MR Imaging in Rectal Cancer

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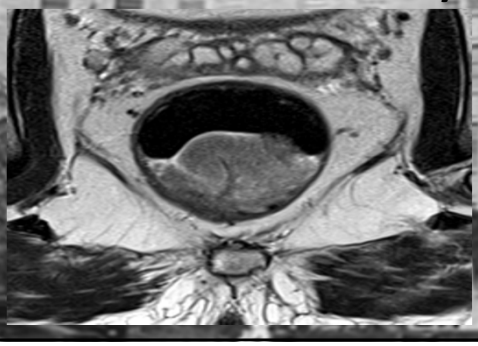

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Rectal MRI - Background

•After prostate and lung cancer, colorectal cancer is the third most common in men and second most common in women after breast.

•1/3 of colorectal Cancers are rectal cancer.

•5-Year Relative Survival Rates has been improved for colon and rectal cancers in United States in-between 1975–2005.

Colon 52 to 66%, Rectum 49 to 69%

– *Jemal A, Siegel R, Xu J, Ward E. Cancer statistics, 2010. CA Cancer J Clin 2010;60(5): 277–300.*

•Related to the combined effects of better staging, improved preoperative treatment strategies, and total mesorectal excision (TME) surgery.

Rectal MRI - Background

- Optimal treatment of rectal cancer involves a multidisciplinary approach, with collaboration between radiologists, oncologists, surgeons, and pathologists to achieve local control and decrease the rate of recurrence.
- Currently, surgical resection with stage-appropriate neoadjuvant combined therapy is the mainstay of treatment.
- Advances in preoperative therapies require accurate preoperative staging with MR imaging to select those patients who may benefit from more intensive treatment.
- MR imaging is now an essential tool to enable the oncology team to make appropriate treatment decisions.

MRI Protocol

	Matrix	Slice thickness (mm)	FOV (mm)
Coronal T2 Abdomen	448 x 340	3	400
Axial T1	320 x 288	4	250
Sag T2	320 x 320	4	250
Axial T2	256 x 256	4	250
Coronal T2	320 x 320	4	250
Oblique Axial T2	384 x 269	3	160
Oblique Coronal T2	384 x 269	3	160
DWI	**128 x 103**	**5**	**330**

Oblique axial High Res T2

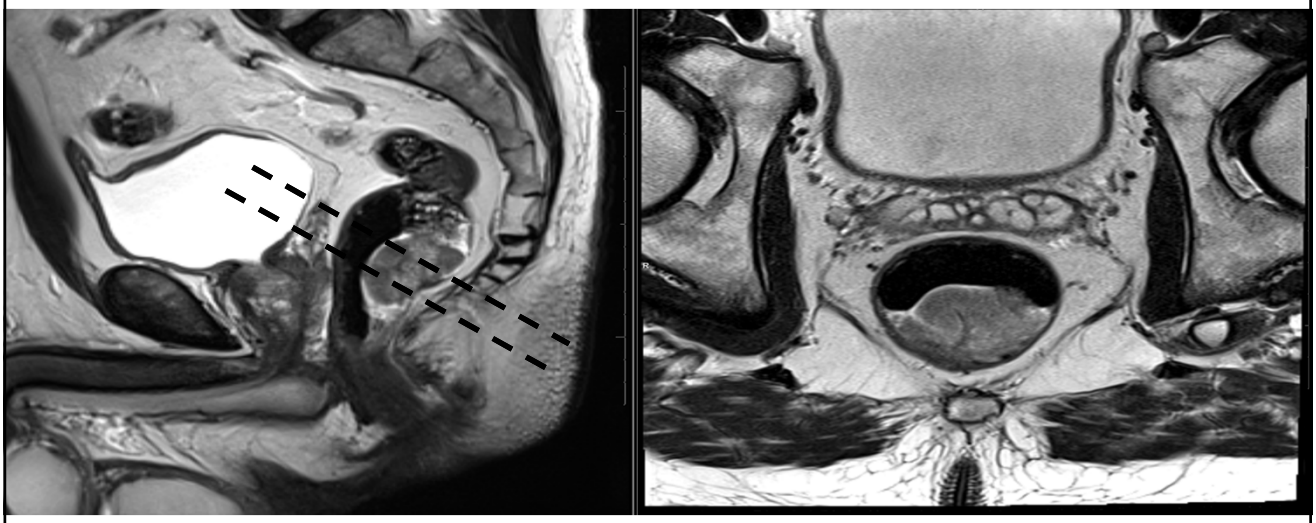
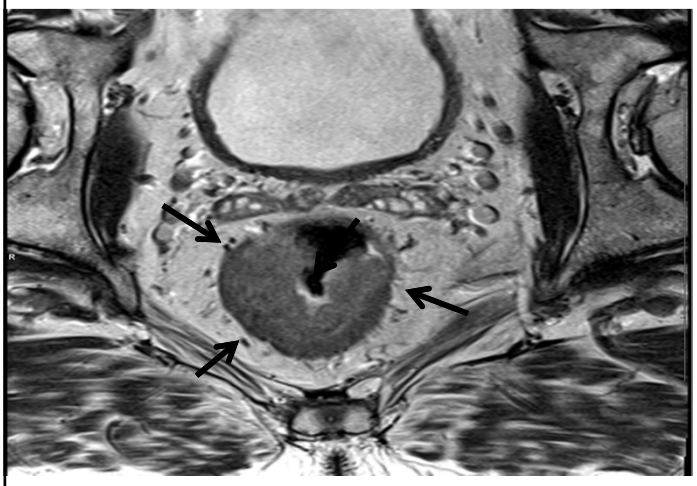
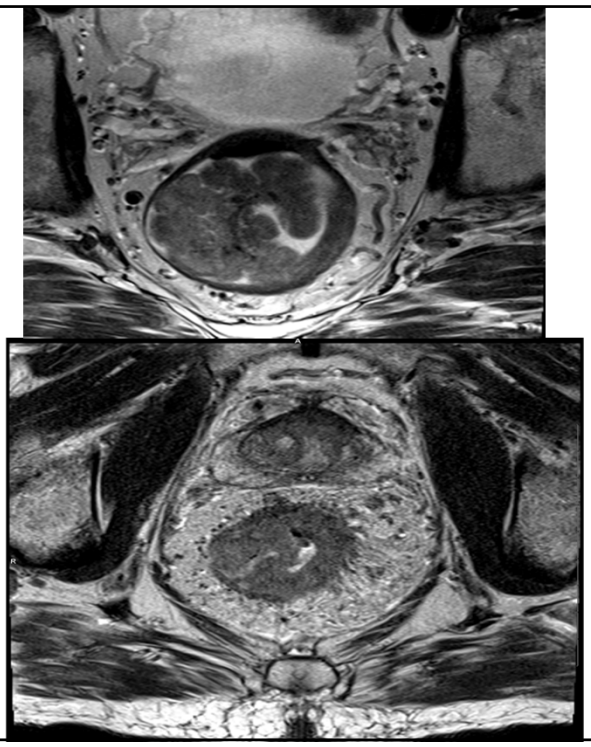


