MR Imaging of Locally Advanced Rectal Cancer

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Objectives

- Understand the role of Rectal MRI in initial staging of rectal cancer
- Understand common patterns of local spread of tumor, with a particular focus on locally advanced T4 disease
- Appreciate the capabilities and limitations of rectal MRI in assessing treatment response
- Appreciate some key important technical factors that make for a great Rectal Protocol MRI

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Outline

- Review some relevant anatomy to facilitate a basic understanding of Rectal MRI
- Summarize the important MRI findings used to stage and risk-stratify patients prior to treatment and inform surgical planning
- Review cases of locally advanced tumors with a focus on T4 disease to illustrate these findings
- Discuss post-treatment Rectal MRI and review the differences in assessment from pretreatment exams

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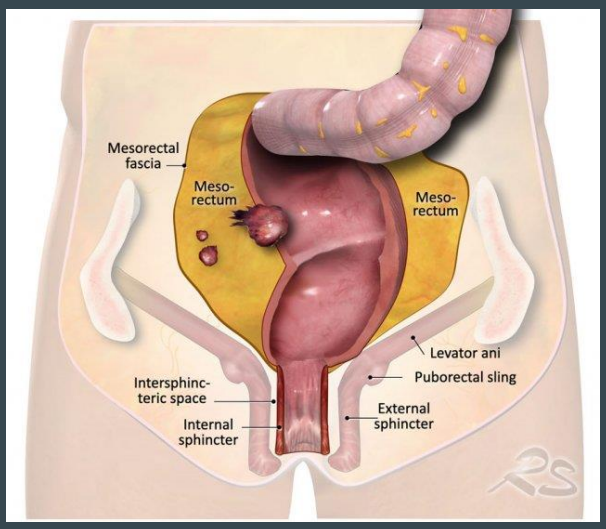
Pelvic and Rectal Anatomy



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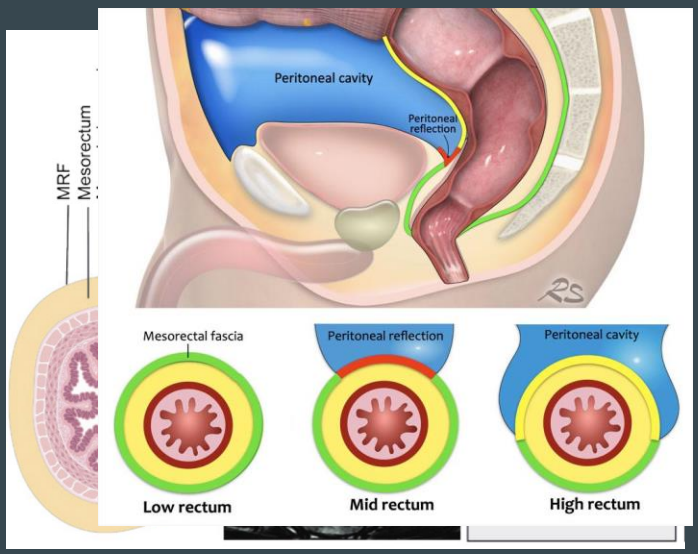
Pelvic and Rectal Anatomy

- Rectal wall layers
  - Mucosa, submucosa, and muscularis propria
- Mesorectal Fascia
  - Layer of fascial tissue surrounding the mesorectal fat, estimates the expected resection plane in a total mesorectal excision
- Anterior Peritoneal Reflection
  - Lowest point of the peritoneal cavity, where the peritoneal lining touches the anterior rectum
  - Divides the intraperitoneal and extraperitoneal rectum
  - The portion of rectum covered by mesorectum vs peritoneum changes as you move superiorly



