

Role of MRI for Staging Rectal Cancer

- High-resolution MRI has supplanted endoscopic ultrasound for staging rectal cancer.
- High-resolution MR images closely match histology and can show details such as clear resection margin, infiltration of the vasculature and/or adjacent structures, and suspicious nodes.
- MRI can provide prognostic and predictive information and is useful for guiding rectal cancer treatment.
- If the patient is treated with neoadjuvant therapy, MRI is strongly recommended for restaging rectal cancer before deciding on subsequent treatment.

Accurate staging of rectal cancer is critical for attaining the best possible outcome for patients and minimizing the debilitating side effects of treatment. Up until a few years ago, endoscopic ultrasound was the standard imaging method for evaluating rectal cancer. However, endoscopic ultrasound is limited in its ability to evaluate tumor extension into the mesorectal fat, fascia, or adjacent organs. It is also difficult to perform in stenosing and high rectal tumors and is uncomfortable for the patient.

The advent of multichannel, phased-array coils and high-resolution MRI techniques has ushered in a new era. This method is not only more comfortable for patients, but it also yields high-quality images that closely correspond to histological sections. To evaluate the extent of the tumor, T2 MRI sequences acquire thin slices in sagittal, oblique axial, and oblique coronal planes, followed by very high-resolution stacks of images that follow the contour of the rectum and are perpendicular to the plane of the tumor. In these images (Figure 1), each layer of the rectum has a distinct appearance with contrasting intensity and clear boundaries. These high-quality images differ substantially from older generation MR images in which the layers of the bowel are not clearly differentiated and the thin rim of the mesorectal fascia, which defines traditional surgical planes, is not clearly identified.

T2 MRI sequences can also identify other concerning features, including invasion of the tumor into blood vessels and suspicious lymph nodes, which are recognizable not from their size but from the unevenness of their margins. Clinical studies have shown that the prognosis of findings of blood-vessel invasion is more concerning than that for suspicious nodes.

The value of these MR images has been investigated in several clinical trials. For example, the Magnetic Resonance Imaging and Rectal Cancer European Equivalence (MERCURY) study showed that high-resolution rectal MRI could identify those patients with high-risk rectal cancer in a reproducible manner and accurately predict both the

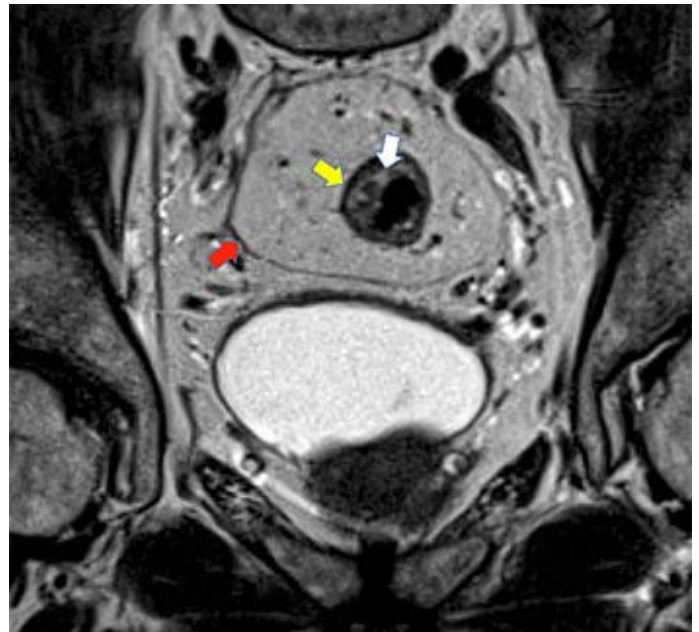


Figure 1. Coronal T2-weighted images showing rectal and mesorectal anatomy. The mesorectal fascia (red arrow) is seen as a dark line surrounding the mesorectal fat. The inner hyperintense ring (white arrow) in the rectal wall represents the mucosa and submucosa whereas the muscularis is seen as a dark ring (yellow arrow).