Image interpretation

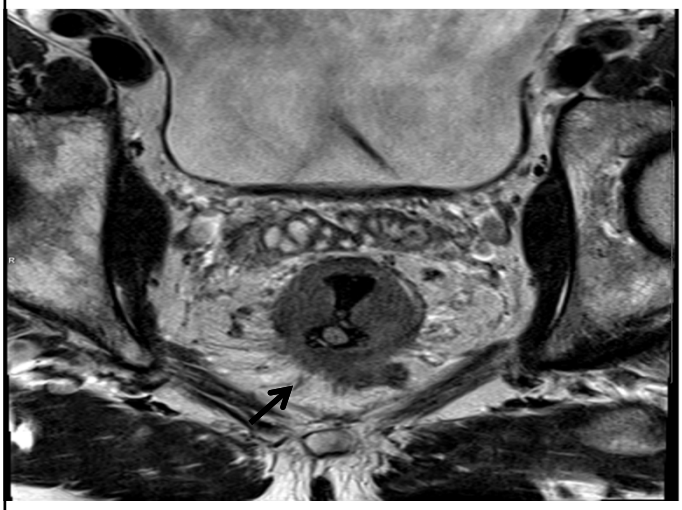
- Morphology.
- Distance from lower edge to anal verge.
- Distance to Anal sphincter complex.
- Tumor relation to Peritoneal reflection.
- T staging.
- CRM.
- EMVI (Extramural vascular invasion).
- Nodal staging.