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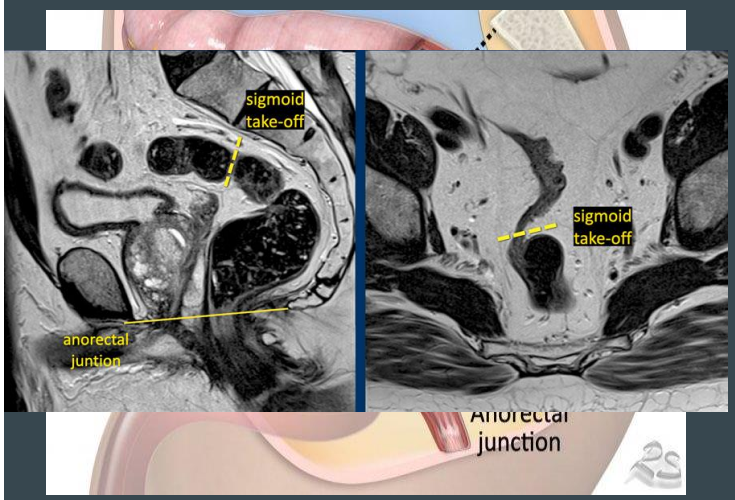
Pelvic and Rectal Anatomy



- Defining the high, middle and low rectum
  - Distance from the anal verge (0-5, 5-10, 10-15 cm)
  - Relative to the peritoneal reflection
- Defining the transition from the rectum to the sigmoid colon
  - Sigmoid takeoff

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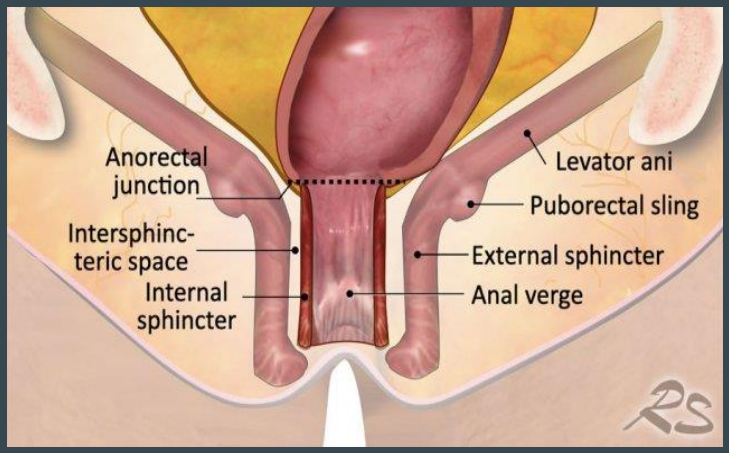
Anal Canal Anatomy



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Anal Canal Anatomy

- Internal sphincter appears as an inseparable continuation of the muscularis propria inferiorly
- Intersphincteric space typically contains fat, though is often difficult to see

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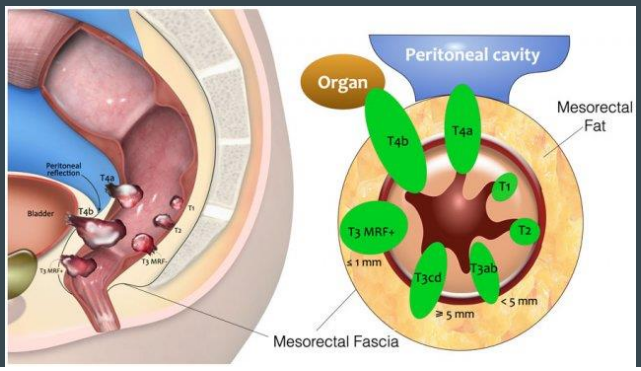
T Staging

- T1 - invades submucosa
- T2 - invades muscularis propria
- T3 - extends beyond the rectal wall into the mesorectal fat
  - Mesorectal Fascia involvement (MRF+)
- T4a - involved the peritoneum / APR
- T4b - invades other pelvic organs or other structures outside of the mesorectal compartment



