

Preoperative Staging of Rectal Cancer with MR Imaging: Correlation with Surgical and Histopathologic Findings¹

TEACHING POINTS

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Rectal cancer is a common malignancy that continues to have a highly variable outcome, with local pelvic recurrence after surgical resection usually leading to incurable disease. The success of tumor excision depends largely upon accurate tumor staging and appropriate surgical technique, although the results of recent surgical trials indicate that evaluation of the involvement of the mesorectal fat and mesorectal fascia is even more important than T staging for treatment planning.

Magnetic resonance (MR) imaging is increasingly being used to evaluate tumor resectability in patients with rectal cancer and to determine which patients can be treated with surgery alone and which will require radiation therapy to promote tumor regression. High-spatial-resolution MR imaging has proved useful in clarifying the relationship between a tumor and the mesorectal fascia, which represents the circumferential resection margin at total mesorectal excision. Phased-array surface coil MR imaging in particular plays a vital role in the therapeutic management of rectal cancer. At present, phased-array MR imaging best fulfills the clinical requirements for preoperative staging of rectal cancer. However, preoperative evaluation of the other prognostic factor, nodal status, is still problematic, and further studies will be needed to better define the role of MR imaging in this context.

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Abbreviations: CRM = circumferential resection margin, H-E = hematoxylin-eosin, TME = total mesorectal excision

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Introduction

Rectal cancer is a common disease with a high rate of mortality in Western countries. Many improvements have been made over the past 20 years in the surgical, radiologic, and oncologic treatment of rectal cancer. However, this neoplasm remains associated with a poor prognosis owing to the high risk of metastases and local recurrence. After surgical treatment, local recurrence rates for rectal cancer can vary from 3% to 32% (1–5).

Total mesorectal excision (TME) involves resection of both the tumor and the surrounding mesorectal fat. At present, TME is the surgical treatment of choice for rectal cancer, being associated with a recurrence rate of less than 10% when used as a single-modality therapy (6). The introduction of this surgical technique reduced the mortality rate associated with rectal cancer from 16% to 9% in one study (7).

In selected patients with involvement of the mesorectal fascia at the time of diagnosis, the use of preoperative radiation therapy is advocated and has been shown to reduce the recurrence rate from 8.2% to 2.4% at 2 years (6,8). This therapeutic approach demands accurate preoperative tumor staging—namely, detection of rectal carcinoma infiltration into the mesorectal fat, involvement of the mesorectal fascia, and nodal involvement.

The goal of imaging in rectal cancer is to stratify cases on the basis of the risks of recurrence by means of accurate evaluation of the T staging. At present, there is no consensus on the role of diagnostic imaging (endorectal ultrasonography [US], computed tomography, and magnetic resonance [MR] imaging) in the preoperative T staging of rectal cancer.

In this article, we discuss the diagnosis, management, and treatment of rectal cancer and review the normal rectal anatomy. We also discuss and illustrate the correlation of MR imaging findings with pathologic findings in rectal cancer and the clinical impact of MR imaging in this setting.

Histologic Criteria* for T Staging of Rectal Cancer

Tumor Stage	Criterion
T1	Tumor invades the submucosa
T2	Tumor invades the muscularis propria
T3	Tumor penetrates the muscularis propria and invades the subserosa or nonperitonealized perirectal tissue
T4	Tumor directly invades other organs or structures

*2003 criteria from the International Union Against Cancer.

Rectal Cancer

Rectal cancer is one of the most common tumors in industrialized countries (40 cases in every 100,000 individuals) and one of the most common malignant tumors of the gastrointestinal tract (9). Rectal cancer has a slight male predilection, and its prevalence increases steadily after the age of 50 years. **Adenocarcinomas account for the vast majority (98%) of rectal cancers** and are the focus of this article. Other rectal tumors are relatively rare and include carcinoid tumors (0.1% of cases), lymphoma (1.3%), and gastrointestinal stromal tumors (<1%).