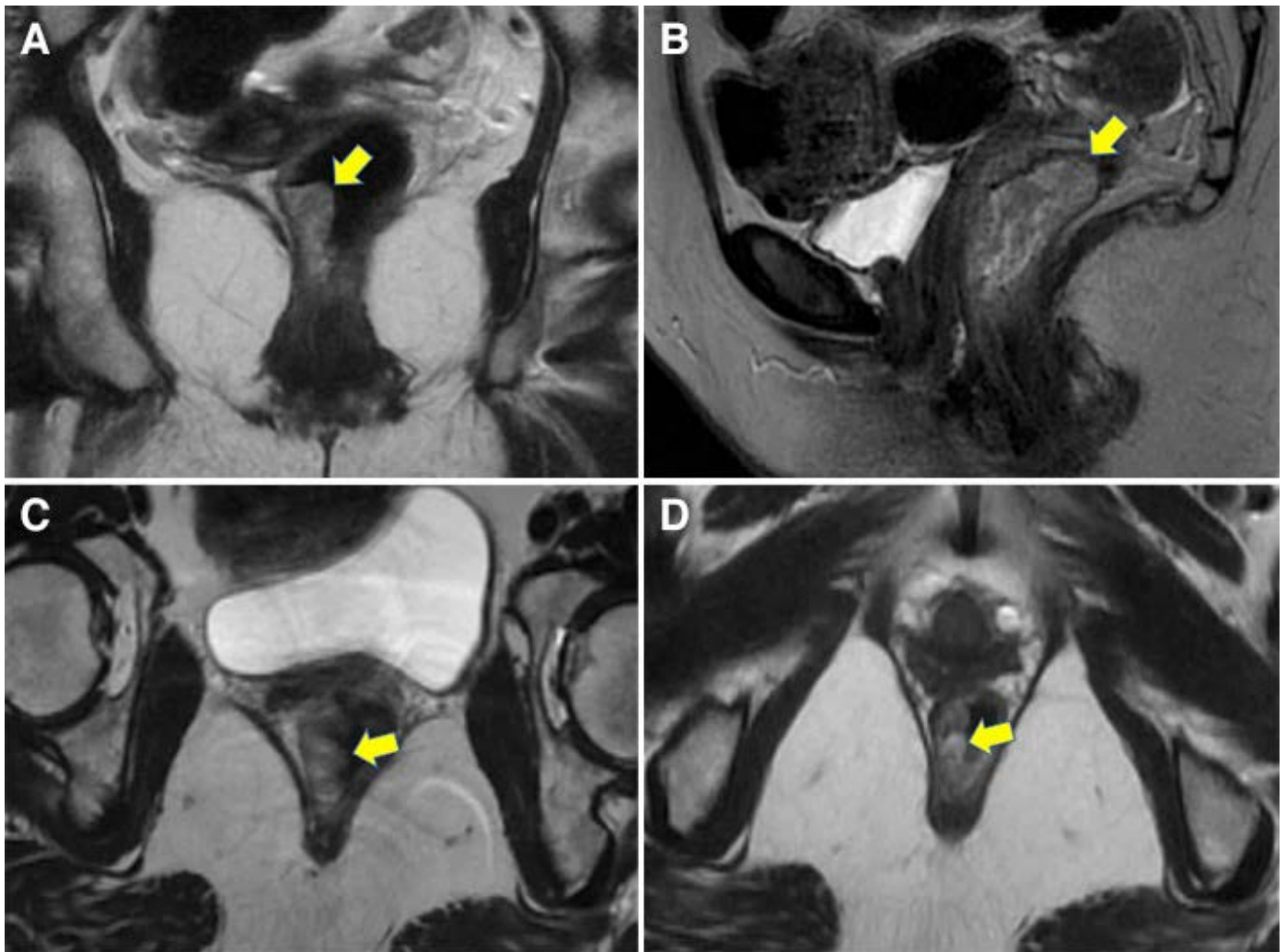


Figure 2. Multiplanar T2-weighted images showing a low rectal tumor (arrows) at the level of the levators and confined to the rectal wall.