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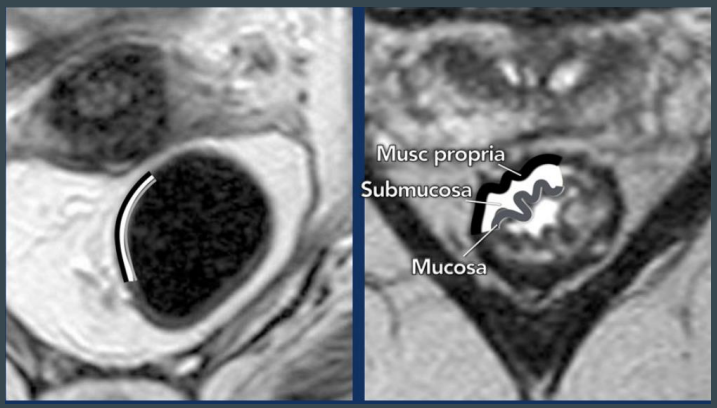
T Staging - T1 vs T2



Normal Submucosal edema

- Rectal wall layers are normally closely apposed, and the mucosa and submucosa are not usually reliably distinguished
- Therefore, T1 vs. T2 stage is not reliably distinguished by MRI

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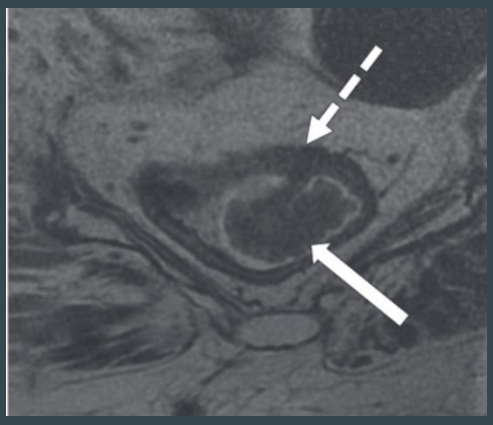
T1/T2 Tumor

Polypoid rectal tumor intact muscularis propria



Polypoid rectal tumor with wall thickening along the base, though the muscularis propria remains intact

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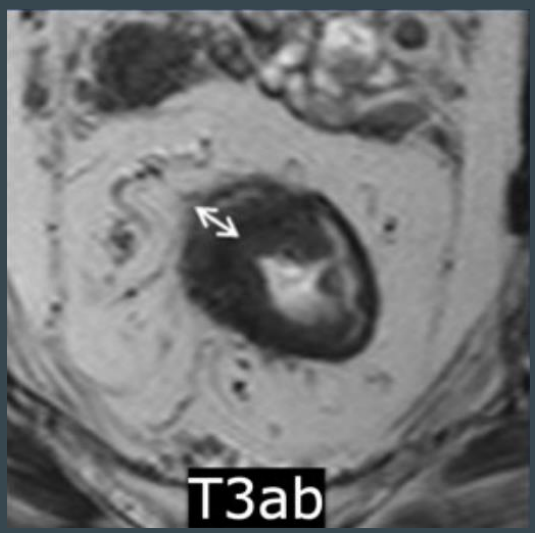
Stage T3

- Tumor extending beyond the muscularis propria into the mesorectal fat
  - Subclassified by distance of tumor beyond the muscularis propria
- Mesorectal fascia involvement – MRF + vs. MRF -
  - Most will consider MRF involved if tumor is within 1 mm
  - 1-2 mm ~ “threatened”



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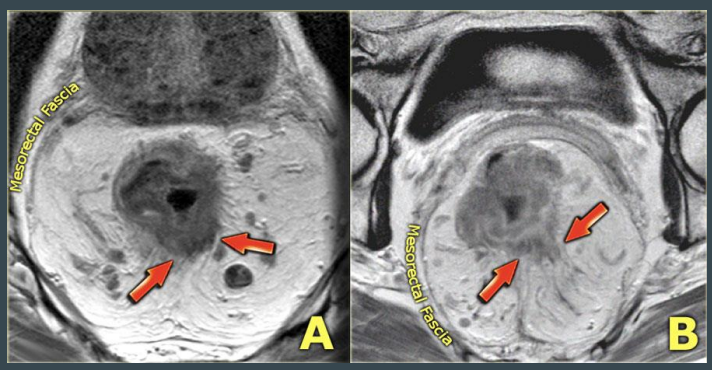
Pitfall - Desmoplastic Reaction

