

Imaging of digestive system treatment related damage

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Ancona

Background

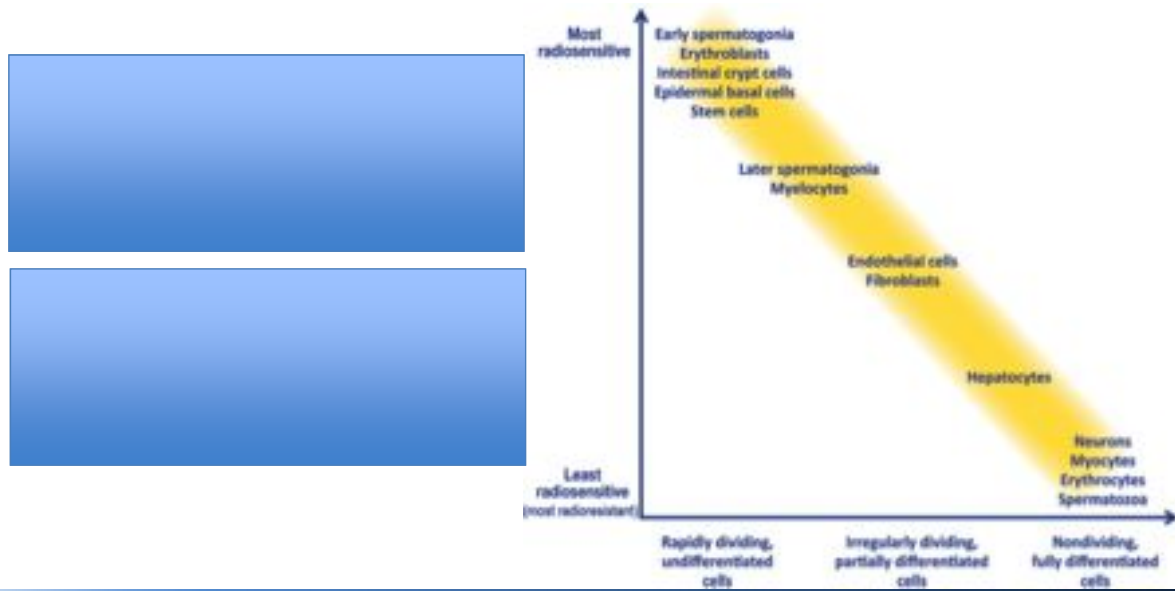
- ✓ Radiotherapy is an important modality in the treatment of cancer patients, justifying frequent findings of radiation-induced changes in the irradiated area.
- ✓ *Approximately 5 - 15% of patients treated with radiotherapy (usually > 4500cGy) develop chronic radiation enteropathy.*

Background

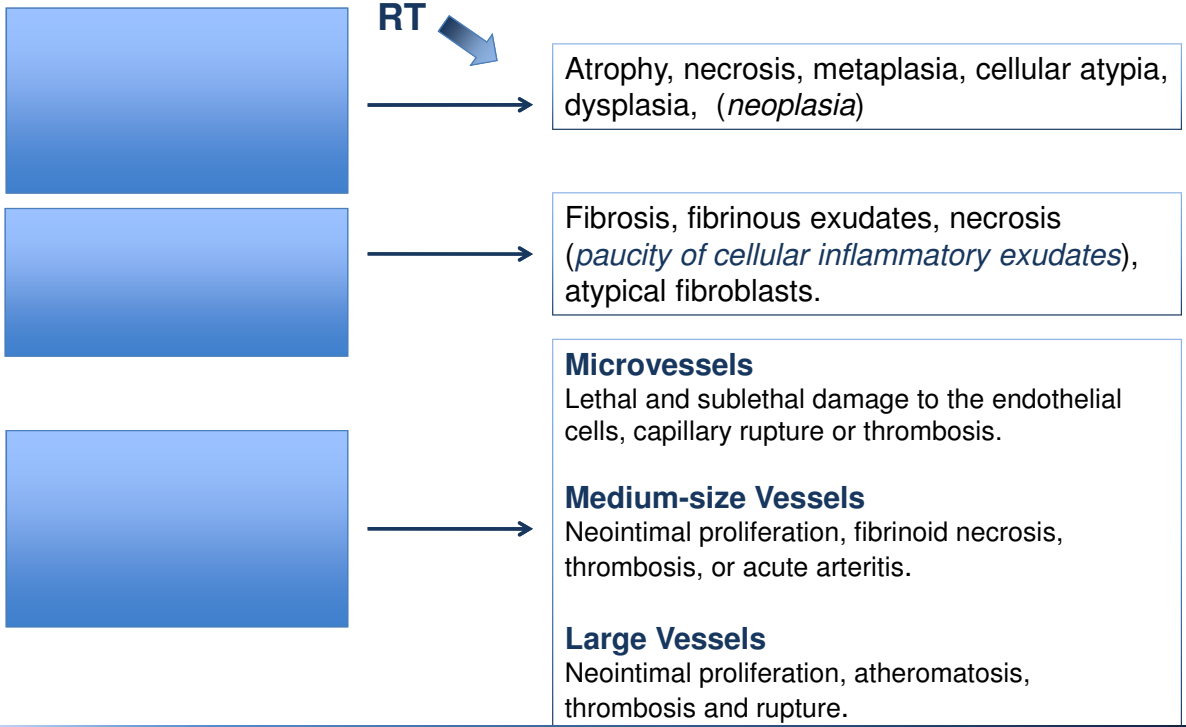
The clinical presentation is nonspecific

Abdominal pain, vomiting, bloody diarrhoea and steatorrhea.