involvement of the surgical resection margin and the depth of extramural spread. This finding has led to the routine (and for many countries mandatory) use of high-resolution rectal MRI for the preoperative assessment of patients. Such imaging is crucial to ensure the appropriate selection of patients for neoadjuvant therapy and for sphincter-preserving surgery. Moreover, accurate staging is predictive of local and distant recurrence and aids in considering treatment benefit versus morbidity. Thus, individualized therapy can be tailored to each patient.

Clinical Examples

The Figure 2 shows a palpable tumor that involves the top of the internal anal sphincter and is confined to the rectal wall. Without high-resolution MRI, surgeons would likely advise an abdominoperineal resection of the rectum and anus. However, because the MR images show a safe surgical plane between the internal and external sphincter, the patient is a candidate for an intersphincteric low anterior total mesorectal excision (TME) to remove a section of the rectum and the surrounding mesorectal envelope. With this treatment, the patient retains intestinal continuity and a much greater quality of life than after more extensive surgery.

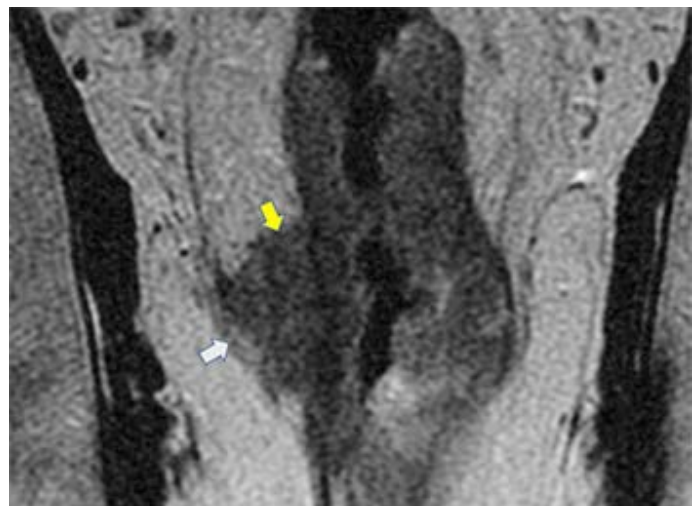


Figure 3. Coronal T2-weighted MRI showing a low rectal tumor (yellow arrow) extending into mesorectal fat and abutting the mesorectal fascia (white arrow) à Circumferential resection margin (CRM) positive.

In the example in Figure 3, MRI shows a tumor that extends into the mesorectal fat and abuts the mesorectal fascia, indicating that the tumor cannot be removed by surgery alone. This patient must first undergo chemotherapy and radiation to shrink the tumor, after which MRI is repeated to determine if the tumor still involved the mesorectal fascia. If so, resection would take place in the extra TME plane, and surgery would be accompanied by intraoperative radiation to the threatened margin to decrease the risk of leaving live cancer cells behind. The results of this MRI also make clear that open surgery is necessary, not laparoscopic surgery, because the surgical plane is non-existent.