- Tumors can cause a desmoplastic reaction in the adjacent mesorectum
- Typically more linear low signal, rather than "mass-like", bulky
- However, this is a common cause of over-staging
- Some centers will use a combined "T2 / possible early T3" category for radiologic staging in these cases



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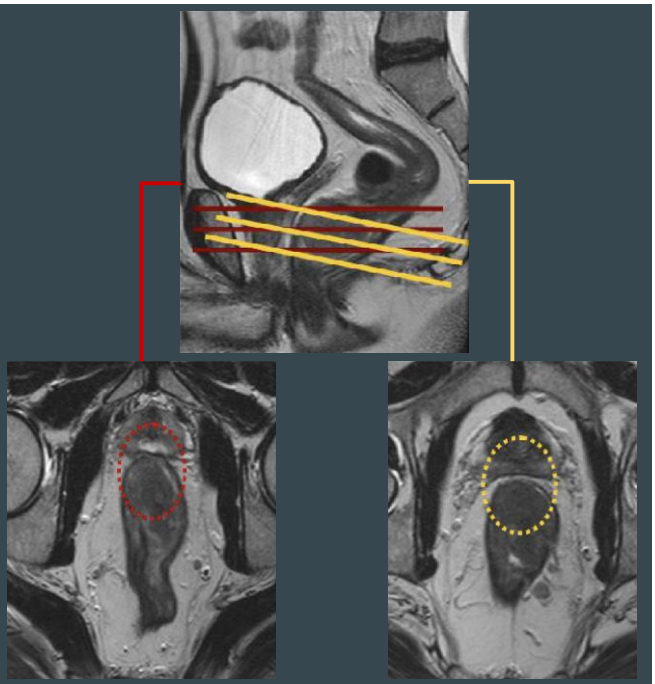
Pitfall - Volume Averaging

- Improper angulation of the imaging plane can lead to volume averaging artifact, causing a tumor to look closer to something (i.e. MRF) than it actually is
- Critical that the T2 sequences are acquired along the axis of the tumor



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Stage T4

- Invasion of the peritoneal reflection, peritoneum, or other pelvic structures beyond the mesorectum
  - Low rectal tumors
    - External anal sphincter/pelvic floor musculature
    - Vagina
    - Urethra
  - High rectal tumors
    - Peritoneal cavity
    - Adjacent loops of large or small bowel in the pelvis
    - Bladder, prostate/seminal vesicles, uterus

T4a invade the peritoneum or peritoneal reflection

T4b invade other organs or structures outside the meso-rectum:

- pelvic organs (incl. uterus, ovaries, vagina, prostate, seminal vesicles, bladder)
- bone
- striated/skeletal muscle (incl. external anal sphincter, puborectalis and levator ani, obturator, piriformis, and ischiococcygeus)
- ureters and urethra
- sciatic or sacral nerves
- sacrospinous/sacrotuberous ligaments
- any vessel outside the mesorectal compartment
- any loop of small or large bowel in the pelvis (separate from the primary site from which the tumor originates)
- any fat in an anatomical compartment outside the mesorectal compartment (i.e. obturator, para-iliac or ischiorectal space

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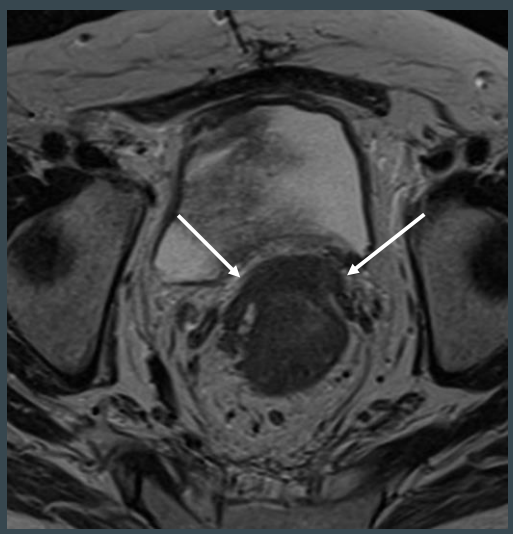
Stage T4a