Chronic radiation enteritis associated to deficiencies of calcium, iron and B12.



Radiation Changes: Pathology



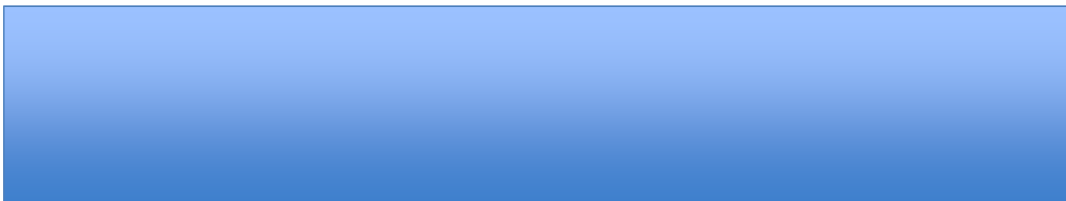
Diagnosis of TCT changes : Role of Radiology

- Difference between primary diagnosis of suspected RT changes
- Diagnosis of extent or a complication of known
 - Explanation of symptoms or lab abnormalities
 - Clarification of disease extent and severity
 - Cancer screening and surveillance
 - Prognosis, adjunctive to additional testing
 - Choice of therapy (class or delivery system)
 - Prevention of disease expression or complications

Binder V. *Dig Dis.* 1998 Nov-Dec;16(6):351-5.

LIVER

- ✓ *Mainly involved as a consequence of irradiation to neighbouring structures;*
- ✓ *Treatments for liver malignancies : ⁹⁰Y and external therapies*



Liver: Pathology-Imaging Correlation

- ✓ Limits of the lesion **do not respect** subjacent anatomy;
- ✓ Limits are straight and **follow the path** of the beam;

Early Findings:

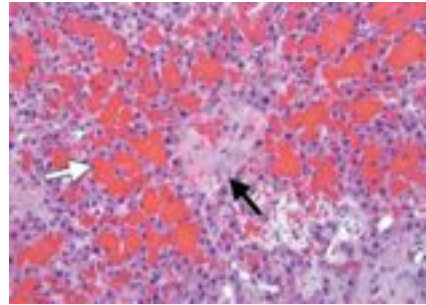
↑water content;
↓perfusion,
↓function



Late Findings

veno-occlusive disease:
↓ blood outflow,
↓ function

Usually 2 – 6 weeks after irradiation, in most cases returns to normal in 3-5 months.



Histopathology

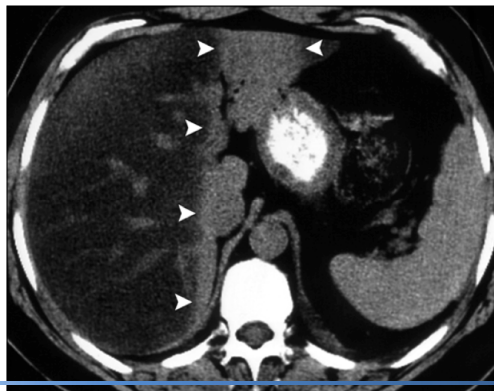
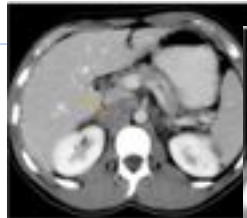
Subtotal collagenous venous occlusion with sinusoidal congestion leading to reduced blood outflow and hypoperfusion. Reduced cellularity, steatosis.

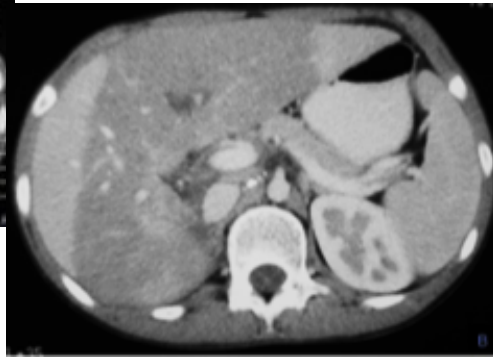
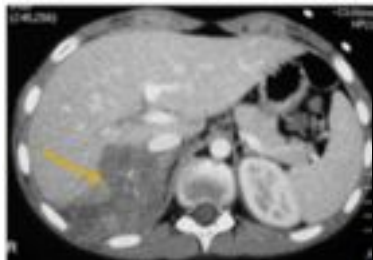
Liver CT

Hypoattenuation
(reverse in fatty-replaced livers);

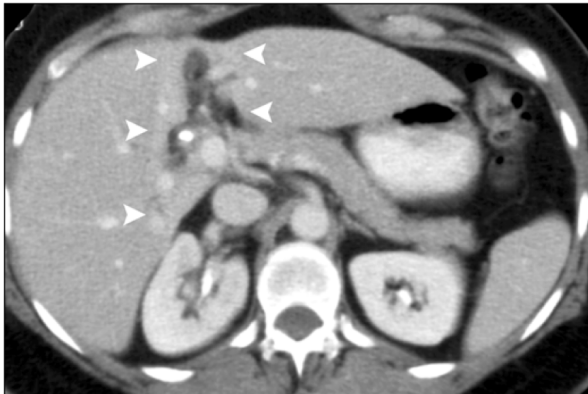
CM

↓ enhancement (hypoperfusion)
↑ enhancement in portal venous
and delayed phase
(↓ blood outflow)





Adrenal Metastasis before and after RT.
Non-anatomic hypoattenuation of liver parenchyma



Liver metastasis after RT.

