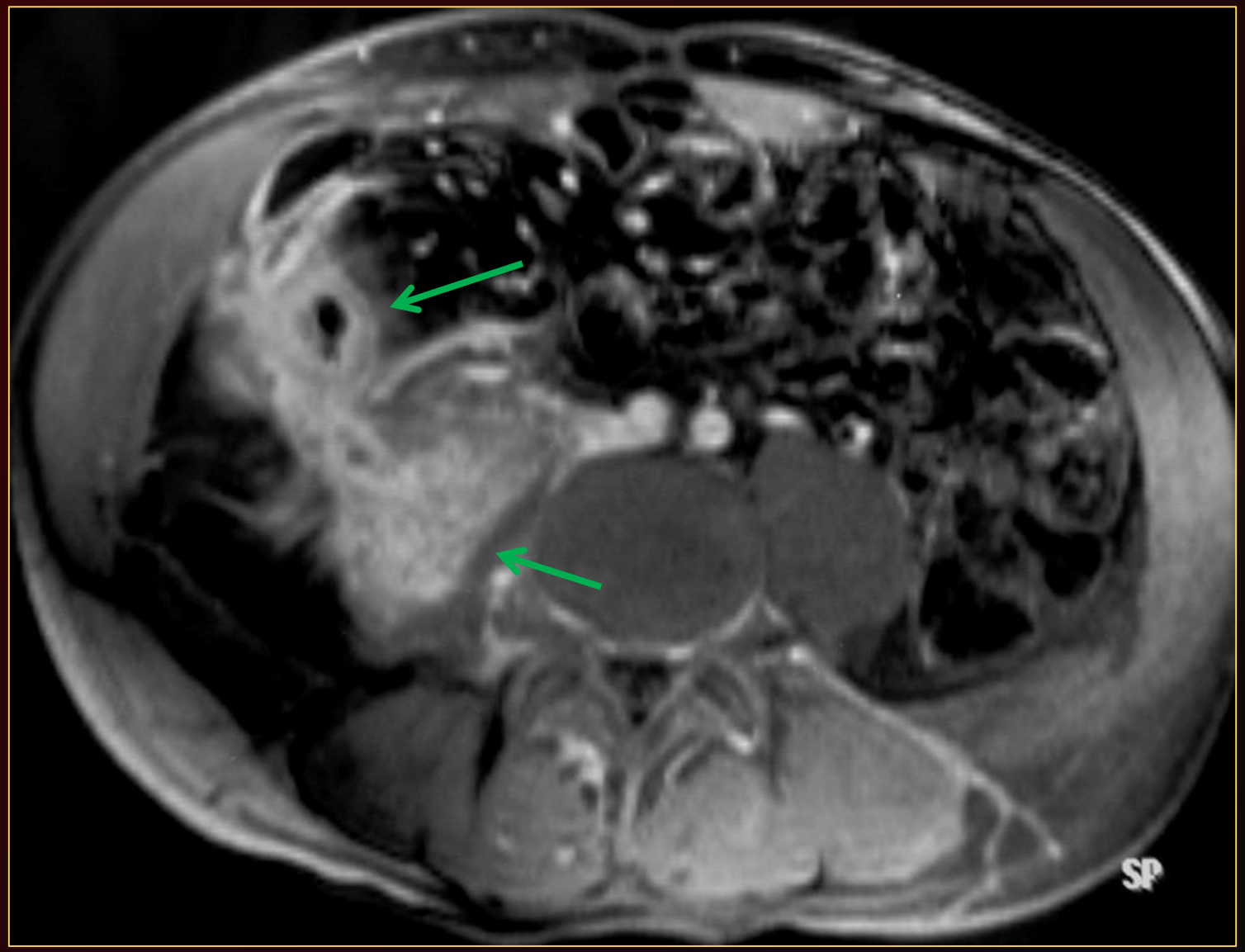
- FS HASTE Axial, LAVA T1w post Gd (A,B)
- HASTE Coronal T2 w (C)
- DWI, b value: 1000, ADC map (D,E)

Notice the restricted diffusion of pus.

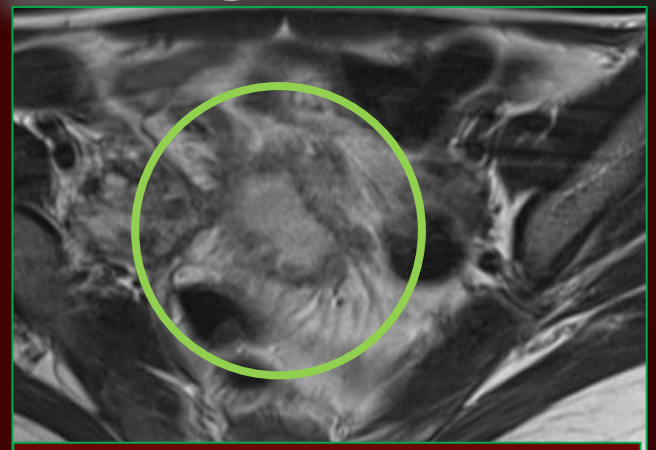
Imaging Findings:
Psoas muscle Phlegmon

Coronal and axial T1 VIBE afer Gd showing a psoas muscle phlegmon due to severe distal ileum disease.