Annular rectal tumor with T2-intermediate thickening of the anterior peritoneal reflection / peritoneum, compatible with invasion

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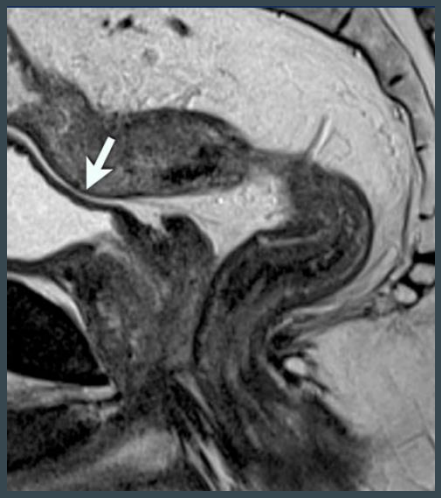
Pitfall - APR "Abutment" vs Involvement



Circumferential high rectal tumor without extension beyond the muscularis propria, no APR involvement (T1/T2)

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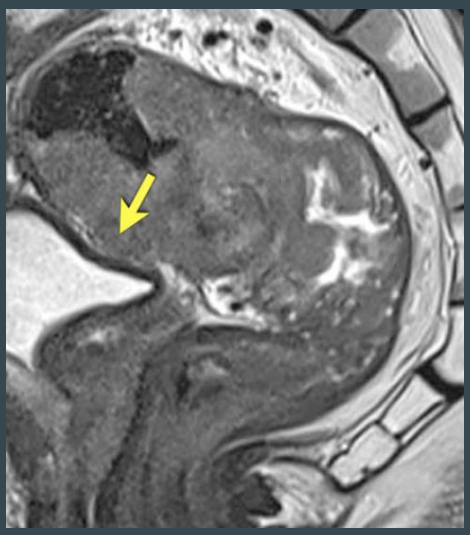
Pitfall - APR "Abutment" vs Involvement



High rectal tumor with extension beyond the muscularis propria, involving the APR (T4)

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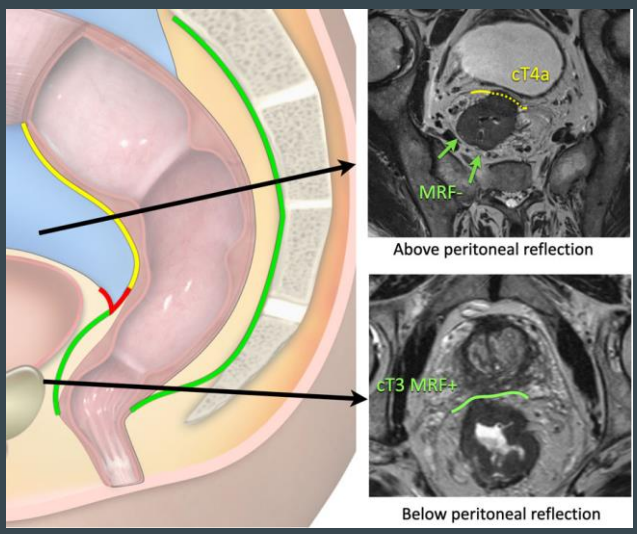
Stage T4a

- Level of tumor (high vs. low) impacts the possibility of MRF vs. APR involvement, affecting T stage
- Highlights the importance of identifying the APR



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Stage T4b

Anterior semi-annular low rectal tumor with invasion of the prostate gland (T4b)