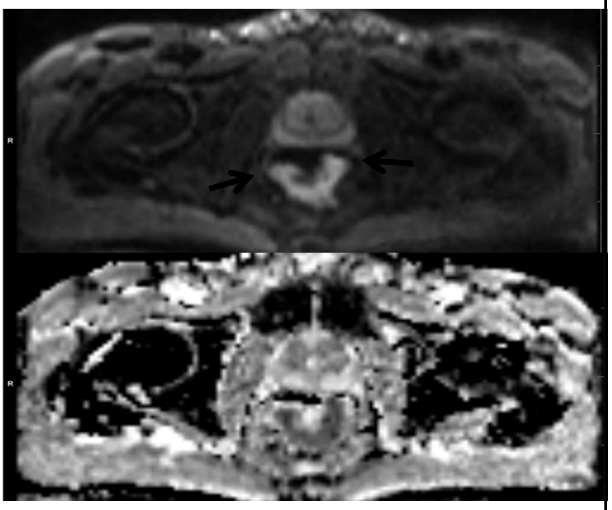
Morphology



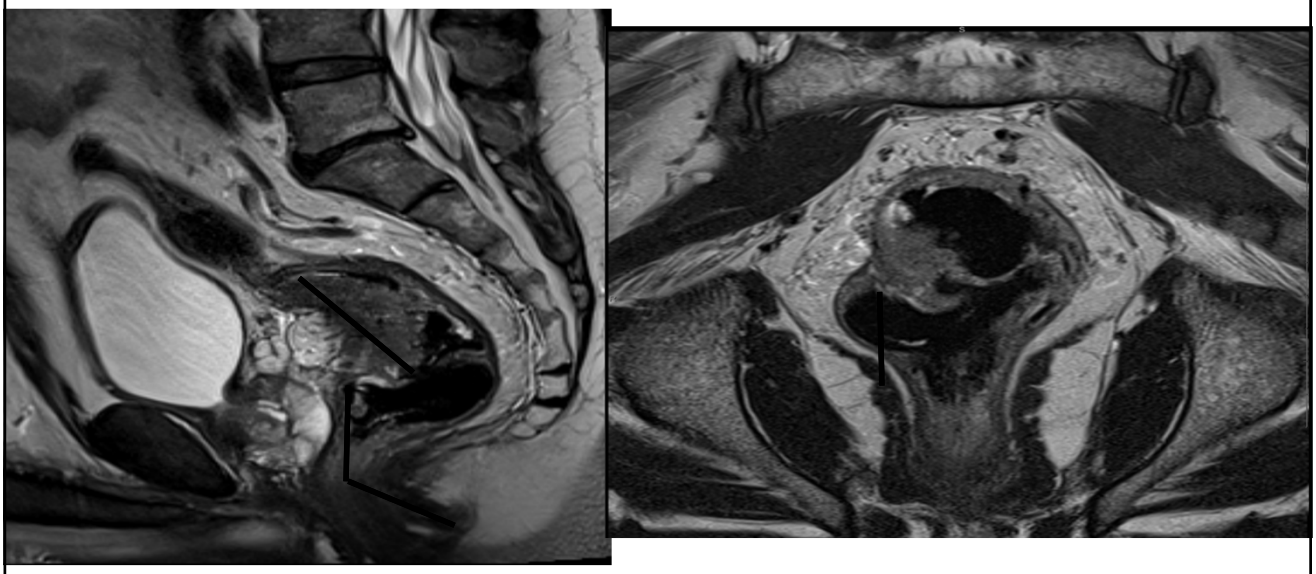


Morphology

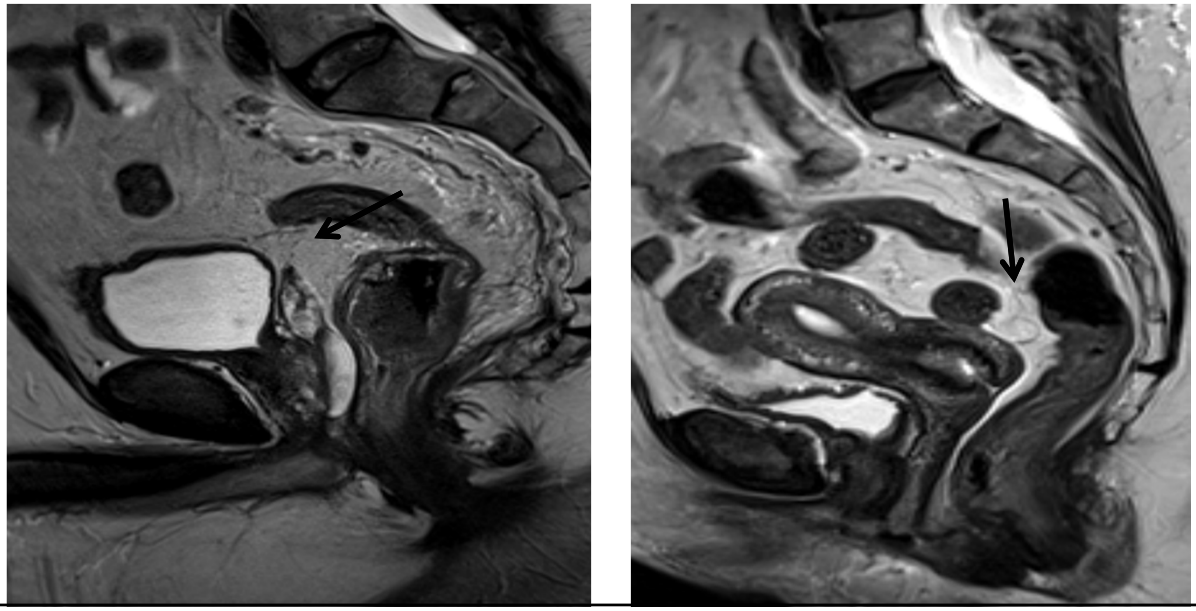




Distance from lower edge to anal verge and in low rectal cancers to anal sphincter complex.