Symptoms: low-back pain, no fever

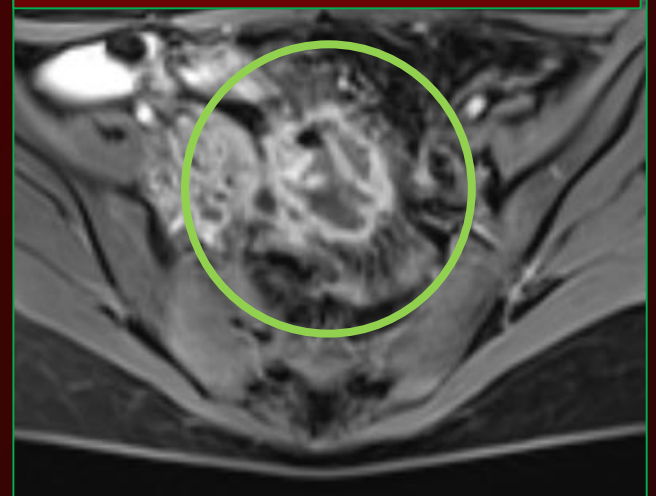


Imaging Findings:
Abdominal abscess with right ureter stenosis



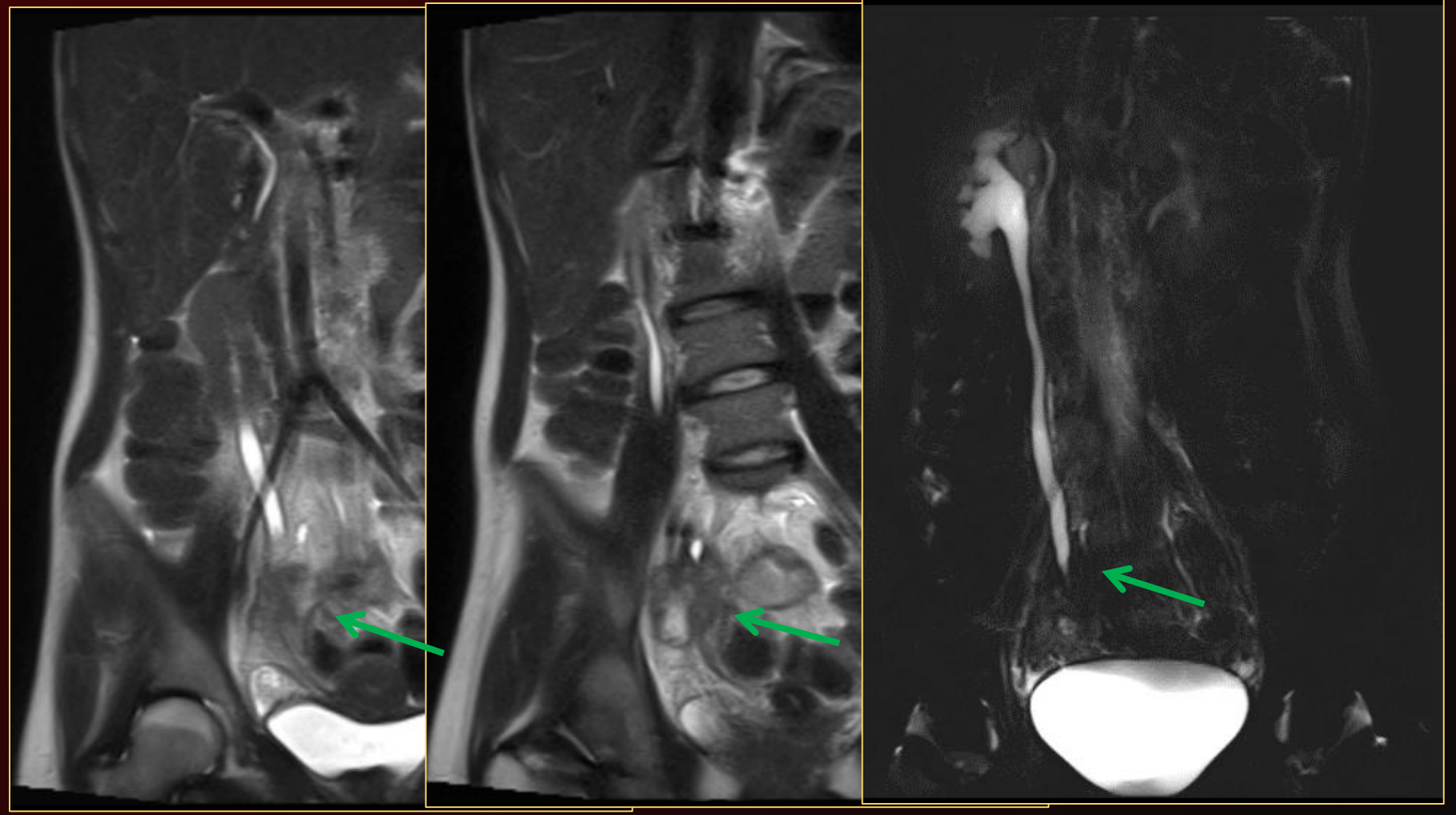
Axial T2 and T1 VIBE after Gd

abdominal perivisceral abscess.

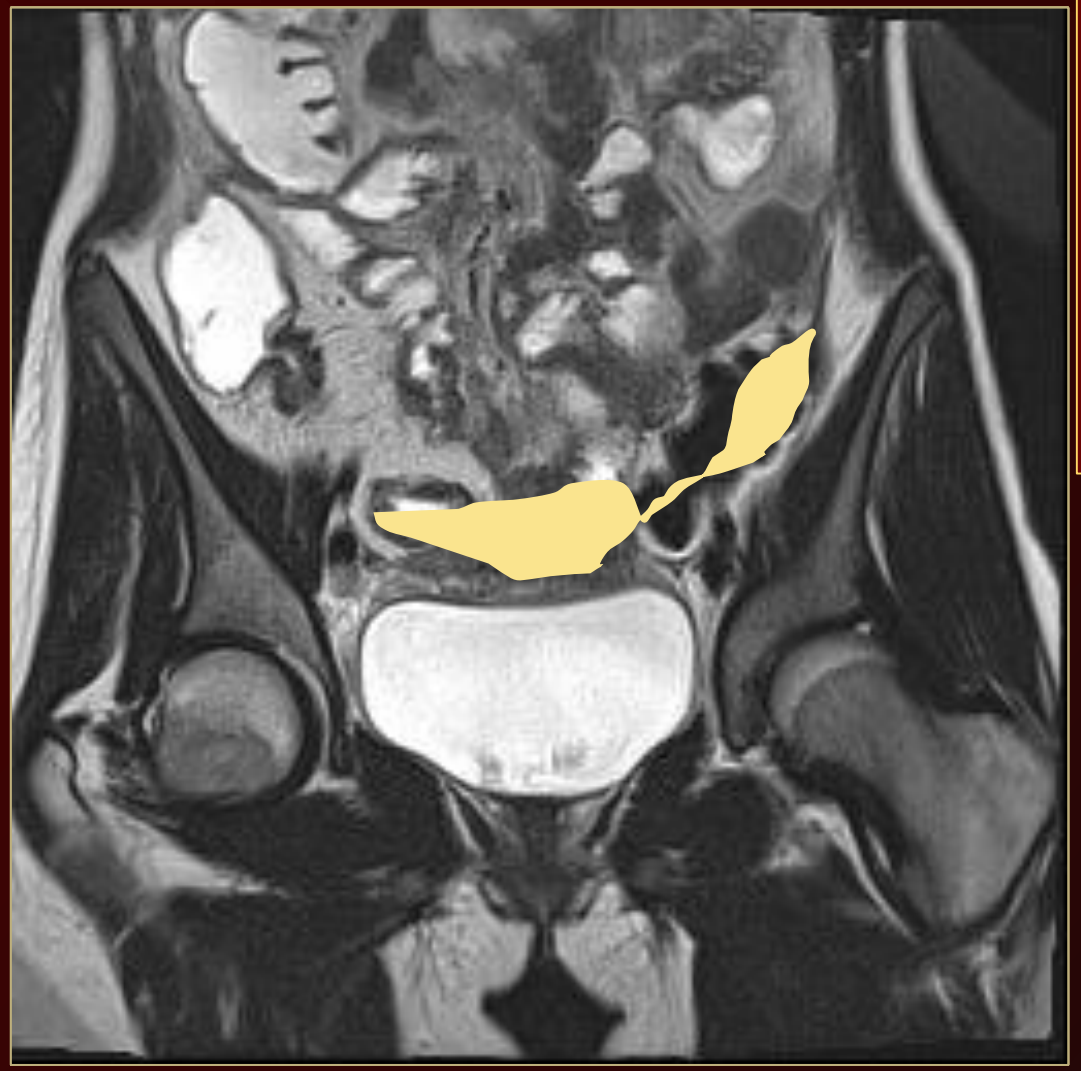


Coronal HASTE and thick slab T2w sequences

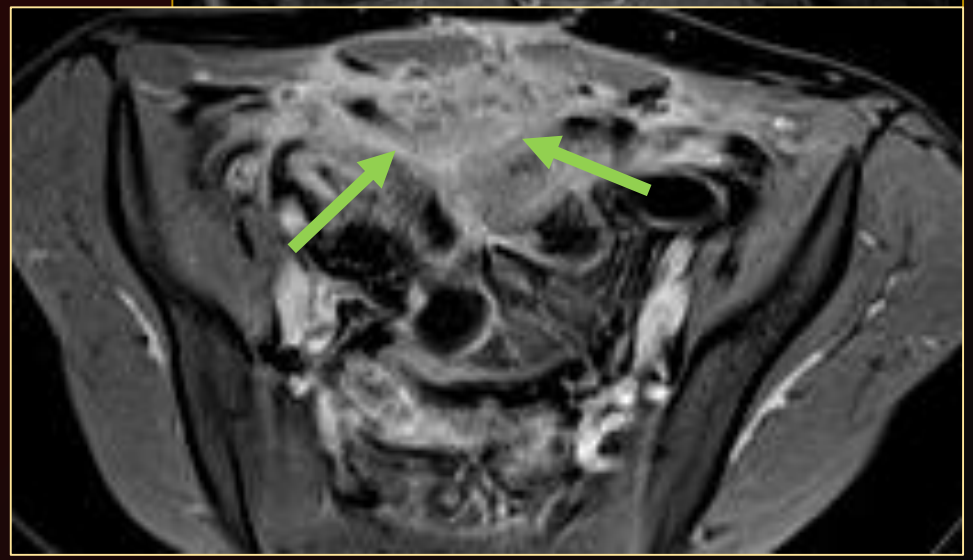
The abscess causes stenosis of the nearby right ureter with hydronephrosis.