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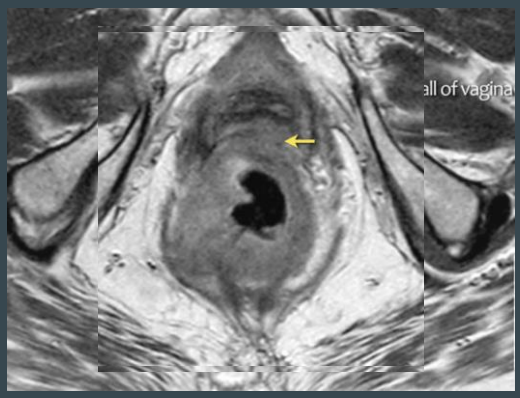
Stage T4b



Moving superiorly to inferiorly

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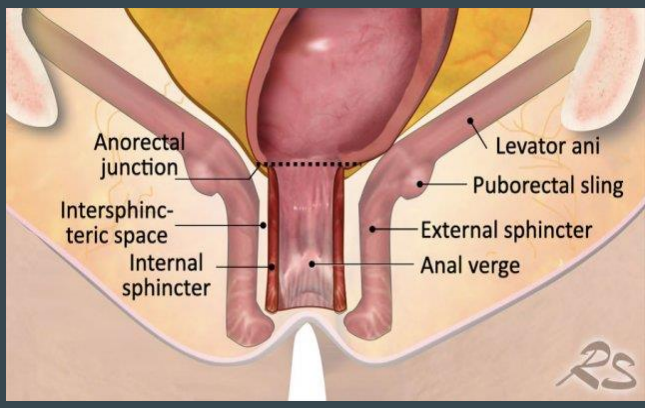
Locally Invasive Low Rectal Tumors

- Additional factors to consider for low rectal tumors
  - Extension to the anorectal junction
  - Extension into the anal canal (upper, middle, or lower third)
  - Internal sphincter, intersphincteric space and external anal sphincter involvement
  - Puborectalis and pelvic floor musculature involvement



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Locally Invasive Low Rectal Tumors

- Low rectal tumor extending inferiorly into the anal canal internal sphincter
- No invasion of the intersphincteric space or external anal sphincter
- While it does not affect the T stage, the degree of extension into the anal canal (upper, middle or lower third) is still reported for surgical planning purposes

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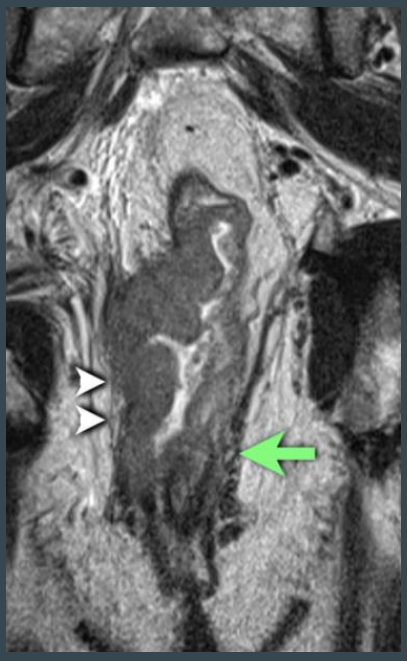
Locally Invasive Low Rectal Tumors

- Low rectal tumor with internal and external sphincter involvement (white arrows)
- Compare with preserved low signal intensity (dark) appearance of the external sphincter and levator ani on the left (green arrow)



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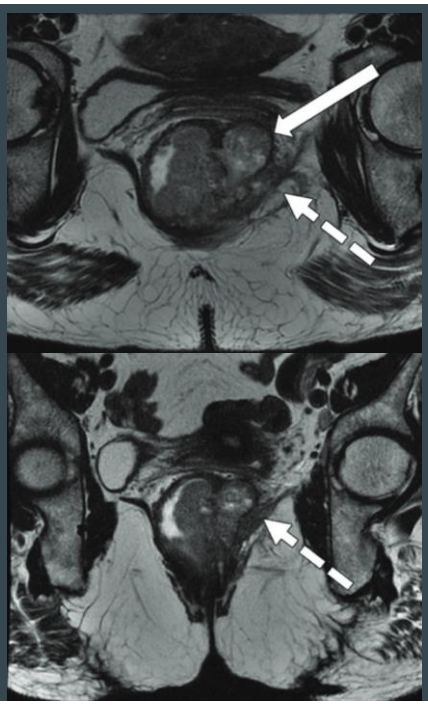
Locally Invasive Low Rectal Tumors

