Rectal MRI: how to do it and what is it for?

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Learning objectives

- To comment the role of new MR techniques in rectal cancer staging.
- To describe how imaging is used to guide surgical and radiation planning.
- To use a structured report to accurately assess what clinicians need to know from radiologists in rectal cancer staging.
- To discuss the pitfalls in interpretation of images.
Background

Optimal treatment of rectal cancer involves a multidisciplinary approach and requires collaboration between radiologists, oncologists, surgeons and pathologists to achieve an optimal result and decrease the rate of recurrence.

Magnetic Resonance Imaging (MRI) imaging has an important role in accurately staging rectal cancer for a correct surgical and radiation planning.
Findings and procedure details

We review patients with rectal cancer in the last 3 years that have preoperative MRI, correlating their findings with data provided by colonoscopy and pathology reports of surgical specimen.

MRI technique is described, including diffusion weighted imaging (DWI) for location of tumor, avoiding administration of cleansing enemas.

We specify the criteria to consider in assessing preoperative staging:

**MR IMAGING TECHNIQUE:**

Our imaging protocol performed has the following sequences:

**SHORT AXIS OBLIQUE (AXIAL TSE) T2 SEQUENCE:** The main pulse sequence is a thin-section (3-mm) T2-weighted fast spin-echo sequence performed in a plane orthogonal to tumor. With this sequence it is possible to precisely evaluate the tumor and its relationship to intestinal wall, mesorectal fascia, and pelvic organs. Indeed, an incorrect plane of acquisition could lead to an incorrect volume average of muscularis propria and may lead to overstaging. Placement of the orthogonal plane is based on the tumor location on the sagittal T2-weighted images.

**CORONAL (TSE) T2 SEQUENCE:** For patients with low rectal cancers, high-spatial-resolution T2-weighted fast spin-echo coronal imaging is added to optimally depict the levator muscles, the sphincter complex, the intersphincteric plane, and the relationship to the rectal wall.

**SAGITTAL T2 (TSE) SEQUENCE:** With this sequence it is possible to evaluate the tumor location, its height from anal verge and the relationship to peritoneal reflection. (Image 1)

**DIFFUSION-WEIGHTED (DW) IMAGING:** DW imaging does not have sufficient resolution to determine the precise depth of extramural spread nor sufficient sensitivity and specificity to improve nodal staging. However, DW imaging can be helpful in detection of extramural venous invasion, in localization of lymph nodes, and in response assessment after chemotherapy and radiation therapy. We can combine a diffusion sequence centered in the area for location of tumor with a whole body diffusion acquisition with several stations and subsequent pasting for distant staging (Image 2).

**ADDITIONAL SEQUENCES:** T1 TSE STIR AXIAL. Primarily for assessment of regional or distant involvement (lymph nodes, bone metastases, etc).
DISTANCE FROM INFERIOR PART OF TUMOR TO TRANSITIONAL SKIN

The level of the tumor is given from the anal verge (distal end of the anal canal, forming a transitional zone between the skin of the anal canal and the perianal skin) because this is a useful reference point for surgeons. It is measured from the most caudal aspect of the raised edge of the tumor to the anal verge. Traditionally the rectum has been divided into thirds since outcomes and surgical management are affected by tumor location (Image 3).

**Upper.** - The lowest edge of the tumor is more than 10 cm from the anal verge. The anterior wall of the upper rectum is covered by the peritoneal reflection; the risk of peritoneal perforation in upper rectal tumors is high, and a warning to the surgeon will enable careful dissection to minimize the risk of tumor spillage. Moreover, the point of peritoneal reflection attachment occurs at a variable height, particularly in women, and can be as low as 5 cm from the anal verge. Careful assessment of the peritoneal reflection must be performed in upper rectal tumors (Image 4).

**Middle.** - The lowest edge of the tumor is located between 5 and 10 cm from the anal verge. This segment of the rectum, which lies below the peritoneal reflection, is completely encircled by mesorectum and will therefore be suitable for total mesorectal excision. The surgical margins will be formed by the mesorectal fascia; this is the plane of dissection in total mesorectal excision surgery.

**Lower.** - The lowest edge of the tumor is less than 5 cm from the anal verge. At this level, the mesorectum tapers sharply. Anteriorly the mesorectal fascia fuses with the remnant of the urogenital septum. This is a dense fascia band (rectoprostatic fascia in the male; rectovaginal septum in the female). The anorectal junction is held forward by the puborectal sling. At the anorectal junction, the muscularis propria of the rectum changes: The circular layer thickens and becomes the internal sphincter. The external sphincter complex is composed of the most inferior part of the levator ani muscle, the puborectalis sling, and the external sphincter muscles. Submucosal apposition of the two sphincters in the lower anal canal gives rise to palpable intersphincteric groove (Image 5).

**T STAGING (Image 6)**

- **Tx:** Primary tumor can not be assessed
- **T0:** No evidence of primary tumor
- T1: Tumor invades submucosa but does not extend into circular muscle layer.
- T2: Tumor invades but does not penetrate muscularis propria.
- T3: Tumor invades subserosa through muscularis propria.
- T3a: Tumor extends <1 mm beyond muscularis propria
- T3b: Tumor extends 1-5 mm beyond muscularis propria.
- T3c: Tumor extends 5-15 mm beyond muscularis propria.
- T3d: Tumor extends >15 mm beyond muscularis propria.
- T4: Tumor invades:
  - T4a: peritoneal reflection
  - T4b: other organs (Image 7) (Image 8) (Image 9).