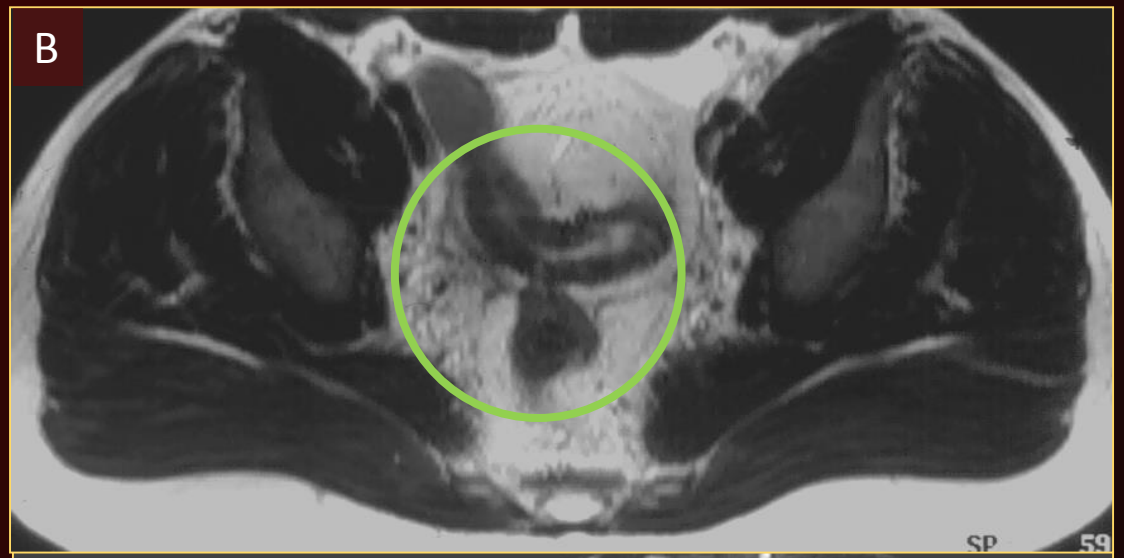
Imaging Findings: **Peritonitis and Phlegmon**

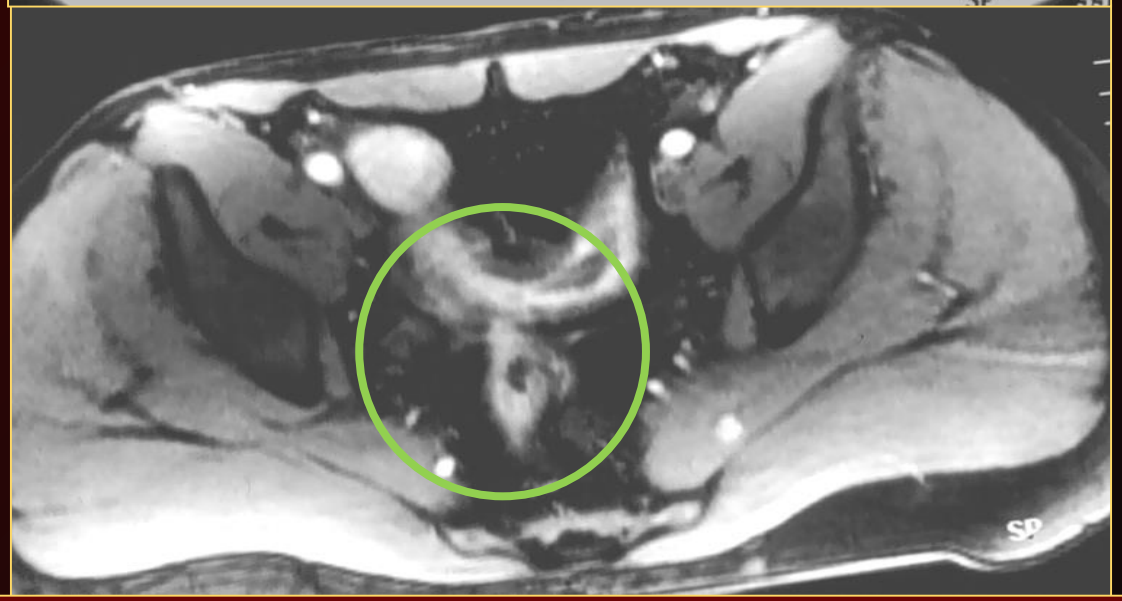


Coronal T2 BLADE, Coronal and axial T1 VIBE after Gd showing severe terminal ileum disease with adhesions, diffuse peritoneal inflammation and perivisceral abscess/ phlegmon following erroneous appendicectomy in a 15-year old girl.



Imaging Findings:
From adhesion to fistula





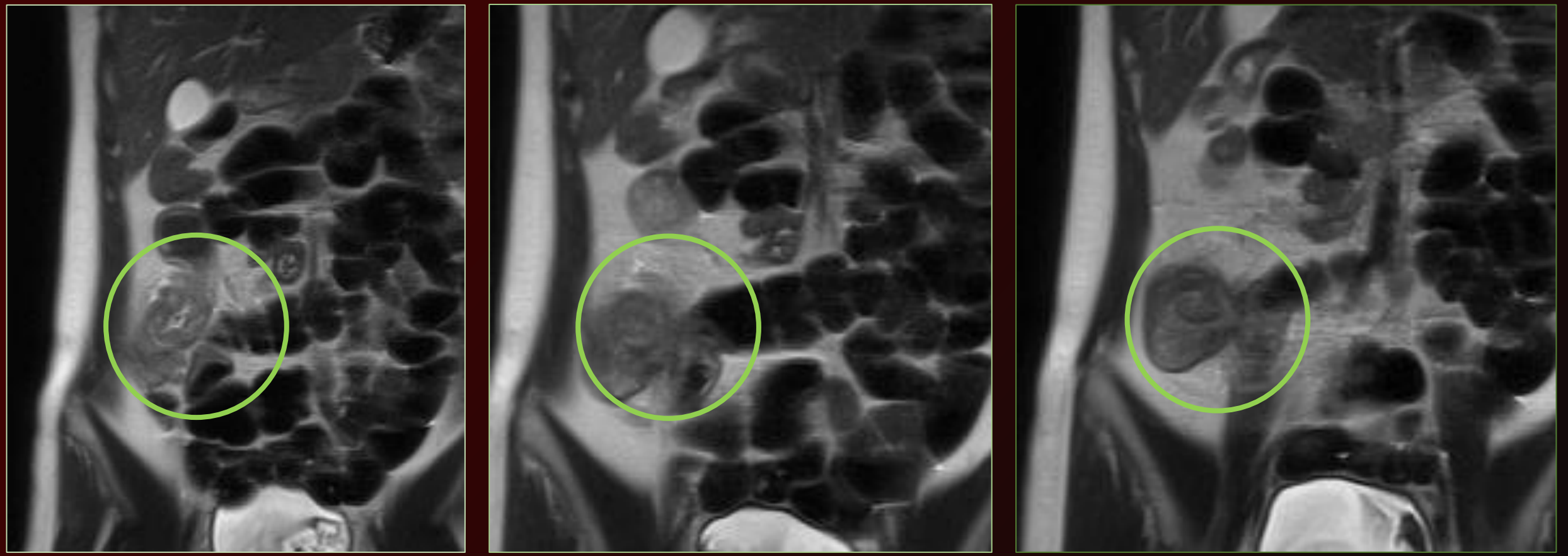
Different cases of entero-enteric adhesions followed by fistulization:

Coronal T2 (A) showing a ileum-transverse colon adhesion.