- Low rectal tumor extending beyond the muscularis propria and invading external anal sphincter and levator ani on the left (dashed line), stage T4b



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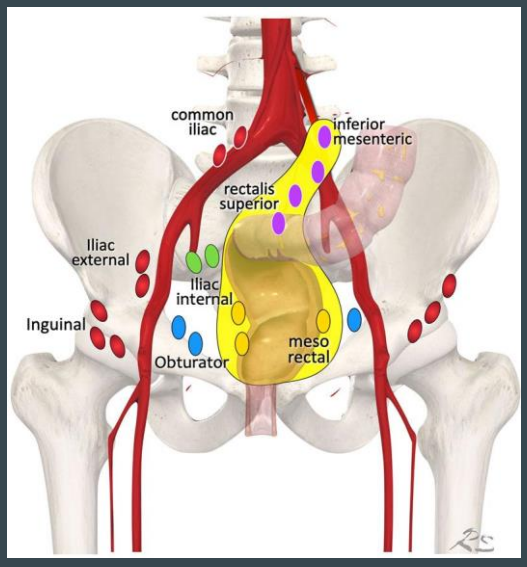
Lymph Node Metastasis

- Locoregional Lymph Nodes
  - Mesorectal
  - Superior Rectal
  - Inferior Mesenteric
  - Internal iliac
  - Obturator
- Non-regional lymph nodes - everything else
  - Inguinal
  - External Iliac
  - Common Iliac
- Not all “locoregional” lymph nodes are always excised in a typical total mesorectal excision (yellow)
- Caveat: inguinal nodes are considered regional for tumors extending into the lower third of the anal canal (below dentate line)



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Nodal Staging by MRI

STAGING

	Size (short axis)
TME (mesorectal, superior rectal)	<5 mm: 3 5-9 mm: 2 > 9 mm: suspicious
Internal Iliac	> 7 mm
Obturator	>7 mm
M1 (inguinal, external iliac, common iliac, retroperitoneal)	> 10 mm
Mucin within the lymph nodes	Suspicious regardless of size or location*

RESTAGING

	Size (short axis)
TME (mesorectal, superior rectal)	> 5 mm
Internal Iliac	> 4 mm
Obturator	>6 mm
M1 (inguinal, external iliac, common iliac, retroperitoneal)	> 10 mm
Mucin within the lymph nodes	Suspicious regardless of size or location*

* MRI is unable to differentiate cellular from acellular mucin

- MRI is relatively insensitive and nonspecific in determining nodal metastatic disease
- SAR criteria above attempts to standardize, combining size and morphology

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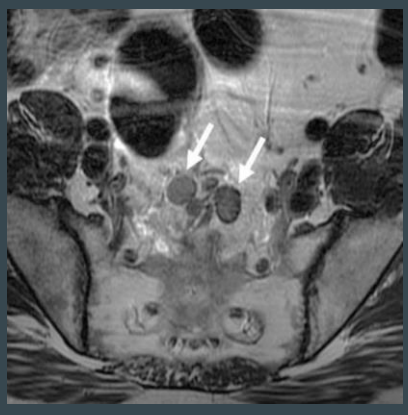
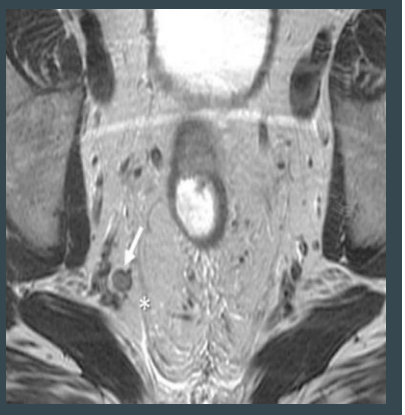
Nodal Staging by MRI