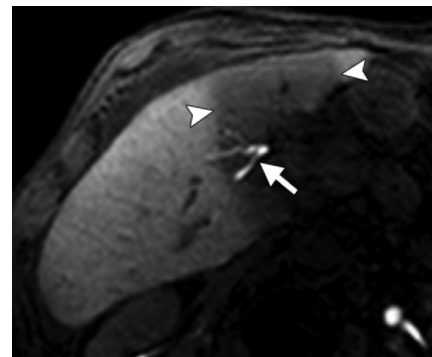
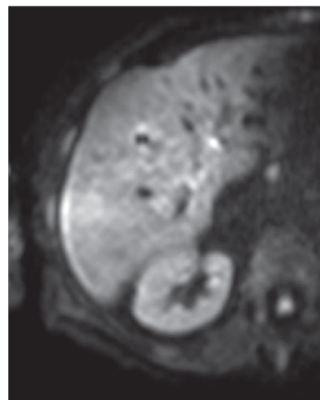
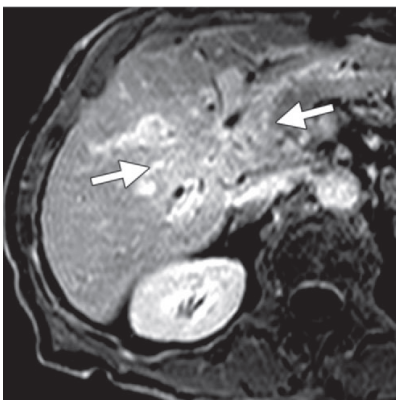
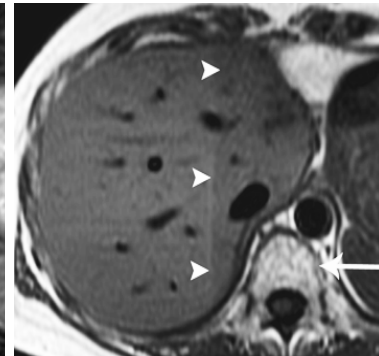
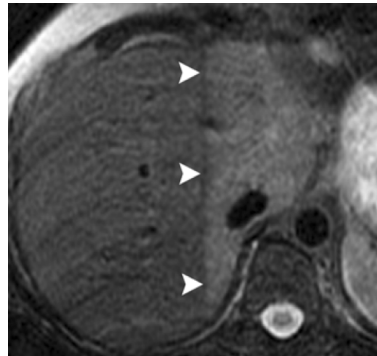
Hyperattenuating and atrophic liver parenchyma. Chronic damage in right kidney.

Liver MRI

↑T2; ↓T1;
Steatosis;

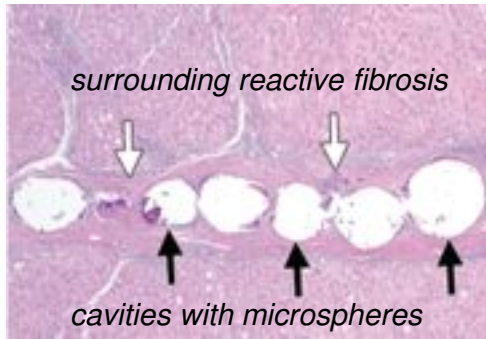
CM: same of CT
(↓ perfusion; ↓ blood outflow)

Gd-EOB-DTPA: ↓ excretion



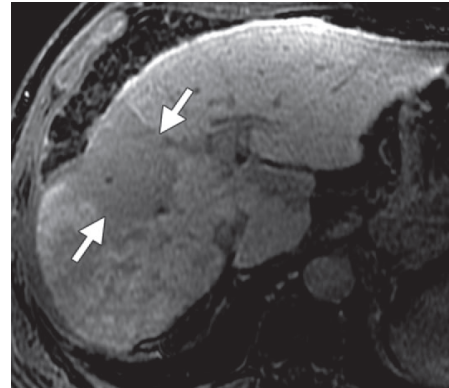
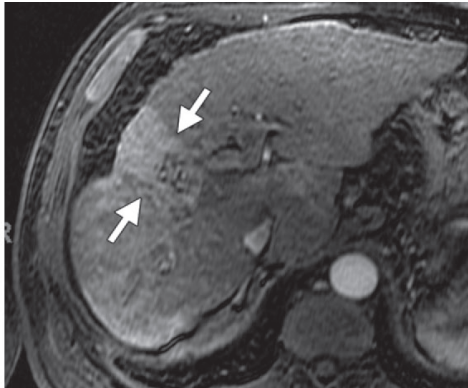
Impaired CM outflow after 5 min and No restriction in DWI

Gd-EOB-DTPA: ↓ excretion



LIVER MRI: ^{90}Y

Explanted Liver after ^{90}Y for HCC



Hyperenhancement of surrounding parenchyma with loss of function at 20 min Gd-EOB-DTPA

PANCREAS

Pathology and Clinical Features

- Necrosis and fibrosis similar to chronic pancreatitis;
- Islet Cells \ll sensitive \ll Acinar Cells.

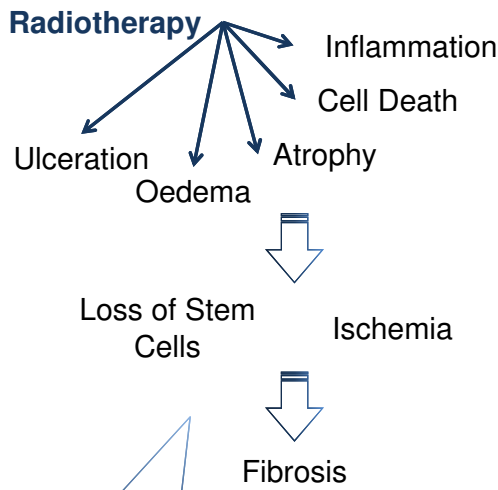
RT for Gastric Lymphoma:



Imaging Findings

- Parenchymal atrophy and calcifications.