Axial T1 post mdc and T2 (B) showing ileum-rectal adhesion with a small erosion.

Both cases developed later in entero-colonic fistula.

Imaging Findings:
Entero-enteric fistula



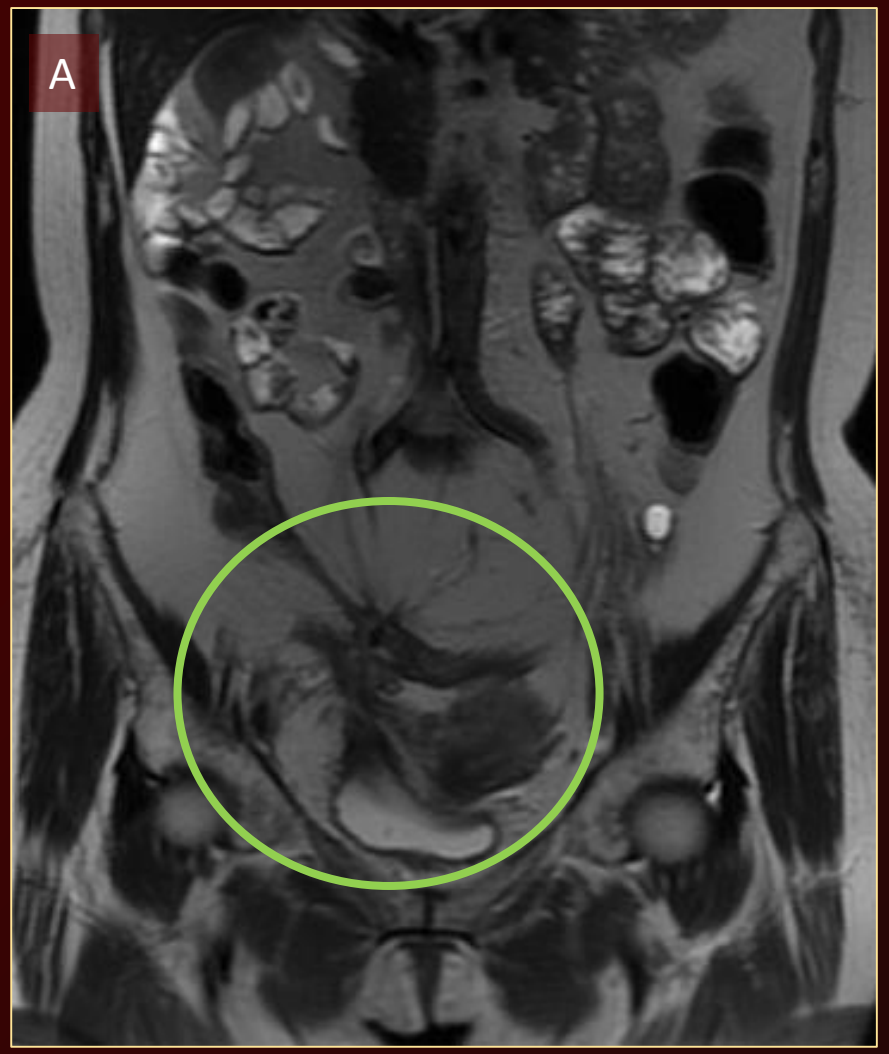
Coronal T2 HASTE showing a cecum-sigma adhesion with fistulization.

Imaging Findings:
Entero-enteric fistula

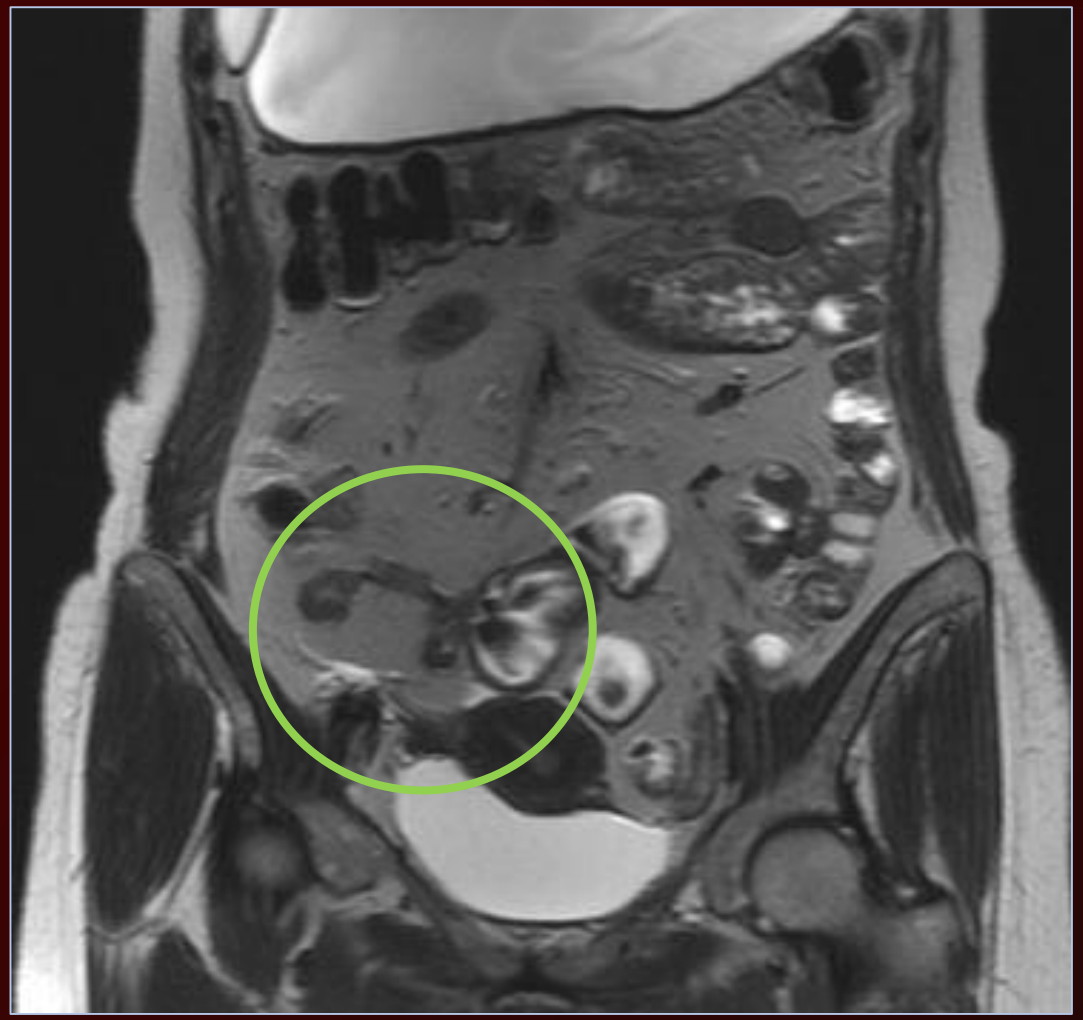
Different cases of entero-enteric fistulas:

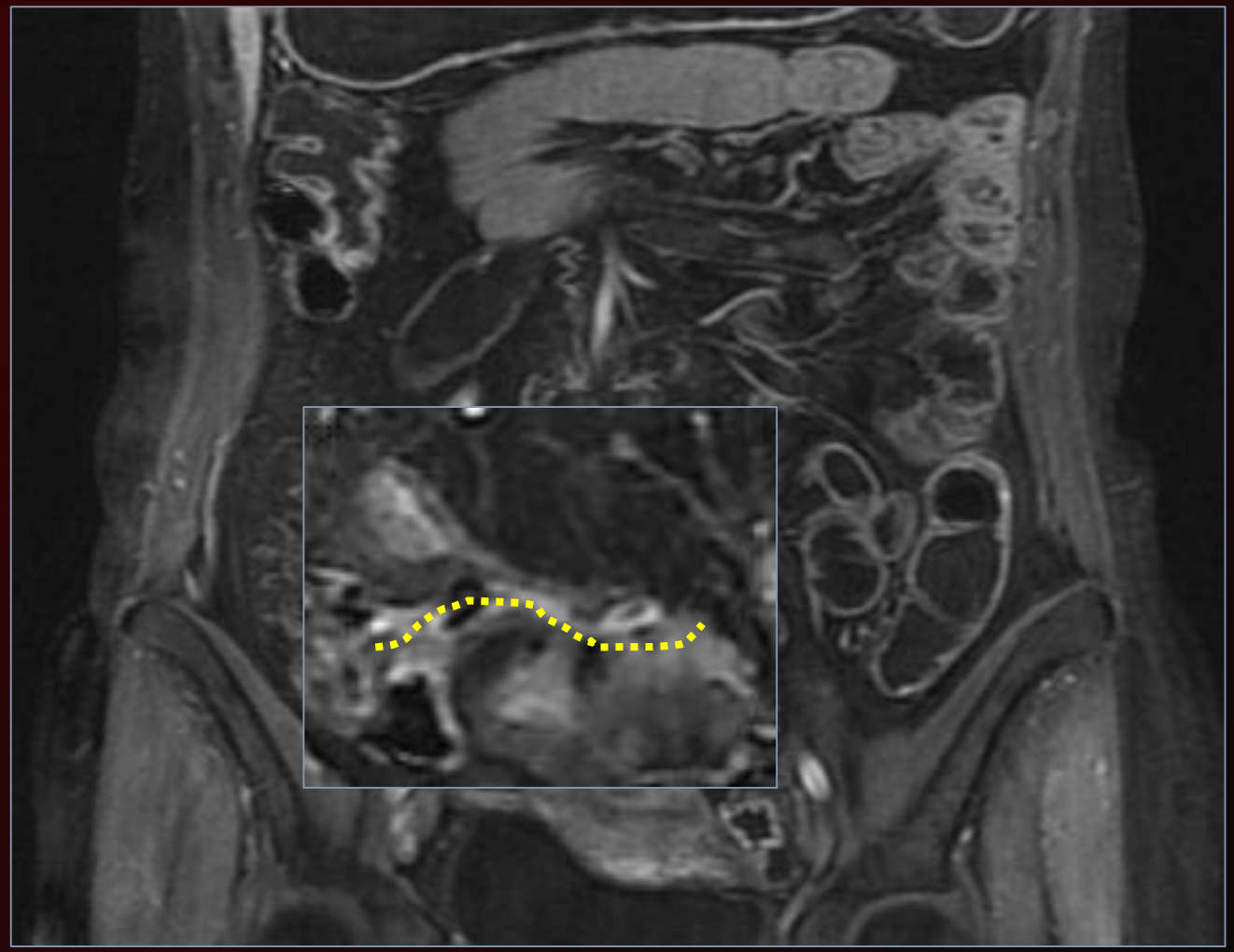
Coronal T2 SSFSE (A) showing entero-sigma and entero-vascical fistula

Coronal T2 Haste (B) showing entero-sigma fistula with involvement of the uterine fund and with possible underlying fistulization (flower sign)



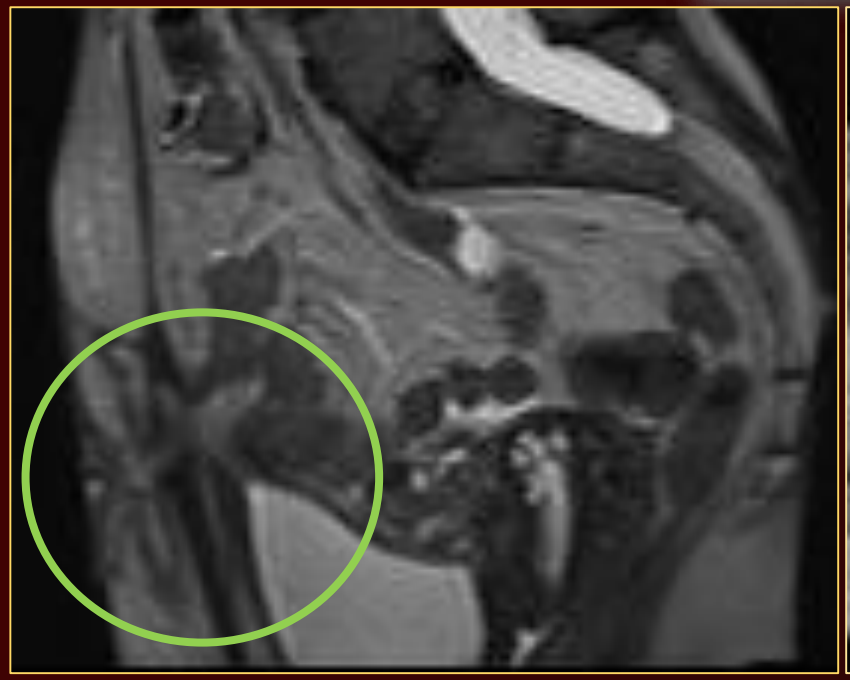
Imaging Findings:
Entero-enteric fistula





Coronal T2 SSFSE and T1 LAVA post Gd showing the root of an entero-enteric fistula.

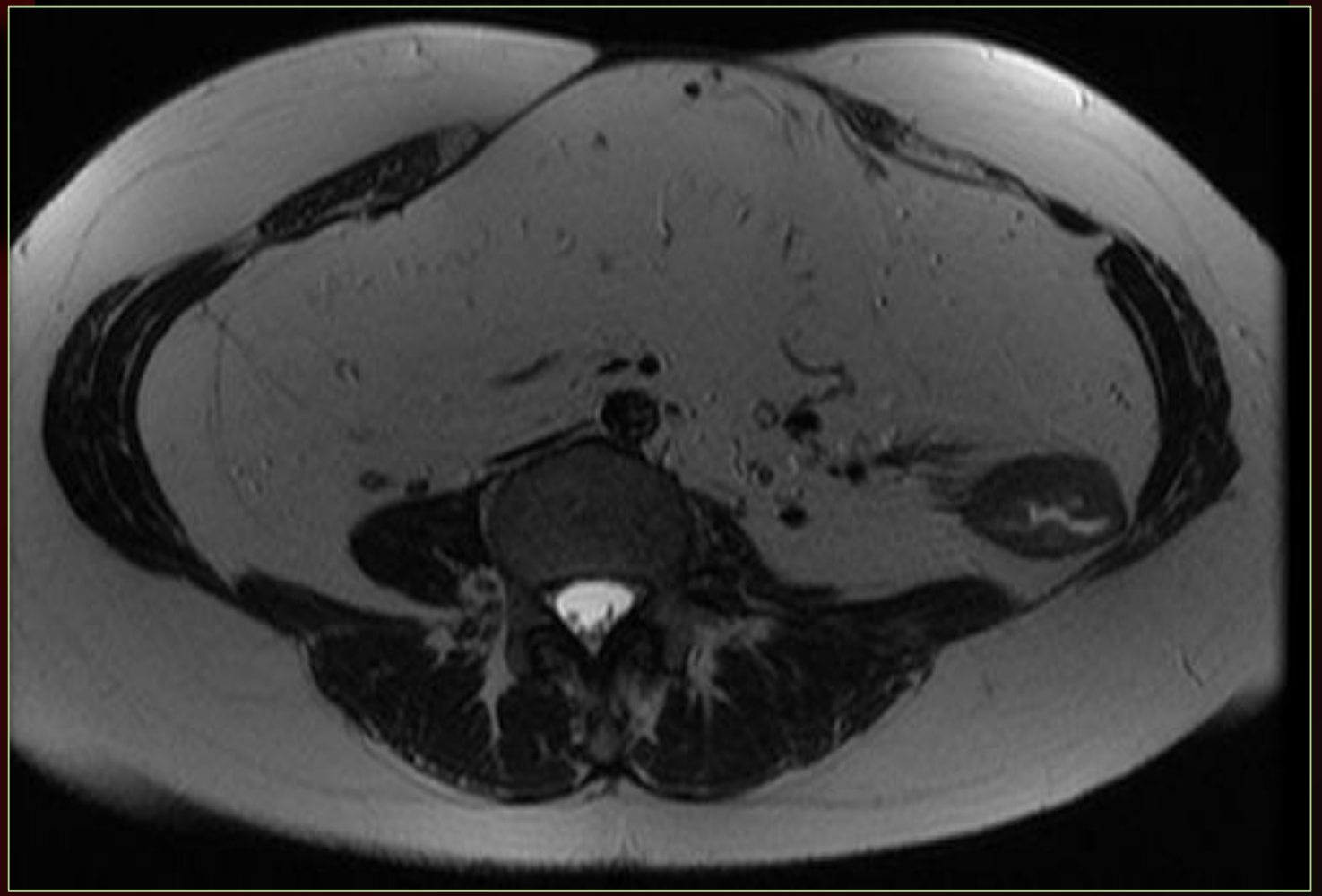
Imaging Findings:
Entero-cutaneous fistula