Mesorectal



Superior Rectal / Inferior Mesenteric



Internal Iliac

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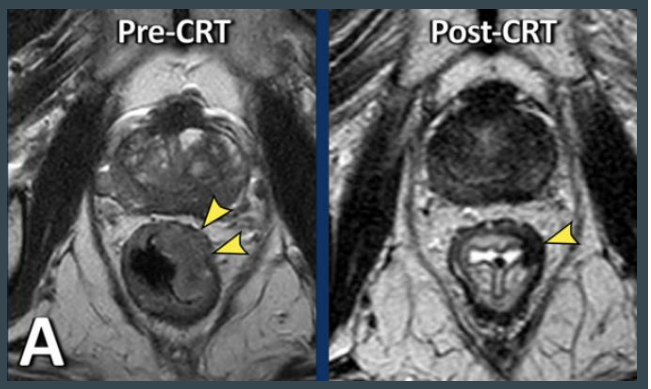
Post-treatment Response Assessment

- Tumors typically shrink and become increasingly fibrotic after neoadjuvant therapy
- Rarely, the rectal wall can “normalize” in appearance
- How to identify residual tumor?
  - T2 - residual intermediate signal
  - Diffusion restriction on diffusion weighted imaging



Treated tumor, no evidence of residual viable tumor by T2

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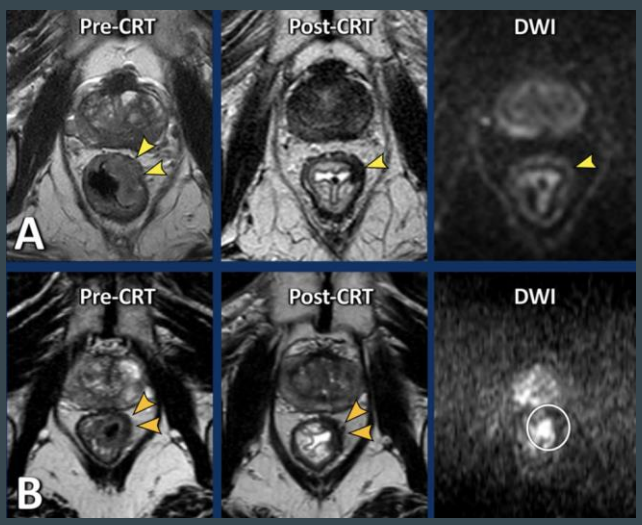
Post-treatment Response Assessment



Diffusion weighted imaging from the prior case, no significant diffusion restriction. No residual viable tumor at resection

Comparison Case – treated tumor with T2 dark fibrosis, but diffusion restriction. Residual T2 disease at resection

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Post-treatment Response Assessment

Table 4: Tumor Regression Grade Features at MRI

TRG 1	Complete radiologic response: no evidence of treated tumor
TRG 2	Good response: dense fibrosis (>75%); no obvious residual tumor, signifying minimal residual disease, or no tumor
TRG 3	Moderate response: >50% fibrosis or mucin* and visible intermediate signal intensity
TRG 4	Slight response: little areas of fibrosis or mucin,* but mostly tumor
TRG 5	No response: intermediate signal intensity; same appearance as that of the original tumor

Note.—TRG = tumor regression grade.
*Data are from references 20 and 25.

TREATED PRIMARY TUMOR CHARACTERISTICS (compare to pre-treatment):

DWI (with associated low ADC) – restricted diffusion and low ADC in tumor or tumor bed
- ❑ Present [(if yes, is it regressed from prior?)]
- ❑ Absent
- ❑ Artifact/equivocal or N/A

MRI-T2W:
- ❑ Intermediate signal intensity, no dark T2/scar
- ❑ Mixed dark T2/scar and intermediate signal
- ❑ Entirely dark T2 signal/scar
- ❑ nearly normalized appearance of rectal wall
- ❑ T2 bright mucin (cannot distinguish between cellular and acellular mucin)

[free text to describe above findings]

Society of Abdominal Radiology
Rectal Cancer Restaging Template

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Thank You!

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Questions?

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