BOWEL



Lesions with 3 mechanisms:
 1) Cytocidal;
 2) Indirect;
 3) Functional.

Mainly mucosal Changes
 Platelet clustering,
 Endothelial occlusion,
 Eosinophilic infiltration,
 Apoptosis,
 Epithelial basement membrane breakdown.

Pathways
Mutated AT gene, HIF, IL1 β , TNF α , IFN γ , TGF β 1, PDGF1, Thrombomodulin, PKC, NO.

Acute Changes

Mainly Submucosal Changes
 Vascular subintimal fibrosis,
 Collagen deposition,
 Fibrinoid necrosis,
 Reduced endothelial cells number,
 Abnormal capillary cells proliferation,
 Immature smooth muscle cells.

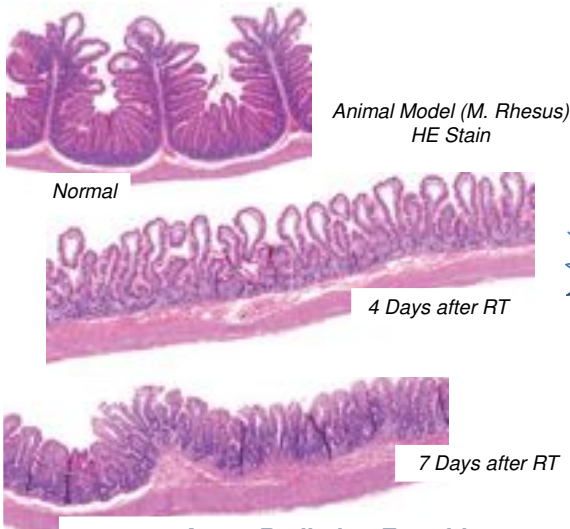
Pathways
Rho/Rock, XRCC3, VEGF, TGF β , PAR1/2, CTGF, PDGF, Fibronectin, O₂ and NO reactive species

Chronic Changes

Radiation Changes: Histopathology

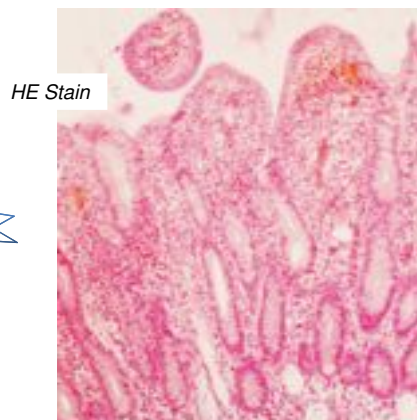
Usually radiotherapy changes are characterized by a decrease in inflammatory cells in irradiated tissue:

Terms such as *enteritis* may not always be correct!



Acute Radiation Enteritis

- Disappearance of plicae circulares;
- Crypt irregularity;
- Pronounced villous atrophy.



Acute Enteritis

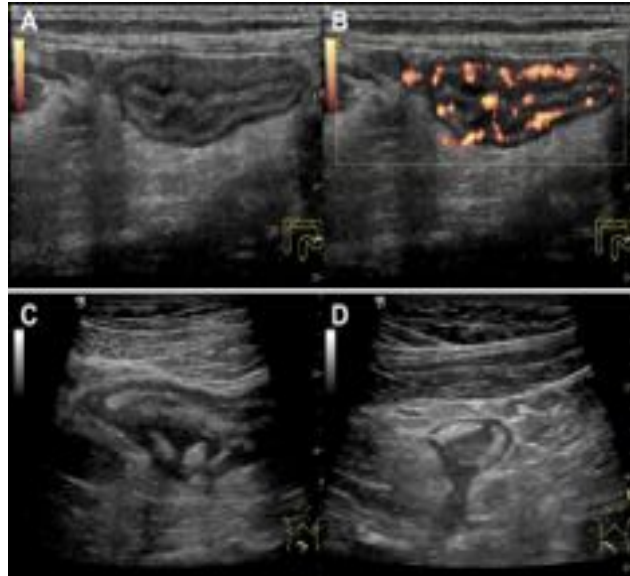
- Mucosal Oedema and increased amount of inflammatory cells, mainly neutrophils, lymphocytes and plasma cells.
- Capillaries are dilated and congested.
- Villous and crypt architecture well preserved



Transabdominal Ultrasound

US is becoming an increasingly important tool in diagnosing small bowel disease

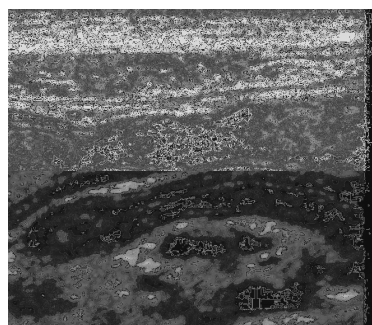
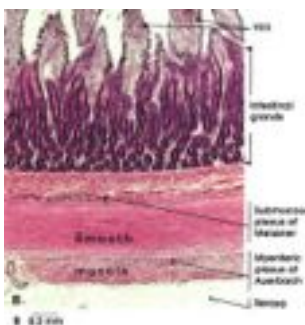
- US can detect inflamed areas of the small bowel and colon
- Doppler sonography can be used to measure blood flow parameters
- Allows for detection of lymphadenopathy, abscesses, stenoses, and fistulae as well