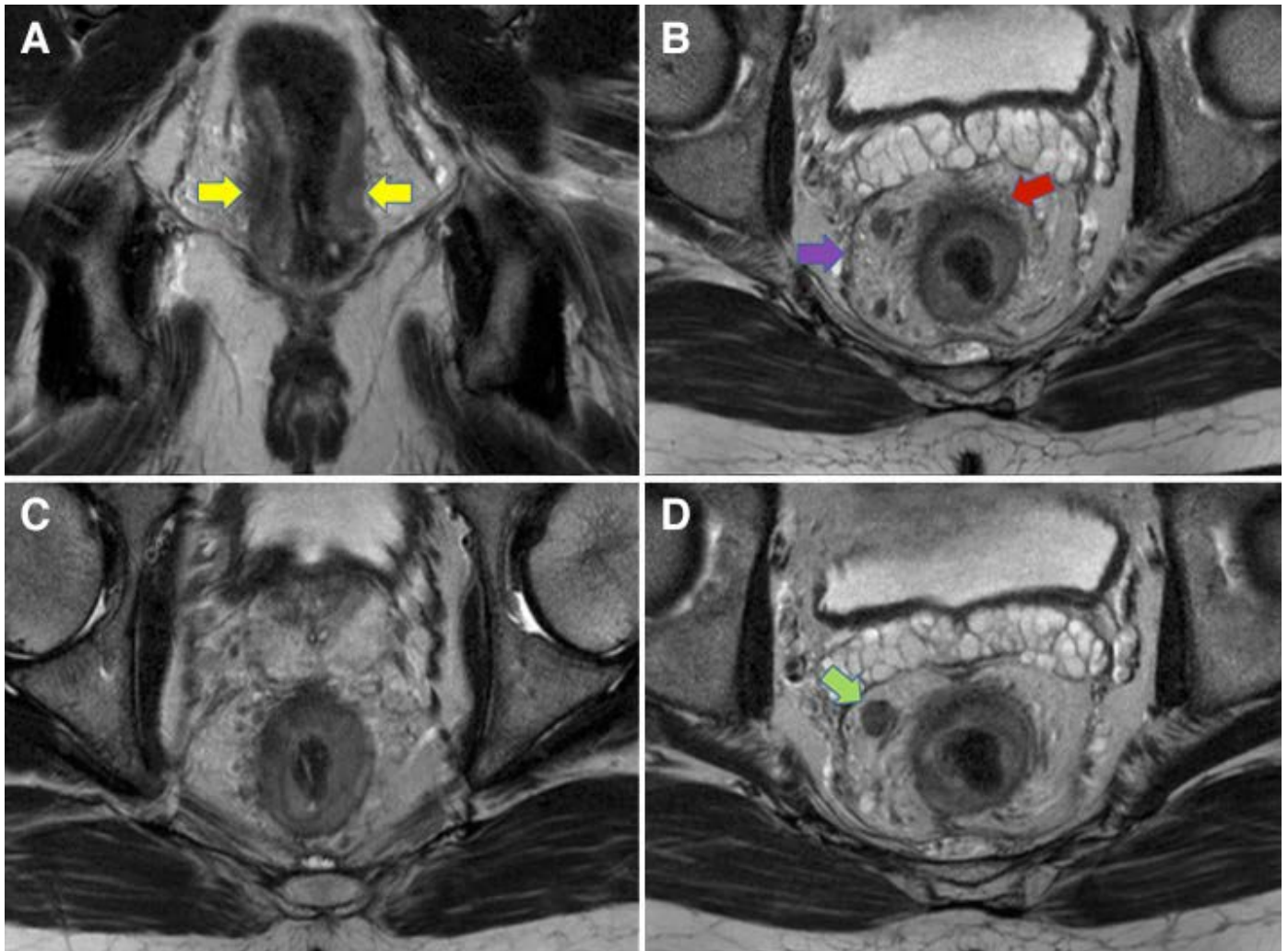


Figure 4. Multiplanar T2-weighted MRI showing a low rectal tumor (yellow arrows, A) with extension beyond the rectal wall (red arrow, B). MRI also shows enlarged, heterogeneous and ill-defined perirectal node (green arrow, D), seen in mesorectal fat, which is surrounded by the mesorectal fascia (purple arrow, B).

In other cases, the tumor may be large but the surgical margins appear safe (Figure 4). This patient can potentially be spared radiation and its side effects and instead only receive chemotherapy prior to a laparoscopic or robotic procedure. Before high-resolution MRI, the tumors shown in Figures 3 and 4 could not be differentiated, and both patients would have received radiation and chemotherapy prior to surgery.