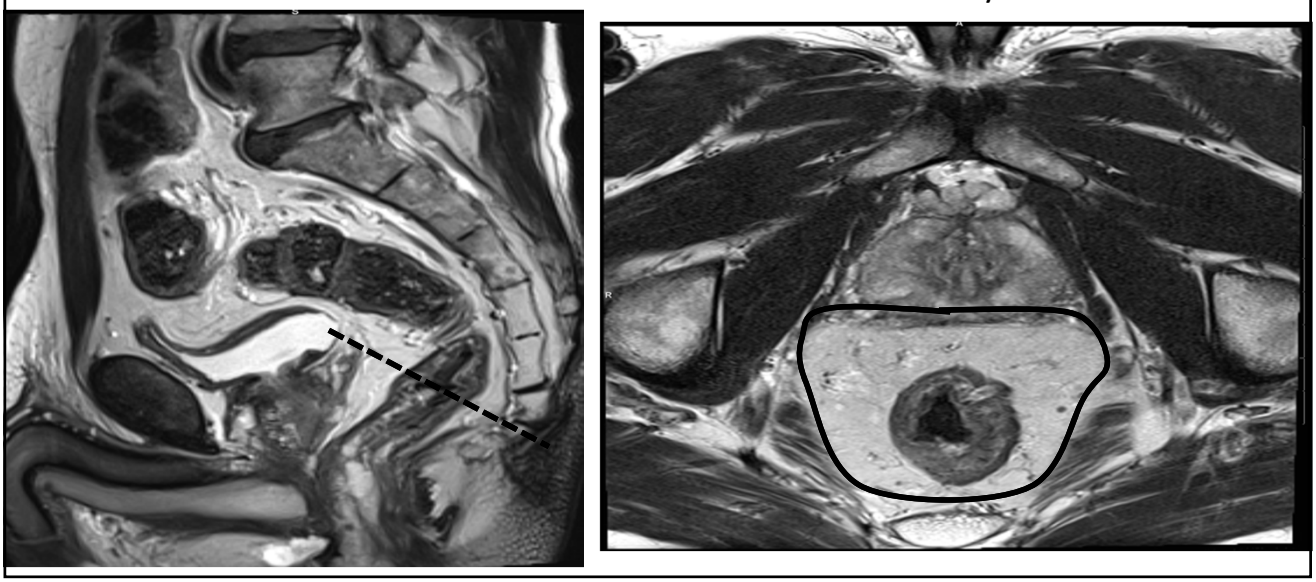


Peritoneal Reflection

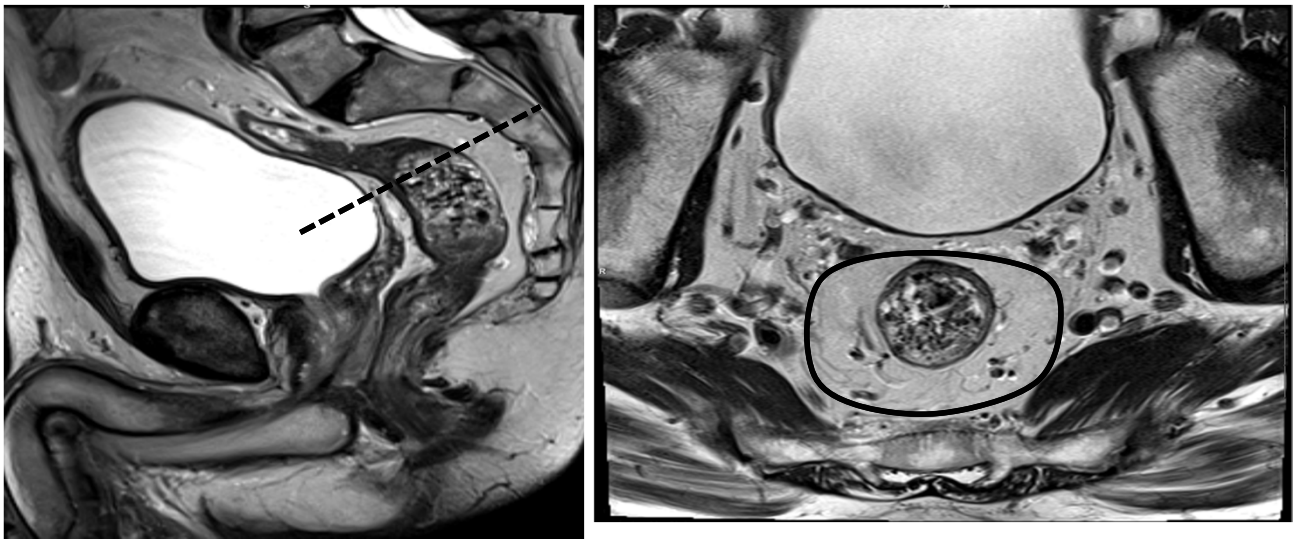


CRM

Low signal line encircling the mesorecal fat. Plane for TME resection.
Should be described for all T3 lesions. MRI accuracy 95%.

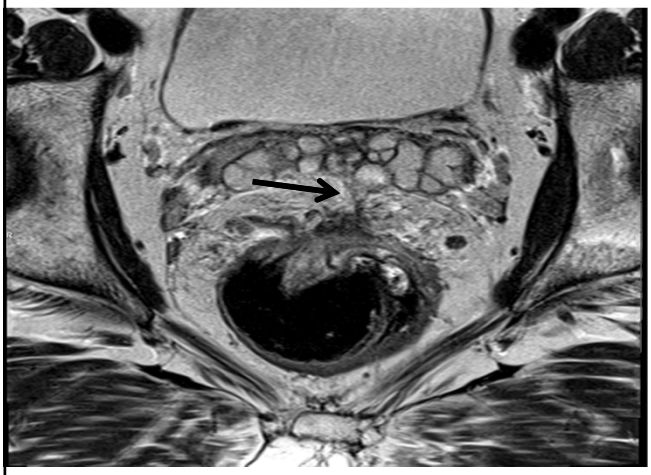


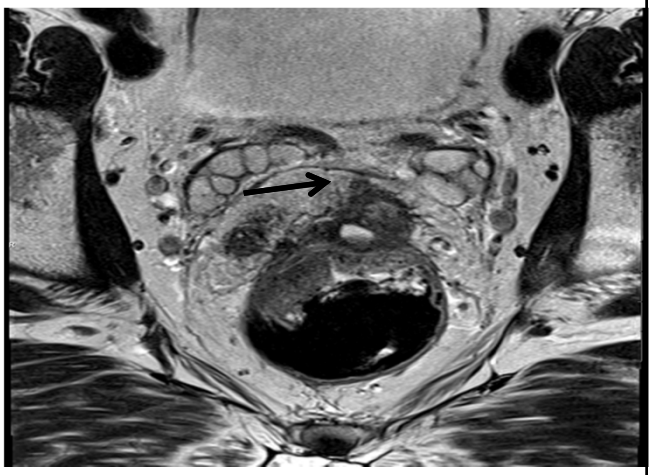
CRM



CRM

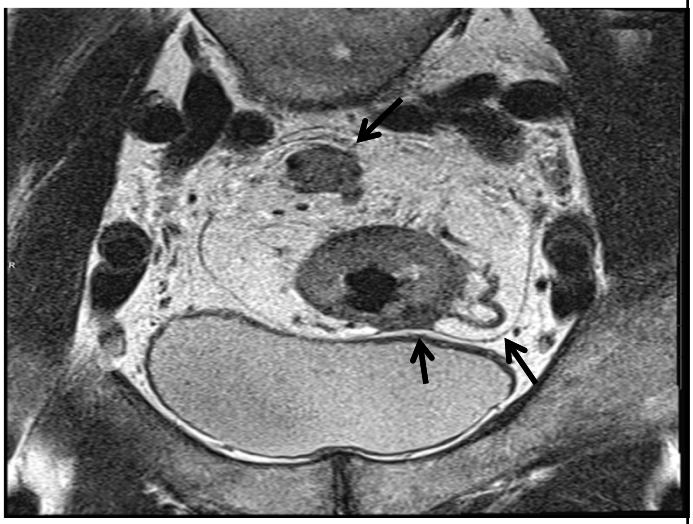
A positive margin is defined as tumor lying within 1 mm of the mesorectal fascia.





CRM

- Tumor deposits.
- Main tumor extension.
- EMVI.
- Suspicious lymph nodes.