Transabdominal Ultrasound

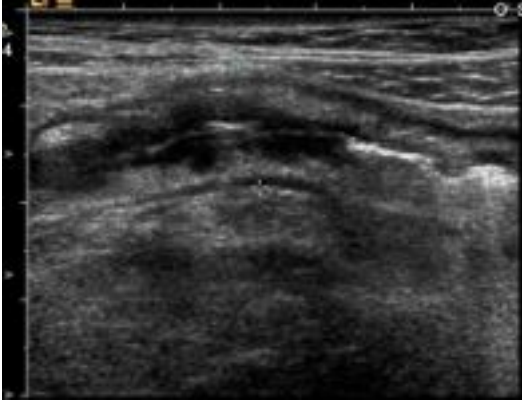
Inflammatory Bowel Disease affecting an ileal loop

- Key Ultrasound Features
 - Bowel wall thickening at compression >5mm
 - Lack of compressibility
 - Absence of peristalsis
 - Total derangement of the normal intestinal wall layering

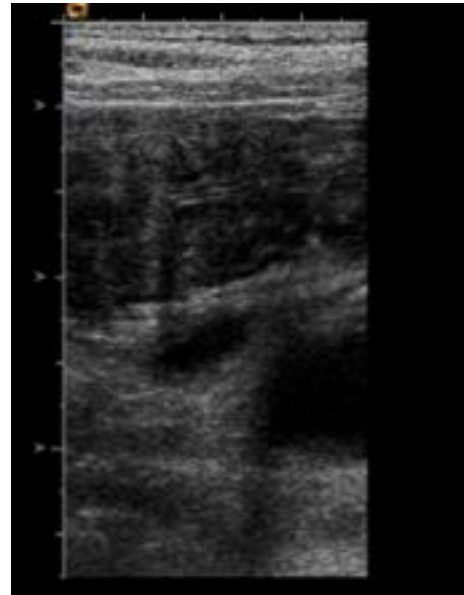


US appearance of the bowel wall layering

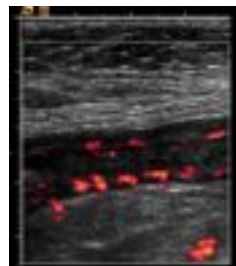
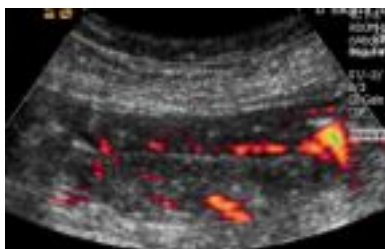
Derangement of bowel wall layering
Presence of ulcerations



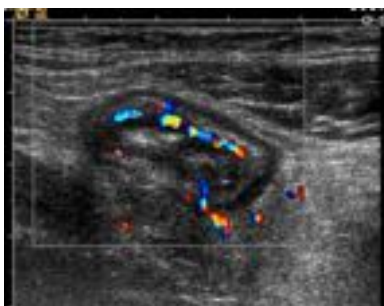
Total destruction of the bowel wall layering



US appearance of the bowel wall layering

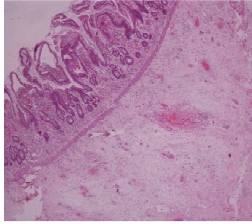


Color and Power Doppler
Mapping of the submucosa
vasculature

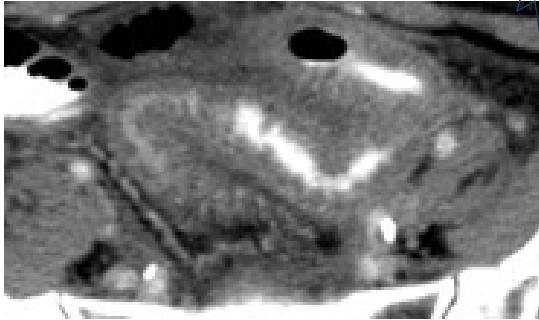


Low Resistance Waveform and increased flow pattern recorded at the
Superior mesenteric artery

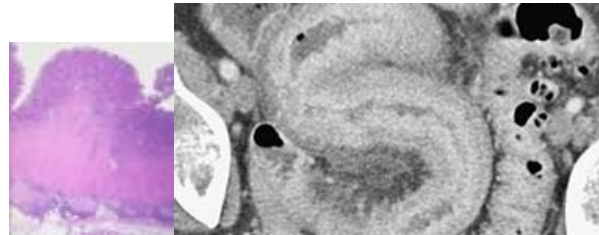
Pathology- Imaging Correlation



VS



Acute Radiation Enteritis



Acute (Crohn) Enteritis

Radiation Changes: Histopathology

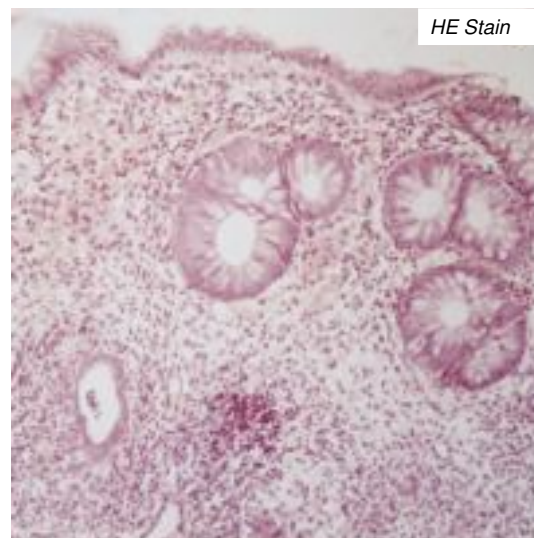


HE Stain

Chronic Radiation Enteritis

- Ischemic-type surface erosions and hemorrhage;
- Crypt atrophy and distortion;
- Telangiectasia;
- **Mild** chronic mucosal – submucosal inflammation.