In Figure 5, high-resolution MRI shows extramural venous invasion (EMVI), a predictor of metastatic disease, as well as a metastatic mesorectal lymph node. Patients such as this one need more aggressive treatment, starting with 4-6 months of chemotherapy followed by chemoradiation. Surgery follows completion of neoadjuvant therapy. In this case, the surgical margins are safe, and surgery can either be open or laparoscopic.

Figure 6 shows a locally advanced tumor that has invaded the prostate gland. Such patients are first treated with chemoradiation, and then a repeat MRI is performed. Advances in technique now allow radiologists to read post-radiation images to reliably predict whether the tumor is gone or not. If the tumor is no longer visible, the patient would receive an open low anterior resection and restoration of intestinal continuity. However, if the tumor does not shrink, the patient would receive more chemotherapy to give radiation more time to work, followed by repeat

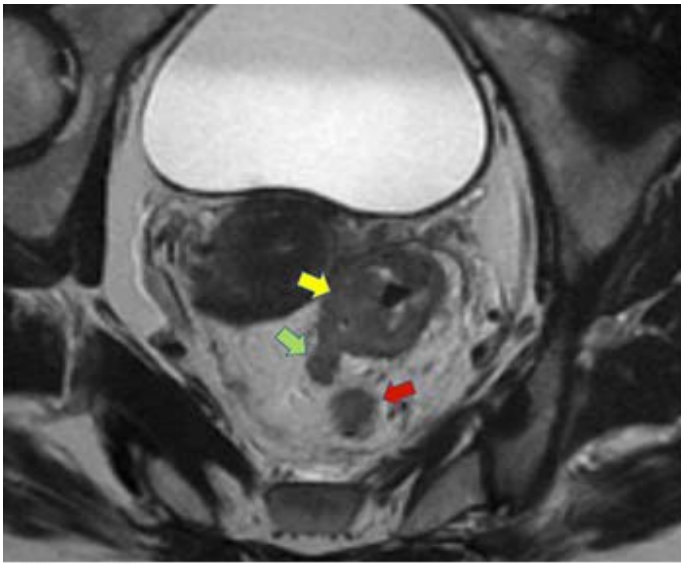


Figure 5

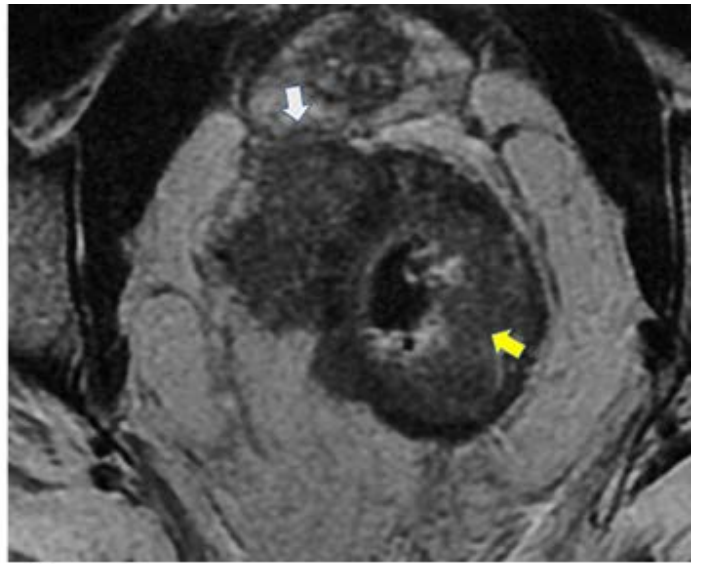


Figure 6

Figure 5. Axial T2-weighted MRI showing a mid-rectal tumor (yellow arrow) with a metastatic mesorectal lymph node (red arrow). Also note extension of tumor into a perirectal vein (green arrow) indicative of EMVI.

Figure 6. Axial T2-weighted MRI showing a mid-rectal tumor (yellow arrow) invading the prostate gland (white arrow).