Axial and sagittal T2 HASTE: Terminal ileum disease with abdominal abscess and entero-cutaneous fistula.

Coronal T2 HASTE: descending colon disease with entero-cutaneous fistula.

Imaging Findings:
Short bowel syndrome



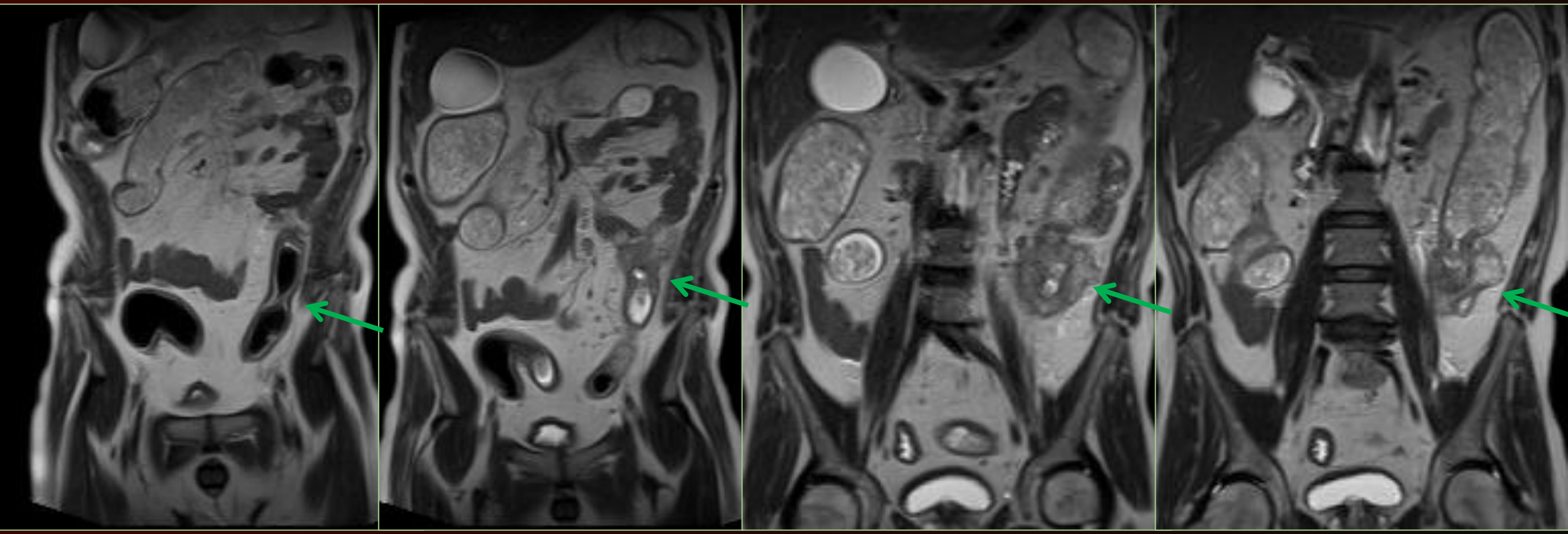
Abdominal cavity mainly occupied by hypertrophic mesenteric adipose tissue.

Patient undergoing total colectomy and multiple jejuno-ileal resections with very short residual intestine and ileostomy in the left side.

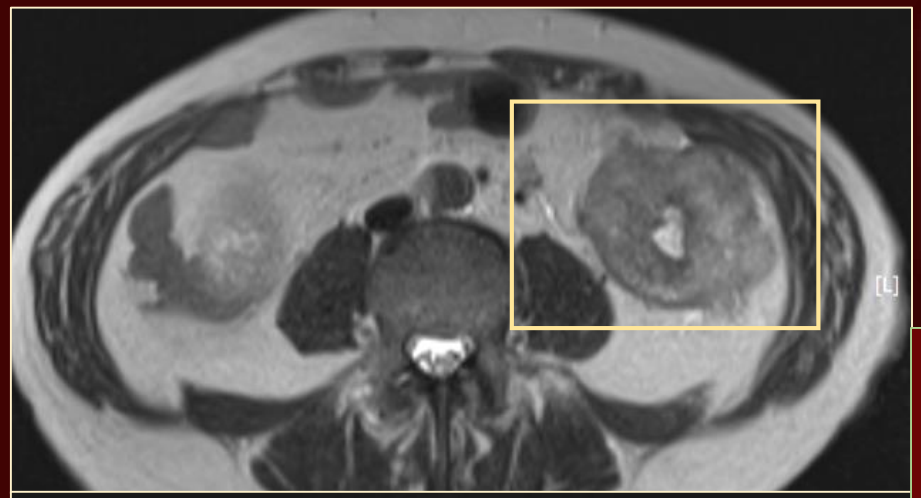
The remaining ileal loops appear characterized by multiple entero-enteric and anterior abdominal wall adhesions.

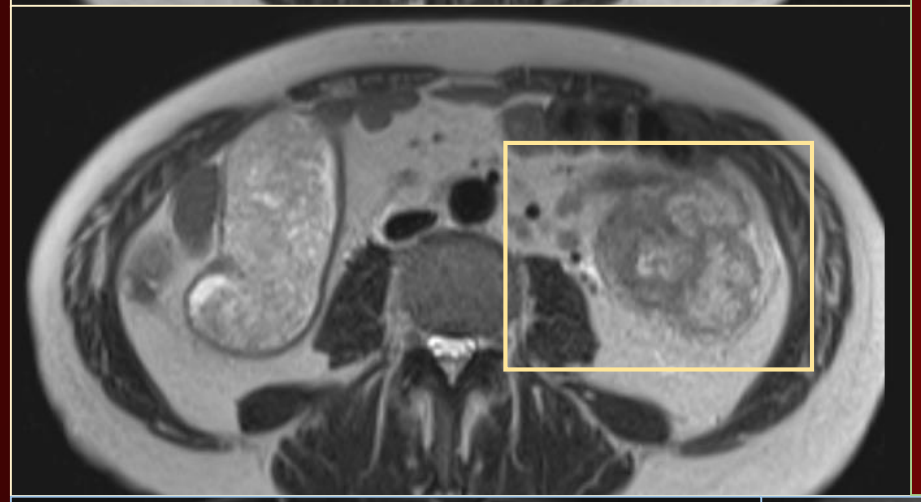
Imaging Findings
Cancer

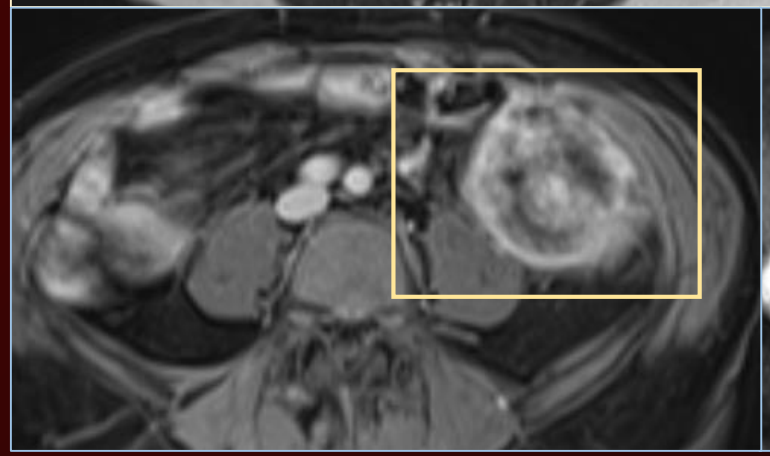
Coronal T2 HASTE. Long standing CD of the terminal ileum and right/left colon with a severe irregular stricture of the descending colon.