VS

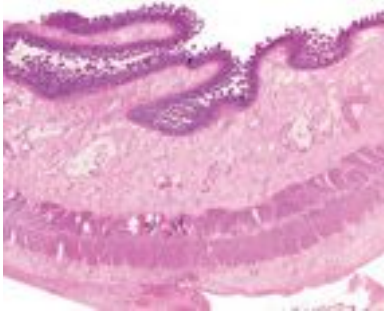


HE Stain

Chronic Enteritis

- Partial villous atrophy;
- Irregular crypts;
- **Dense**, mainly lymphoplasmocytic, infiltrate in Lamina Propria.

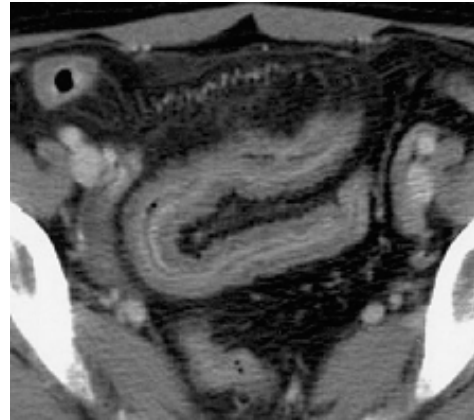
Pathology – Imaging Correlation



vs



Chronic Radiation Enteritis



Chronic (Crohn's) Enteritis

Imaging Changes after Radiotherapy in Abdomen : Gastrointestinal System

Bowel: Pathology

Stomach

Pathology, Clinical Features and Imaging Findings

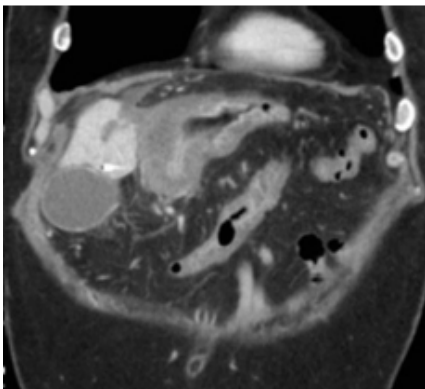
Gastritis usually at 45-60 Gy in 5 weeks

Acute Gastritis

- ✓ 2-8 wk after RT:
- ✓ Edema, mucosal cells degeneration, ulceration, bleeding

Imaging Findings

Wall thickening, ulceration.



Chronic Gastritis

- ✓ Ulceration (5 months after RT), narrowing, deformity, bleeding

Imaging Findings

Ulceration, smoothing of gastric folds, narrowing, antrum stenosis, perigastric fat stranding.



Imaging Changes after Radiotherapy in Abdomen: Gastrointestinal System

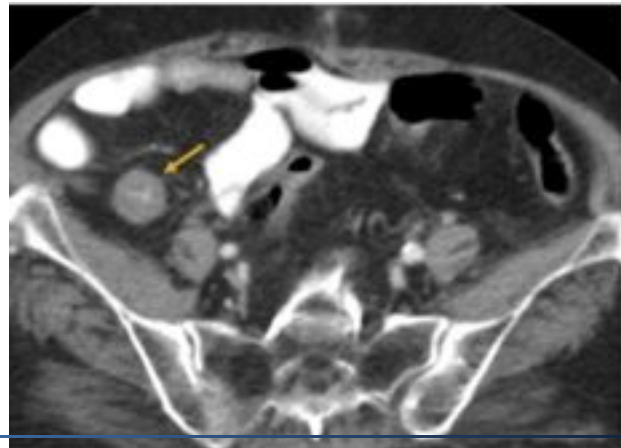
Stomach

Small Bowel

- ✓ Very sensitive: 50 Gy in 6 wks lead to surgery in 10%,
- ✓ Real incidence is lower because of motility: **increased risk for fixed loops.**

Risk Factors:

- Thin habitus;
- Previous Surgery;
- Pelvic Inflammatory disease with adhesions;
- Diabetes;
- Hypertension;
- Combined RT – CHT.



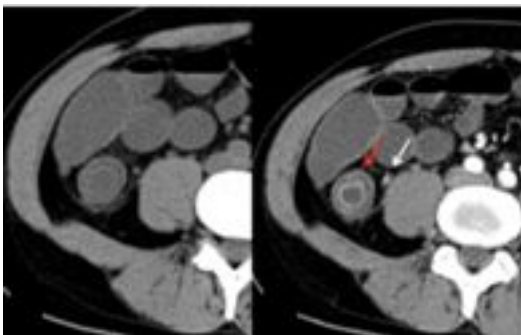
*Radiation Enteritis after RT
for Endometrial Carcinoma*

Imaging Changes after Radiotherapy in Abdomen: Gastrointestinal System

Small Bowel

Radiation Enteritis

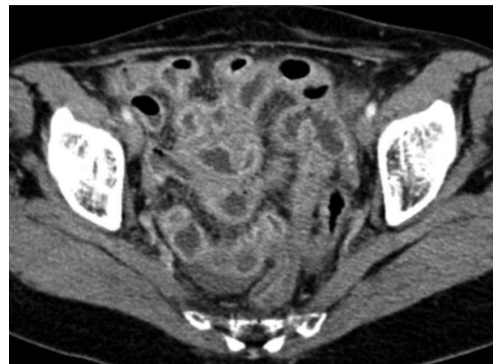
Acute Enteritis (3 wks – 3 mts)



Imaging Findings

- ✓ Dilated loops with wall thickening and hyperenhancement;
- ✓ Target sign.