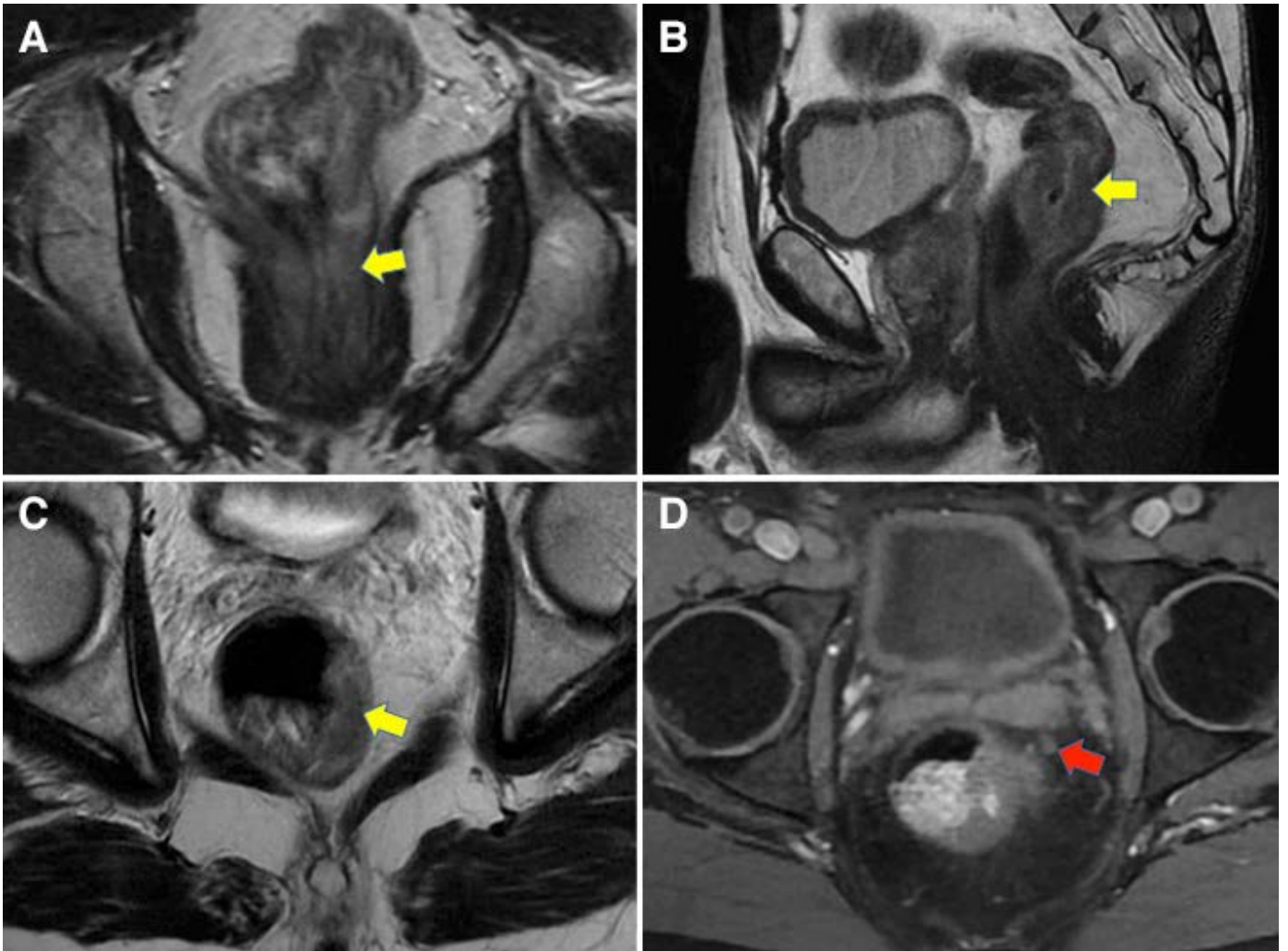


Figure 7. Multiplanar T2-weighted and T1-weighted images showing a low rectal tumor (yellow arrows, A) confined to the rectal wall. There is a suspicious node (red arrow) seen anterior to the primary tumor.

imaging. Only at this time, if the tumor has shrunk, can the patient have an open low anterior resection and restoration of intestinal continuity. However, if the tumor has not shrunk, treatment would require an anterior exenteration, removing the rectum, bladder, and prostate. With this approach, patients have a reasonable quality of life as a result of a radical yet curative surgery.