Imaging plays a crucial role in the preoperative management of rectal carcinoma. Indeed, the diagnosis of rectal cancer is usually made on the basis of a rectal digital examination, sigmoidoscopy or colonoscopy, a double contrast enema examination, and confirmatory histologic findings (10). However, these approaches do not adequately show the depth of tumor spread or the extent of lymph node involvement, both of which are important prognostic features (11–15). **Preoperative staging techniques for rectal cancer should allow identification of (a) patients with extrarectal spread, who might benefit from preoperative radiation therapy; and (b) patients with minimal or no sphincter involvement, who might be suitable for sphincter-sparing surgery.**

For optimal patient outcome, it is crucial to stratify cases into those in which patients can benefit from local therapy (eg, transanal local

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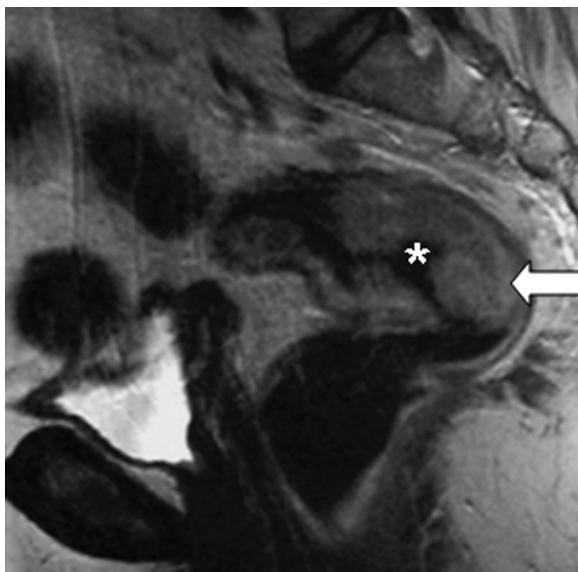


Figure 1. Rectal adenocarcinoma. Sagittal turbo spin-echo T2-weighted MR image obtained with a high-resolution phased-array surface coil shows a stenosing lesion (arrow) of the rectal lumen (*). This lesion is outside the potential field of view of endorectal US and endorectal coil MR imaging.

excision, transanal endoscopic microsurgery)—usually patients with stage T1 cancers (16–19)—and those in which patients will require TME (mainly those with stage T2 and stage T3 tumors). There will also be patients with stage T4 tumors who will need a long course of preoperative (chemotherapeutic) radiation therapy, with the aim of downstaging the tumor (20,21). Histologic criteria for T staging are shown in the Table. In patients who are deemed suitable for TME, precise evaluation of mesorectal fascia involvement represents a second important step (22–24).

In recent years, the use of TME in treating rectal cancer has been emphasized. This technique consists of radical en bloc resection of the rectum along with the surrounding perirectal fat, which contains the regional lymph nodes. TME has been reported to reduce the local recurrence rate and improve the 5-year survival rate compared with conventional surgery (25).

MR Imaging Technique

Use of Coils

MR imaging of the rectum may be performed with either an endorectal coil or a phased-array surface coil. In terms of patient preparation, pulse sequences, and plane acquisition, the imaging protocols are identical.

Use of an endorectal coil yields high-resolution images that fully depict the wall layers of the bowels, although clear differentiation between the mucosa and submucosa is still difficult. The major drawback of endorectal coil MR imaging is difficulty in evaluating stenosing and high rectal carcinomas (26–28). Moreover, a complete assessment of the perirectal structures is rather difficult because portions of the mesorectal fascia, mesorectal fat, and lymph nodes lie outside the field of view, so that evaluation with endorectal coil MR imaging is comparable to that with transrectal sonography (29–34).

Rectal MR imaging with a phased-array surface coil yields high-spatial-resolution images, thereby providing a full evaluation of the rectal wall layers, and has the additional advantage of a large field of view. Moreover, the use of a phased-array surface coil improves patient comfort compared with the use of an endorectal coil. Finally, stenosing lesions and tumors at the rectosigmoid junction can be evaluated in all cases, and the mesorectal fat and mesorectal fascia can be visualized (Fig 1) (28).