Subacute Enteritis (4 – 12 mts)



Imaging Findings

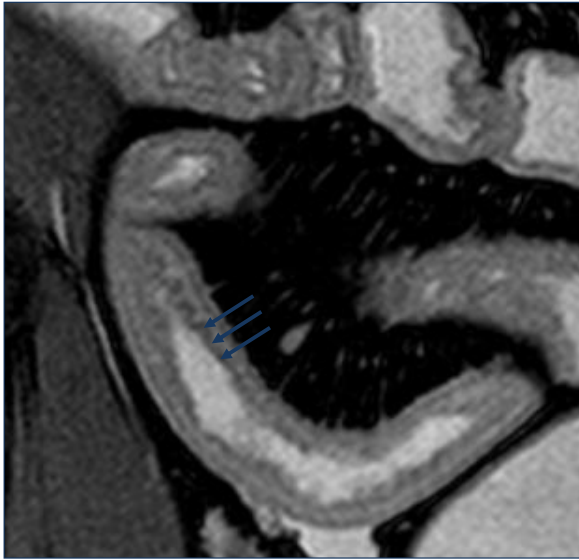
- ✓ Nodular defects,
- ✓ thumbprinting,
- ✓ signs of ischemia

Imaging Changes after Radiotherapy in Abdomen: Gastrointestinal System

Small Bowel

Magnetic Resonance Imaging (MRI)

MR Enteroclysis



Chronic Radiation Enteritis

>12 months after RT

Pathology

- Endarteritis and ischemia;
- Progressive transmural fibrosis;
- When Serosa involved: fistulae, adhesions.

Clinical Features

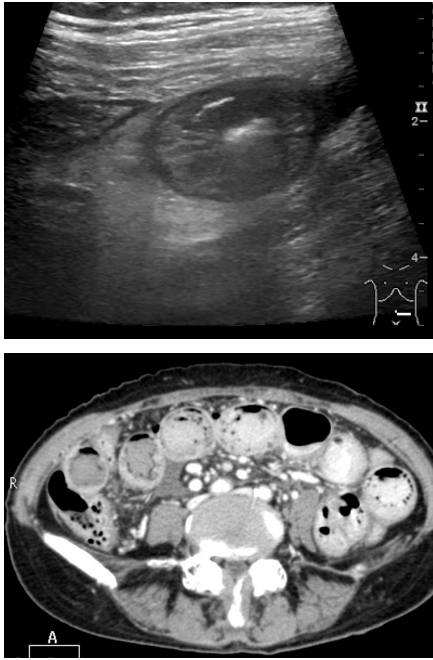
- Diarrhea, malabsorption, fistulae, obstruction.

Imaging Findings

- Submucosal or transmural thickening of irradiated loop;
- Focal narrowing, long strictures;
- Adhesions and obstructions; separation of bowel loops;
- Fistulae, abscesses, perforations;
- Hyperattenuation of mesenteric fat.