In Figure 7, high-resolution MRI shows that a patient had a T2 tumor and a suspicious mesorectal lymph node but that the tumor had not extended past the muscularis. Thus, surgery can be performed without shrinking the tumor. Consequently, the patient only underwent a one-week short course of radiation treatment (instead of a full course of 5.5 weeks). Previously, all patients with radiographically suspicious mesenteric nodes, such as the one in Figure 7, underwent 5.5 weeks of radiation followed by 6 months of chemotherapy after surgery. Now, with high-resolution MRI staging, post-operative chemotherapy is only offered to patients with a histologically confirmed node, avoiding unnecessary and onerous therapy. In this case, metastasis to the lymph node was confirmed on pathology, and the patient received post-operative chemotherapy.

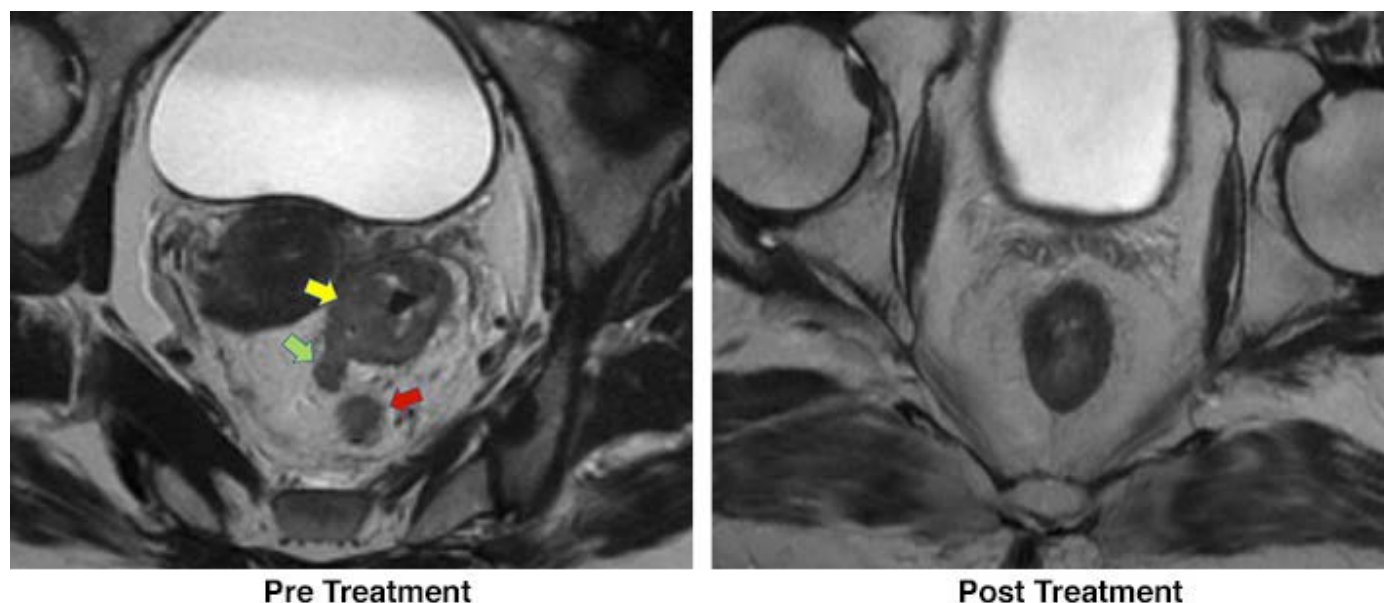


Figure 8. Axial T2-weighted images showing circumferential rectal tumor (yellow arrow) before and after neoadjuvant chemoradiation therapy. No tumor is visible post-treatment, which will alter treatment decisions.