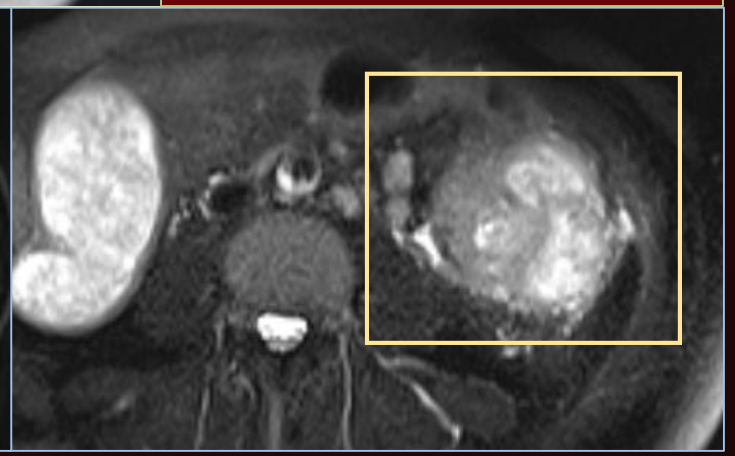


Imaging Findings
Cancer





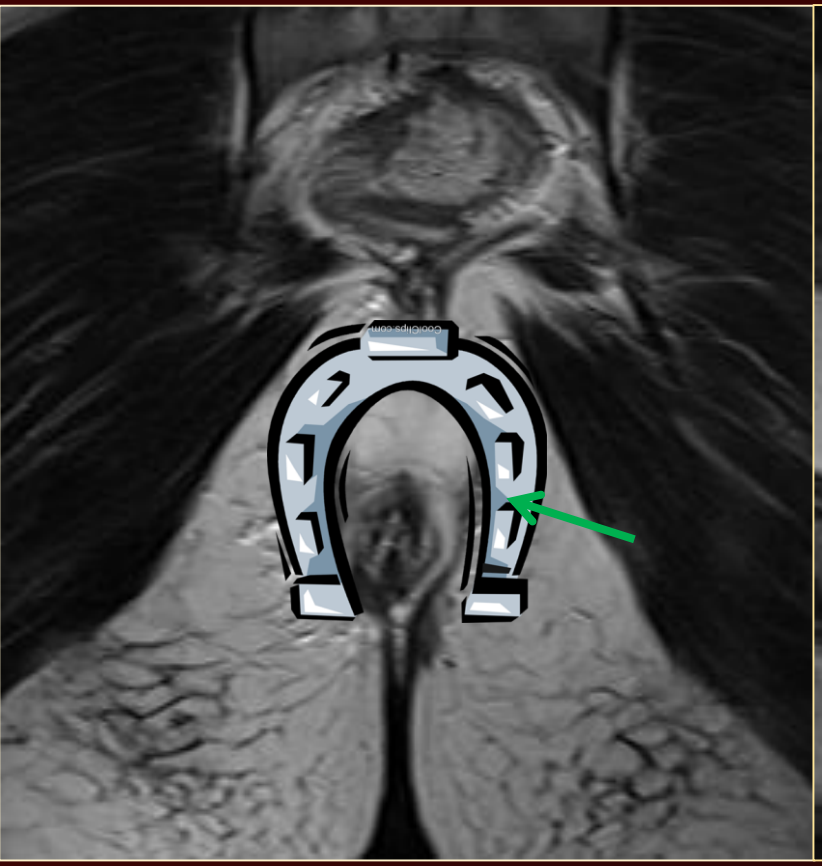


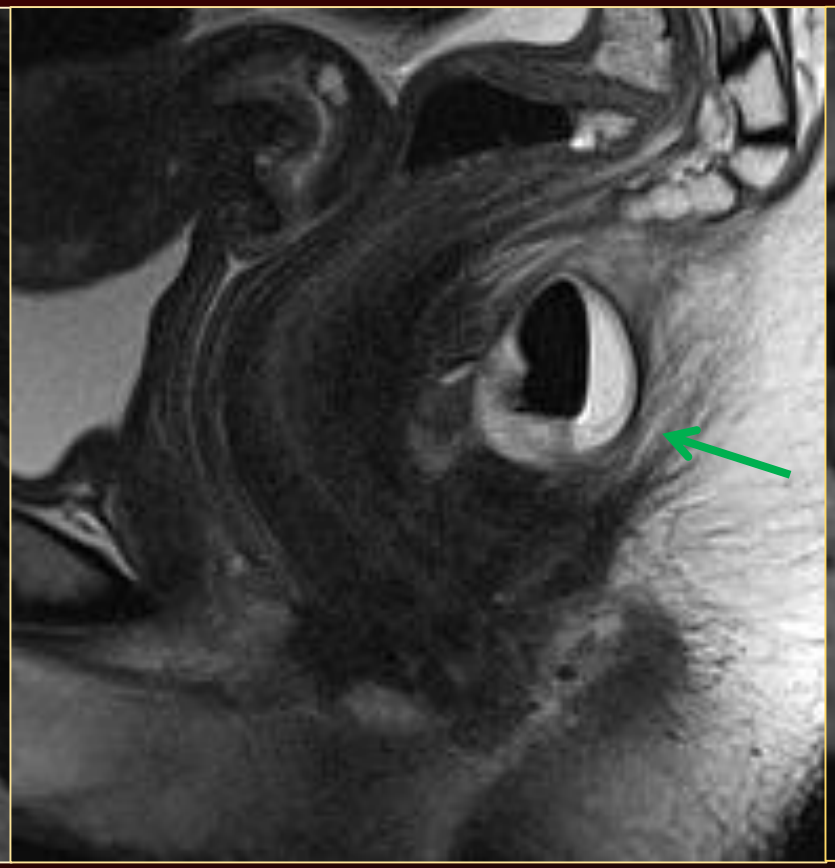


Axial T2 HASTE, Gd-T1w and DWI. Colonic cancer in a Crohn's disease lesion of the descending colon, suspected on MRI and confirmed by histology after surgical resection.