Enteritis: complications

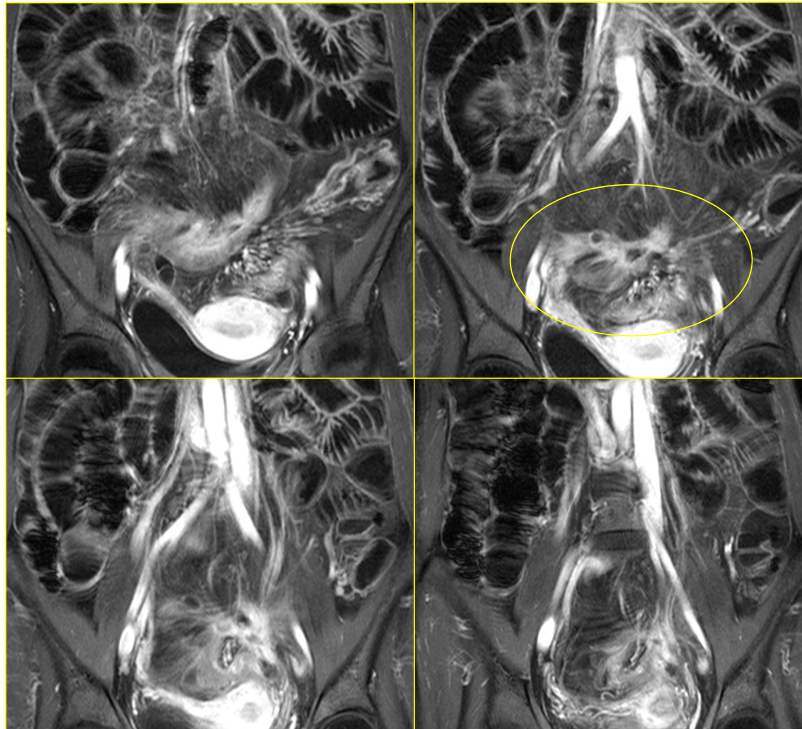


Pneumatosis Intestinalis

Imaging Changes after Radiotherapy in Abdomen: Gastrointestinal System

Small Bowel

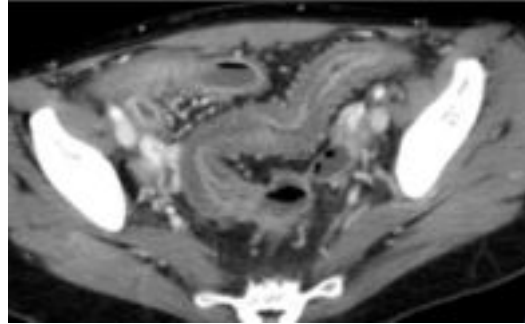
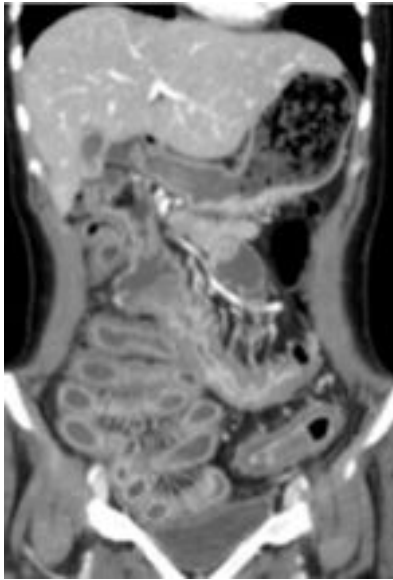
MRE_{ENTEROCLYSIS} *Fistulizing/Perforating*



COLON

Frequently affected by RT in pelvis
45-55 Gy induce chronic lesions in 1-5% patients

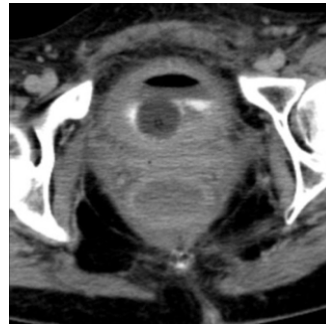
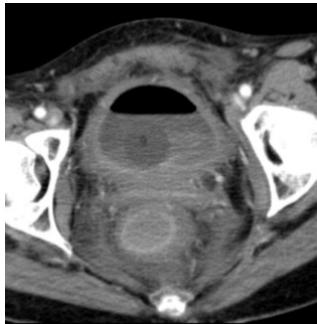
Acute and Subacute proctitis and colitis



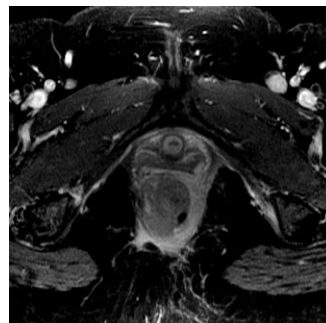
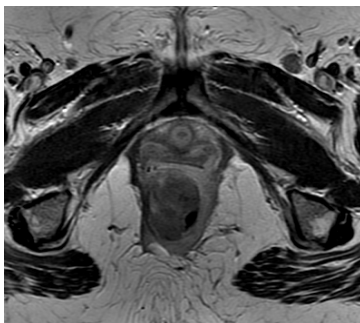
CT/MR:

- Non-specific wall thickening with hyperenhancing mucosa;
- perirectal fat stranding and thickening of perirectal fascia → ↑ perirectal space >1 cm (halo effect);
- ↑ T2 of submucosa, outer wall maintains low T2 signal.

Subacute Proctitis and Colitis



Rectal bleeding 3 months after
RT, CHT

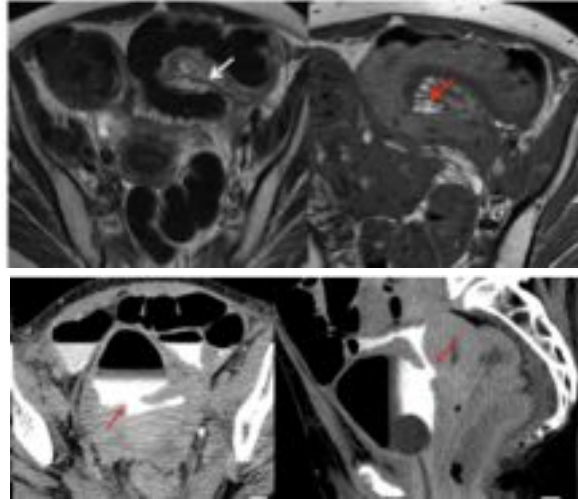
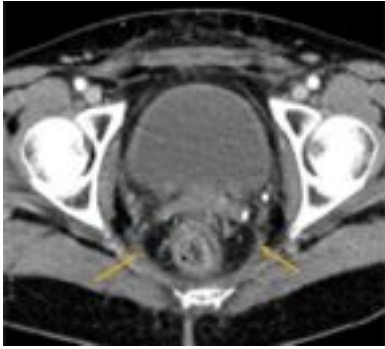


PRE-MDC T1-W

POST-MDC T1-W FAT-SAT

Chronic Proctitis and Colitis

At least 9-12 months after RT



➤ CT/MR:

- wall thickening with loss of definition of wall layers
- ↑T2 of outer wall;
- Colonic hypoplasia rare in children.
- Complication - fistula

Imaging Changes in abdomen after Radiotherapy: Large Intestine

Conclusions

Gastrointestinal system may show significant changes in imaging after RT;

Most of those changes can be self-limiting and asymptomatic, but chronic damages are invalidating;

Radiologist should be familiar with clinical and treatment history, to facilitate the detection of complications and treatment change.