DISTANCE AND POSSIBLE INVOLVEMENT OF ANAL COMPLEX SPHINCTERS

Low rectal tumors are associated with higher rates of positive resection margins, higher local recurrence rates, and poorer survival. Pretreatment MR imaging must be able to allow us to define the location of the tumor relative to the sphincter complex to propose which patients need to receive Conformal Radiation Therapy (CRT) before surgery. For MR imaging of early stage tumors with safe radial and distal margins, primary surgery and avoidance of irradiating the sphincter results in better postoperative sphincter function and lower rates of anastomotic breakdown. Preoperative CRT in locally advanced low rectal tumors has been shown to increase the sphincter preservation rate and disease-free survival. This allows a tumor that previously would have required an abdominoperineal excision would be excised by means of ultra-low resection and coloanal anastomosis (Image 10) (Image 11).

NODAL STAGING (N)

Exact nodal staging is important because the number of metastatic nodes has been shown to affect the prognosis. Determining the presence of nodal involvement on MR images has traditionally relied on size assessment. However, there is considerable overlap in size between normal, reactive, and metastatic lymph nodes. Moreover, micrometastasis in normal-sized lymph nodes is common. Therefore, size is not advocated as a reliable way of assessing whether lymph nodes harbor tumor. Criteria based on the shape, border, and signal intensity characteristics have been shown to be more reliable (Image 12) (Image 13).
The following are diagnostic clues at the workstation for nodal staging:

1. Uniform nodes smaller than 10 mm with homogeneous signal intensity are not suspicious.

2. Nodes with irregular borders, mixed signal intensity, or both are considered to be suspicious.

3. Presence of one to three suspicious nodes is stage N1 and presence of four or more is stage N2.

4. Any lymph node lying within 1 mm of the CRM must be reported because it is highly suspicious of circumferential resection margin involvement.

5. Recording the location and size of any suspicious pelvic sidewall lymph nodes is critical. This will inform the radiation therapy team to change and adjust the radiation therapy field. Secondly, the surgeon will need to perform an extended lymph node resection with additional removal of the internal iliac nodes.

CIRCUMFERENCIAL RESECTION MARGIN

Mesorectal fascia is seen as a fine low-signal-intensity layer enveloping perirectal fat and rectum and represents the surgical excision plane in total mesorectal excision anterior resections. Circumferential resection margin involvement is an important independent prognostic factor for local recurrence and poor survival.

The following are diagnostic clues at the workstation for a positive circumferential resection margin:

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

- Positive margins can be due to tumor deposits, main tumor extension, extramural vascular invasion, or suspicious lymph nodes (Image 14) (Image 15) (Image 16).

EXTRAMURAL VASCULAR INVASION

By definition, extramural vascular invasion must be associated with tumors that are at least category T3. Whenever the tumor is seen to lie close to a vessel, the radiologist should consider the possibility of extramural vascular invasión.

Signs suggestive for extramural vascular invasion are presence of tumor signal intensity within a vascular structure, expanded vessels, and tumoral expansion through and beyond the vessel wall, disrupting the vessel border.
Fig. 1: Sagittal T2-weighted image: measurement of tumor, distance to sphincter complex and anal margin.

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Fig. 2: Sagittal TSE T2 and diffusion weighted imaging (DWI)

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Fig. 3: Sagittal T2-weighted image in a patient with rectal carcinoma show distance (red line) from the anal verge (yellow line).

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Fig. 4: Sagittal T2-weighted image in a patient with upper rectal tumor. Arrows outline peritoneal reflection.

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**Fig. 5:** Sagittal T2-weighted image in a patient with lower tumor, the lowest edge of the tumor is less than 5 cm from the anal verge (yellow arrow).

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Fig. 6: T staging.

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**Fig. 7:** Tumor invades the bladder

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Fig. 8: Tumor invades cervix.

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Fig. 9: Left: Axial T2-weighted image in a patient with infiltration of cervix. Right: STIR sequence in the same patient.

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Fig. 10: Sagittal T2-weighted image. Tumor invades internal anal sphincter.

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**Fig. 11:** Left: Axial T2-weighted image in a patient with tumor that invades internal anal sphincter. Right: STIR sequence in the same patient showing high signal intensity strands in anal complex sphincters.

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Fig. 12: Axial T2-weighted image with heterogeneous signal intensity of a lymph node.

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Fig. 13: Axial T2-weighted image with heterogeneous signal intensity of a lymph node.

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Fig. 14: Axial T2-weighted image showing distance to the mesorectal fascia.

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**Fig. 15:** Axial T2-weighted image showing mesorectal fascia involvement.

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**Fig. 16:** Coronal T2-weighted image showing mesorrectal fascia involvement.

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Conclusion

MRI is now an indispensable tool for the multidisciplinary approach of patient with rectal cancer, providing relevant information for planning and appropriate treatment. It is crucial to perform a technically correct MRI study aimed to assessing the key points to consider for local staging of tumor and being familiar with the keys that allow us a correct interpretation of the images obtained.
References