T-Staging

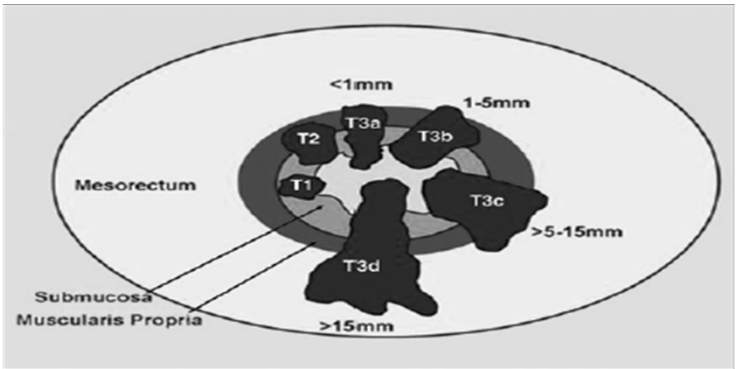
- MRI accuracy: 59-95%.
  - *Brown G, Preoperative staging of rectal cancer:*
    - *The MERCURY research project. Recent Results Cancer Res 2005;165: 58–74.*
  - *Beets-Tan RG. MRI in rectal cancer: the T stage and circumferential resection margin.*
    - *Colorectal Dis 2003;5(5):392–395*
  - *Brown G et al. Rectal carcinoma: thin-section MR imaging for staging in 28 patients.*
    - *Radiology 1999; 211(1):215–222*
- Most staging failures occur in the differentiation between T2 and borderline T3 lesions.

T-Staging

- Clinically and therapeutically, it is much more important to measure the depth of extramural spread in mm than to give the T stage.
- A T2 tumor has almost the same prognosis as a T3 tumor with less than 1 mm spread proven in different histopathologic studies.
  - *Merkel S, Mansmann U et al:*
    A proposal for subdivision of stage III. Cancer 2001;92(11):2754–2759.
    •The prognostic inhomogeneity in pT3 rectal carcinomas. Int J Colorectal Dis 2001;16(5): 298–304.
  - *MERCURY Study Group. Radiology 2007;243(1): 132–139.*
  - *Pedersen BG et al. Reproducibility of depth of extramural tumor spread and distance to circumferential resection margin at rectal MRI. AJR Am J Roentgenol 2011;197(6):1360–1366.*
- Cancer-specific 5 year survival rate:
  - T3 tumor with less that 5mm mesorectal invasion: 84%.
  - T3 tumor with more than 5 mm mesorectal invasion: 54%.

T-Staging

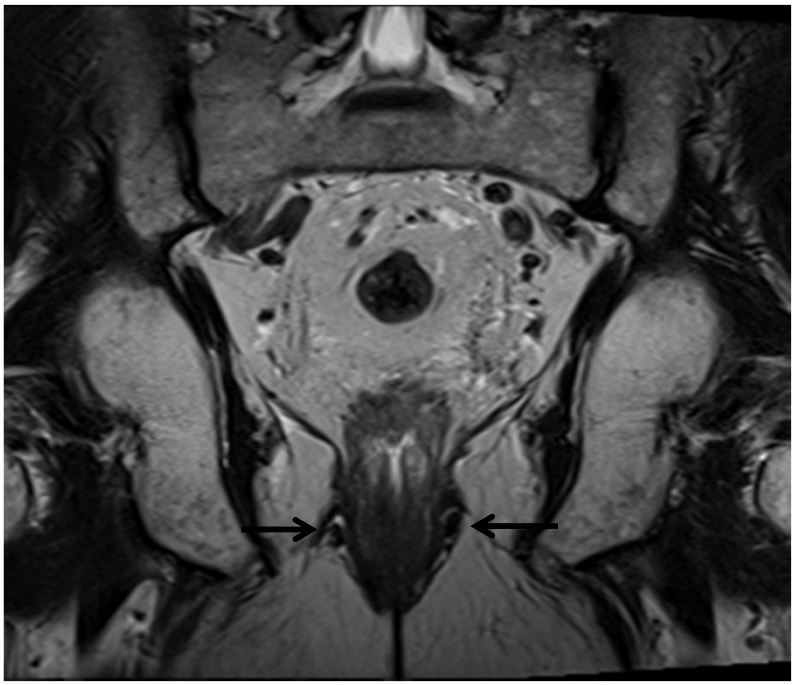
- 1mm distinction between T2 and T3 will not potentially govern treatment decisions.
- The depth of extramural spread is a key factor in determining prognosis and stratifying patients for preoperative therapy.
- Now having sub classifications of T3 staging.
- RCAC, Quick Silver Study.



Gina Brown et al, Radiology: *Volume 268: Number 2—August 2013*

Low Rectal Cancer

- <5 cm from anal verge.
- Muscolaris Propria = Internal sphincter.
- Intersphincteric plane.
- Puborectalis sling. External sphincter complex.



Low Rectal cancer

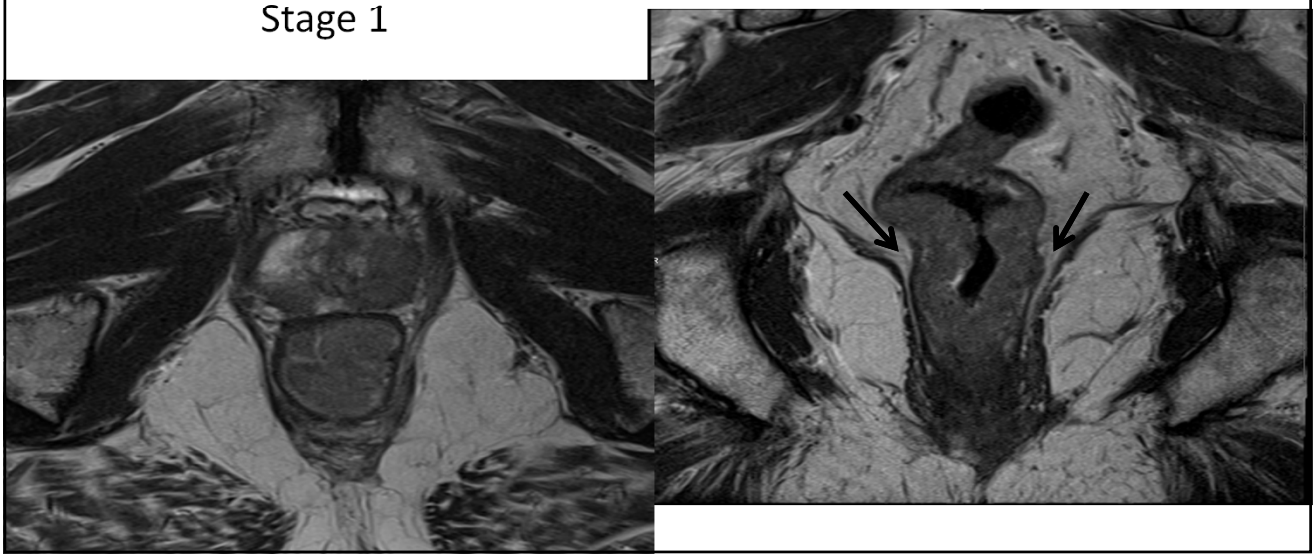
TABLE 3: Stages of Low Rectal Cancer as Seen on MRI