Intraoperative findings

Imaging Findings
Perianal Disease

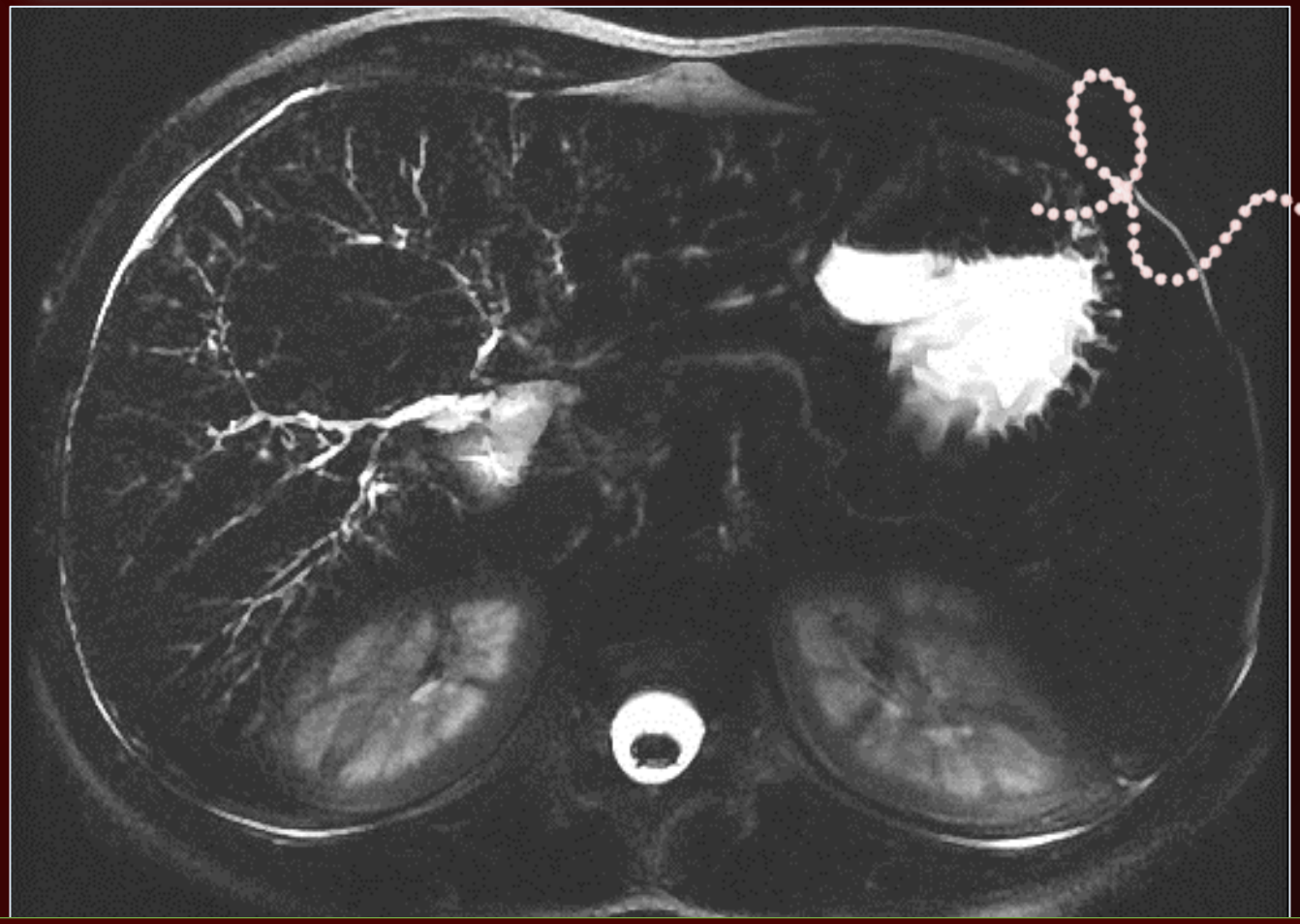




Axial and sagittal TSE High Resolution T2 and axial FS T2. Abscesses in the ischio-anal sub-levator ani bilateral space, originating from a horse shoe fistula.

Imaging Findings: **Sclerosing colangitis**

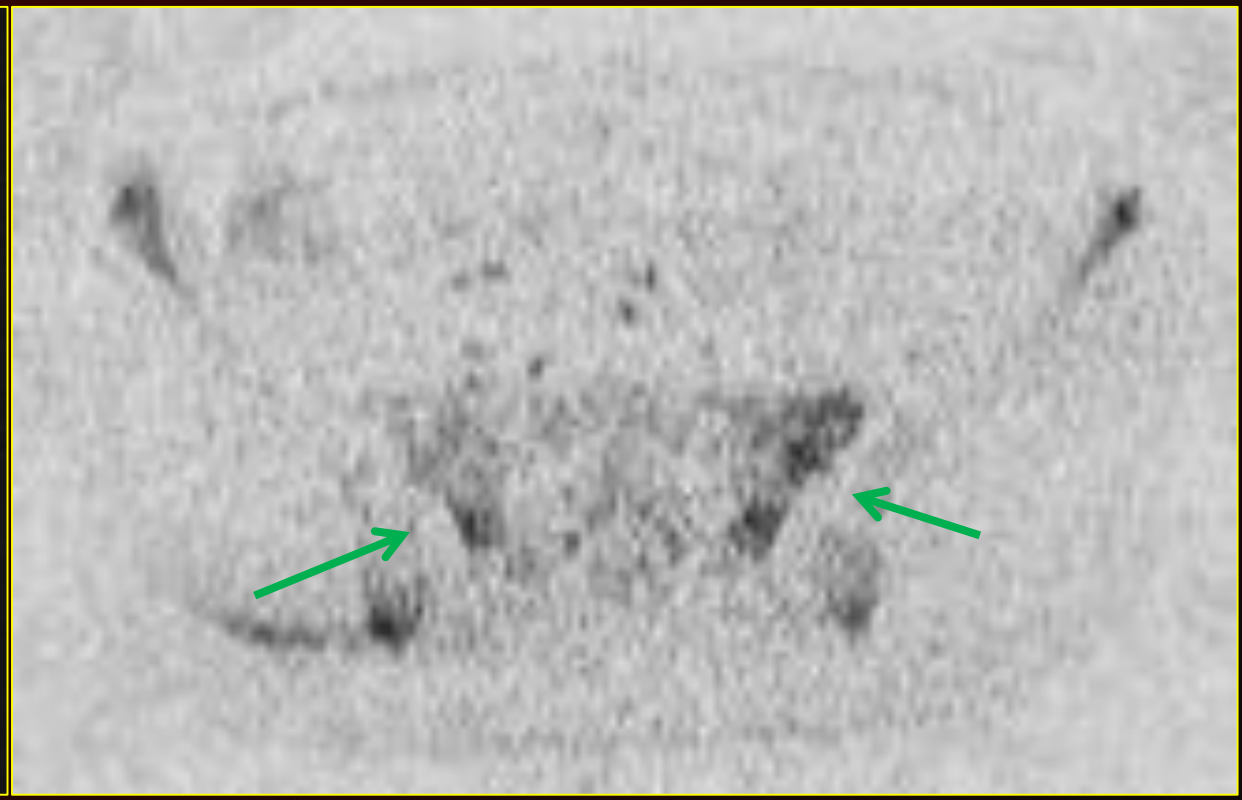
2D axial and coronal colangiographic images showing hydropic gallbladder and intrahepatic bile duct dilation with focal stenoses; liver biopsy confirmed sclerosing colangitis



Primary Sclerosing Colangitis

Discontinuous, intrahepatic biliary ductal dilatation and/extrahepatic ductal wall thickening or enhancement, without significant upstream dilation with pearl necklace appearance

Imaging Findings:
Bilateral sacroileitis



STIR and DWI (inverted) images showing marked bone oedema of the sacral wings and ileosacral joints in a 18-year-old patient with severe ileal Crohn’s Disease and fever.

Conclusions

- Crohn's disease produces different and severe intestinal complications, most of them requiring surgical treatment. Different complications (stricures, abscesses, fistulas) may coexist.
- The incidence of complications increases with the age of the disease (19% in the first year, 60% in the 7° year).
- CT has been advocated as the gold standard for assessing CD complications. However MRI has shown similar or higher accuracy in detecting all the main intestinal complications
- Early recognition and staging of complications with MRI is crucial for surgical and therapeutic planning
- Extraintestinal complications are rare, usually clinically idientified. However, MRI fan assess two of them, sclerosing cholangitis and ankylosing spondilytis

Thank you for your attention

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