Figure 8 illustrates the importance of repeat MR imaging after neoadjuvant therapy. In this patient, imaging shows that the response to chemoradiation was complete. As a result, the patient could be placed on a watch-and-wait experimental trial protocol and was spared surgery.

Scheduling

High-resolution MRI is performed on the main campus of Massachusetts General Hospital in Boston and at outpatient locations in Waltham, MA and Chelsea, MA. Appointments can be made through Epic (inside the Partners network) or [Physician Gateway](#) (outside the Partners network) or by calling 617-724-XRAY.

Further Information

Massachusetts General Hospital is a participant in the Consortium for Optimizing the Treatment of Rectal Cancer ([OSTRiCh](#)) and is on the forefront of developing modern algorithms for high-resolution MRI staging for rectal cancer. Mass General physicians together with Gina Brown, MD, Royal Marsden Hospital, London, offer [continuing medical education](#) workshops to surgeons, radiologists, pathologists, and oncologists on MRI for rectal cancer staging and multidisciplinary treatment of rectal cancer.

For further information on MRI staging of patients with rectal cancer, please contact Mukesh Harisinghani, MD, Division of Abdominal Radiology, Department of Radiology, Massachusetts General Hospital, at 617-643-2009. For further information on treatment options for rectal cancer, please contact [Liliana Bordeianou, MD](#), Director, MGH Colorectal Surgery Center, or [Hiroko Kunitake, MD](#), Department of Surgery, Massachusetts General Hospital.

We would like to thank Mukesh Harisinghani, MD, Liliana Bordeianou, MD, Hiroko Kunitake, MD, and Vikram Deshpande, MD, Department of Pathology, Massachusetts General Hospital, for their advice and assistance in preparing this article.

References

- Battersby NJ, Moran B, Yu S, et al. (2014). *MR imaging for rectal cancer: the role in staging the primary and response to neoadjuvant therapy*. *Expert Rev Gastroenterol Hepatol* **8**:703-19.
- Bordeianou L, Maguire LM, Alavi K, et al. (2014). *Sphincter-Sparing Surgery in Patients with Low-Lying Rectal Cancer: Techniques, Oncologic Outcomes, and Functional Results*. *J Gastrointest Surg* DOI 10.1007/s11605-014-2528-y.
- Chand M, Swift RI, Chau I, et al. (2014). *Adjuvant therapy decisions based on magnetic resonance imaging of extramural venous invasion and other prognostic factors in colorectal cancer*. *Ann R Coll Surg Engl* **96**:543-6.
- Chand M, Swift RI, Tekkis PP, et al. (2014). *Extramural venous invasion is a potential imaging predictive biomarker of neoadjuvant treatment in rectal cancer*. *Br J Cancer* **110**:19-25.
- Patel UB, Taylor F, Blomqvist L, et al. (2011). *Magnetic resonance imaging-detected tumor response for locally advanced rectal cancer predicts survival outcomes: MERCURY experience*. *J Clin Oncol* **29**:3753-60.
- Taylor FG, Quirke P, Heald RJ, et al. (2014). *Preoperative magnetic resonance imaging assessment of circumferential resection margin predicts disease-free survival and local recurrence: 5-year follow-up results of the MERCURY study*. *J Clin Oncol* **32**:34-43.
- Wale A and Brown G (2014). *A practical review of the performance and interpretation of staging magnetic resonance imaging for rectal cancer*. *Top Magn Reson Imaging* **23**:213-23.
- Yu SK, Tait D, Chau I, et al. (2013). *MRI predictive factors for tumor response in rectal cancer following neoadjuvant chemoradiation therapy--implications for induction chemotherapy?* *Int J Radiat Oncol Biol Phys* **87**:505-11.

©2017 MGH Department of Radiology

Janet Cochrane Miller, D. Phil., Author
Raul N. Uppot, M.D., Editor