Stage 1	Tumor confined to bowel wall but does not extend through full thickness; intact outer muscle coat
Stage 2	Tumor replaces muscle coat but does not extend into intersphincteric plane
Stage 3	Tumor invades intersphincteric plane or lies within 1 mm of levator muscle
Stage 4	Tumor invades external anal sphincter and is within 1 mm and beyond levators with or without invading adjacent organs

AJR:191, December 2008

Lower Rectum

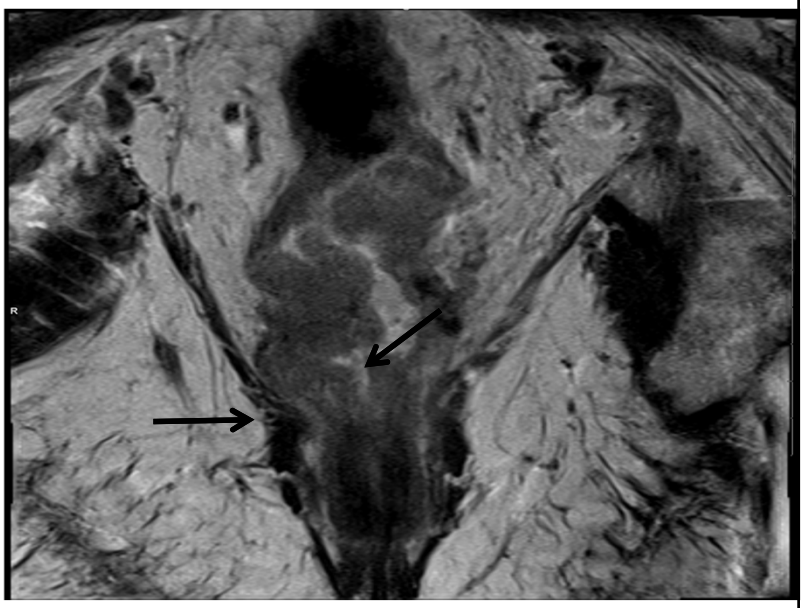
Stage 1



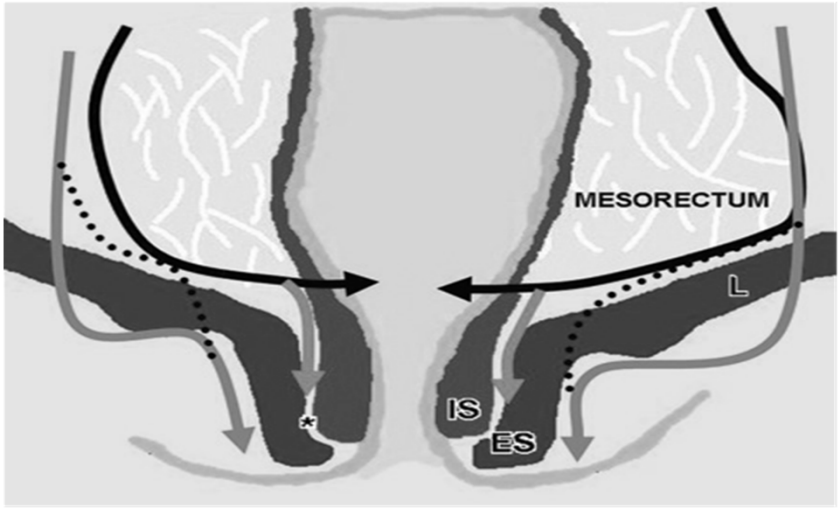
Low rectal cancer

Stage 2, 3 or 4.

Abdominoperineal resection or extralavator APR.



Surgical approach



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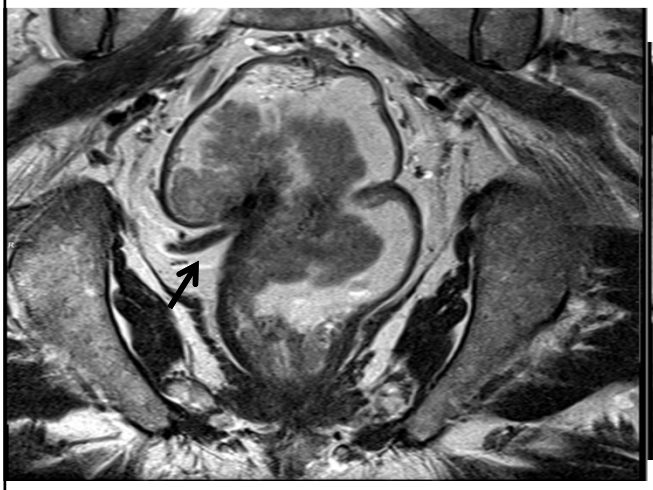
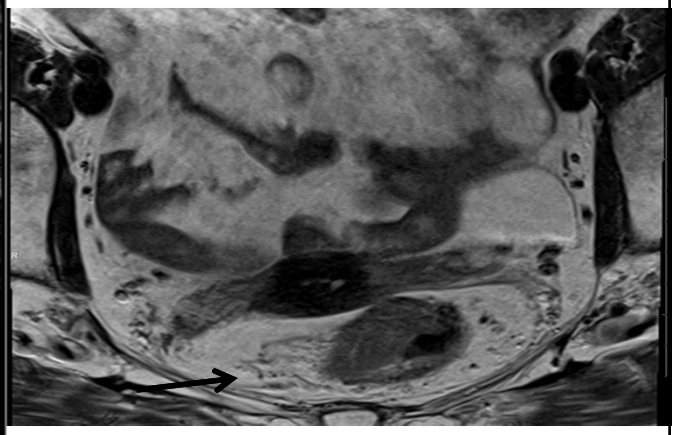
EMVI

Tumor signal. Vascular wall irregularity and spiculation. Dilated rectal vein.

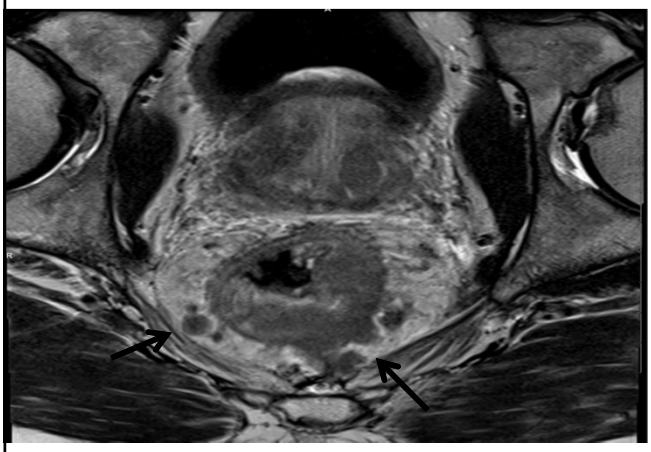


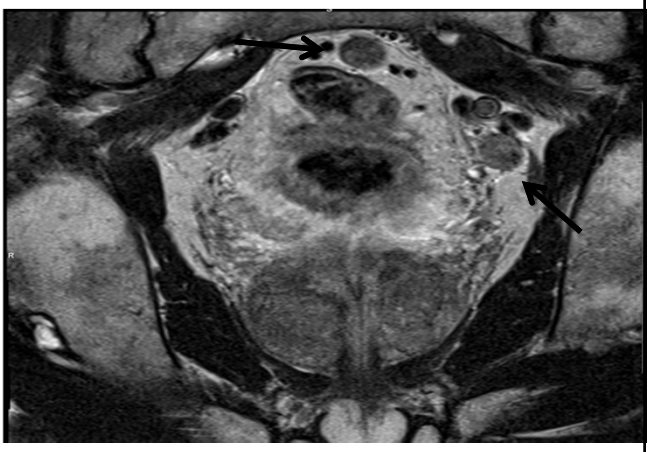


Lymph nodes

- Size, >5mm
- Shape, border and signal.
  - Sens 77-85% and Spec 88-97%
  - ***Brown G et al. "Morphologic predictors of lymph node status in rectal cancer with use of highspatial-resolution MRI with histopathologic comparison".***
    Radiology 2003; 227:371–377
- Accuracy of up to 85%.
- Homogenous signal, well defined margins = Benign NPV 96%
- Stage N1 (1-3 perirectal LN) and N2 (>4 LN).
- Abnormal Ext. Iliac or inguinal LN: Stage M1.
  - *MERCURY Study Group, Br J Surg 2011; 98(12):1798–1804.*
  - *Kim JH et al, Eur J Radiol 2004;52(1):78–83.*
  - *Brown G et al, Radiology 2003;227(2):371–377*

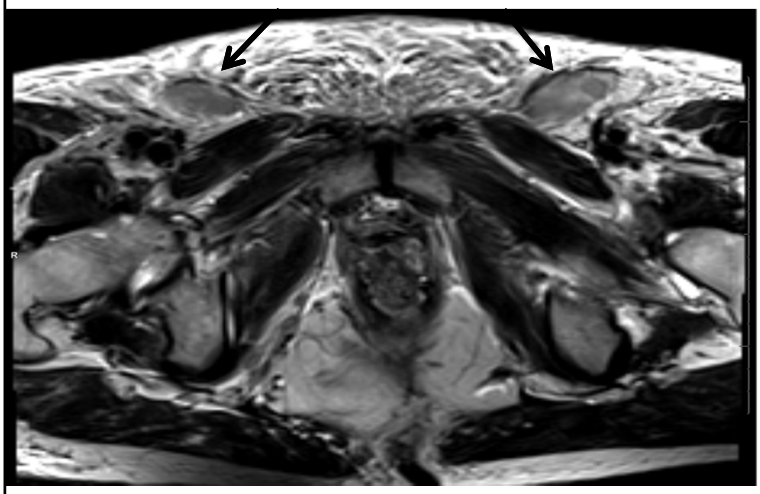
Lymph nodes

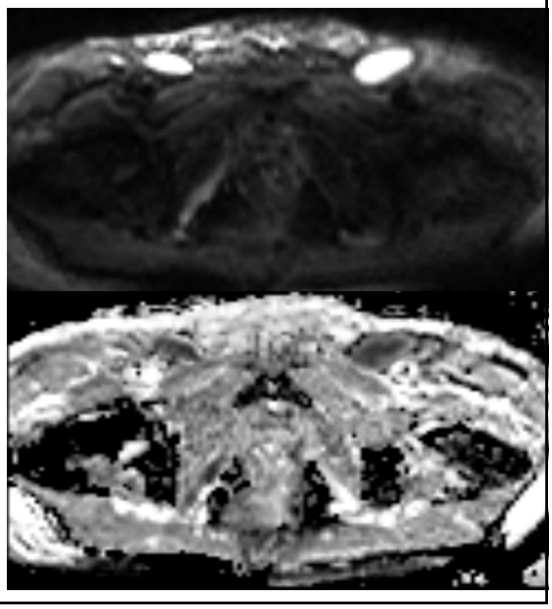




Lymph nodes

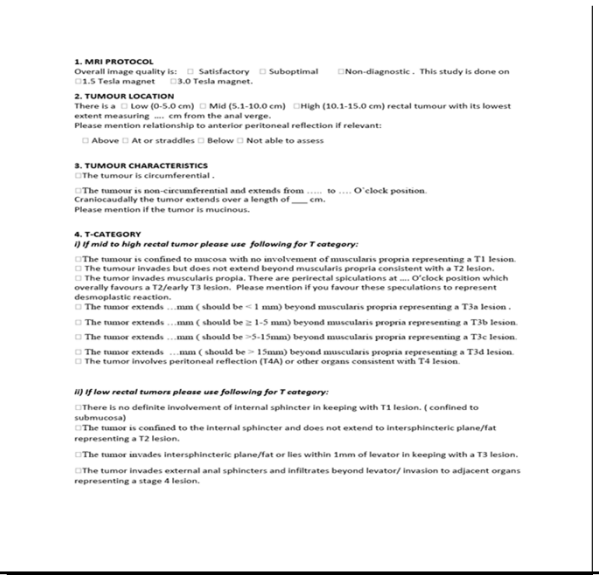
M1 LN.





Synoptic reporting

Cancer Care Ontario
Action Cancer Ontario
Canadian Cancer Society / Société canadienne du cancer



1. MRI PROTOCOL
Overall image quality is: □ Satisfactory □ Suboptimal □Non-diagnostic . This study is done on
□1.5 Tesla magnet □3.0 Tesla magnet.

2. TUMOUR LOCATION
There is a □ Low (0-5.0 cm) □ Mid (5.1-10.0 cm) □High (10.1-15.0 cm) rectal tumour with its lowest extent measuring .... cm from the anal verge.
Please mention relationship to anterior peritoneal reflection if relevant:
□ Above □ At or straddles □ Below □ Not able to assess

3. TUMOUR CHARACTERISTICS
□The tumour is circumferential .
□The tumour is non-circumferential and extends from ..... to .... O'clock position.
Craniocaudally the tumor extends over a length of ___ cm.
Please mention if the tumor is mucinous.

4. T-CATEGORY
i) If mid to high rectal tumor please use following for T category:
□The tumour is confined to mucosa with no involvement of muscularis propria representing a T1 lesion.
□ The tumour invades but does not extend beyond muscularis propria consistent with a T2 lesion.
□ The tumor invades muscularis propia. There are perirectal spiculations at .... O'clock position which overally favours a T2/early T3 lesion. Please mention if you favour these speculations to represent desmoplastic reaction.
□ The tumor extends ...mm (should be < 1 mm) beyond muscularis propria representing a T3a lesion .
□ The tumor extends ...mm (should be ≥ 1-5 mm) beyond muscularis propria representing a T3b lesion.
□ The tumor extends ...mm (should be >5-15mm) beyond muscularis propria representing a T3c lesion.
□ The tumor extends ...mm (should be > 15mm) beyond muscularis propria representing a T3d lesion.
□ The tumor involves peritoneal reflection (T4A) or other organs consistent with T4 lesion.

ii) If low rectal tumors please use following for T category:
□There is no definite involvement of internal sphincter in keeping with T1 lesion. (confined to submucosa)
□The tumor is confined to the internal sphincter and does not extend to intersphincteric plane/fat representing a T2 lesion.
□The tumor invades intersphincteric plane/fat or lies within 1mm of levator in keeping with a T3 lesion.
□The tumor invades external anal sphincters and infiltrates beyond levator/ invasion to adjacent organs representing a stage 4 lesion.

5. DISTANCE TO THE MRF AND EXTRAMURAL DEPTH OF INVASION (EMD) (please mention only in T3 tumours)
Shortest distance of the definitive tumor border to the MRF is___ mm
□There are tumour spiculations closer to the MRF on .... O'clock position, measuring .... mm to MRF.

6. EXTRAMURAL VASCULAR INVASION (EMVI)
EMVI is □ Absent □Present.

7. MESORECTAL LYMPH NODES
□There is no suspicious mesorectal lymph node.
□There is/are suspicious mesorectal lymph nodes.
(suspicious = irregular border, mixed signal intensity and/or > 5 mm)
*If yes: (please complete following)
□Shortest distance of suspicious mesorectal lymph node to MRF is ___mm.
□ The suspicious/abnormal lymph node is at/above/below level of tumor at ____ o'clock position.
(N0: No metastatic lymph node. N1: 1-3 perirectal nodes. N2 Metastasis in 4 or more perirectal nodes)
(Pelvic side wall and inguinal lymph nodes are M1)

8. EXTRAMESORECTAL LYMPH NODES
Please describe any extramesorectal abnormal or suspicious lymph node. (suspicious = irregular border, mixed signal intensity and/or > 1 cm)

9.OTHER FINDINGS

IMPRESSION:
Please provide brief description of location, T staging and nodal status.

Post CRT MRI assessment

- Accuracy average falls from 85 to 50%.
- T2 signal change and use it for tumor regression grading (TRG1-5).
- Tumor volume measurement. (>70% reduction)
  - *Barbaro B, Radiology 2009;250(3):730–739*
  - *Nougaret S, Radiology 2012;263(2): 409–418.*
- DWI sequence.

Summary

- Optimal rectal cancer treatment mandates a multidisciplinary approach.
- Tumor morphology and distance to anal verge and puburectalis.
- T sub-staging.
- CRM and EMVI.
- N and M staging.
- For low rectal cancer: Inter-sphincteric invasion for TME or extended surgery planning.