Teaching Point

Imaging Protocol

Different techniques have been proposed for phased-array surface coil MR imaging of the rectum. To date, there is something of a consensus among radiologists with regard to optimal study technique. Rectal cleansing is suggested to limit image misinterpretation due to stool residues. However, some aspects of the study are still under

discussion, and distention of the rectal lumen is somewhat controversial. The rationale for such distention is improved evaluation of the rectal wall layers; however, in a study by Brown et al (35) with use of high-resolution thin-section MR imaging, optimal results were obtained without luminal distention.

The basic sequence protocols for MR imaging of the rectum have yet to be standardized. At present, there are two approaches: (*a*) use of T2-weighted sequences only, and (*b*) use of both T1 and T2-weighted sequences. With the latter, acquisition of contrast material-enhanced images is mandatory, although contrast-enhanced T1-weighted sequences have not been shown to be effective in the local staging of rectal cancer (5). To date, high-resolution T2-weighted imaging has been used in most studies (36), with images being obtained with a non-breath-hold turbo spin-echo sequence. This sequence features a high-resolution matrix, thin-section (3–5 mm) imaging, and a small (240–250-mm) field of view, resulting in an in-plane resolution of 0.8–1.0 mm. Images are usually acquired in the axial, coronal, and sagittal planes to better depict the length of the tumor and all three of its spatial dimensions. The use of fat-suppressed T2-weighted MR imaging has been advocated to improve visualization of tumor spread into the perirectal fat.

Although volume imaging with a short repetition time and short echo time can provide high-spatial-resolution images, the images do not allow differentiation between the tumors and the bowel wall layers due to their similar signal intensities.

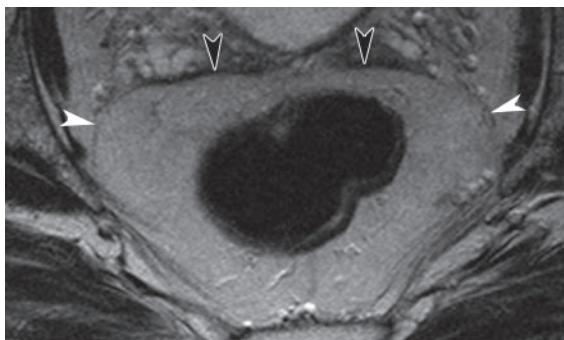
Normal Rectal Anatomy

The rectum is that part of the gastrointestinal tract that extends from the upper end of the anal canal to the rectosigmoid junction and is approximately 15 cm in length. Anatomically, the rectum can be divided into three segments: the lower third, the middle third, and the upper third. These segments correspond (measuring from the anal verge) to the first 7–10 cm, the next 4–5 cm, and the last 4–5 cm (Fig 2).



Figure 2. Coronal turbo spin-echo T2-weighted MR image shows the normal anatomy of the rectum. The white line indicates the lower limit of the rectum at the insertion of the levator ani muscle (arrows) on the rectal wall. The levator ani muscle forms the ceiling of the ischiorectal fossa.

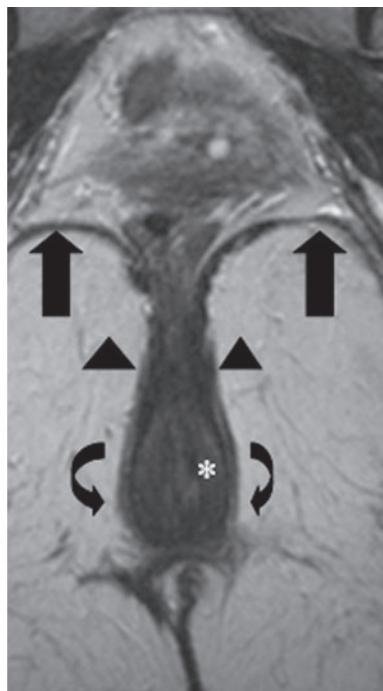
The lower end of the anal canal is characterized by the insertion of the levator ani muscle onto the rectal muscular layer (37). Recognition of the lower limits of the rectum is important because determining the distance between a neoplastic lesion and the levator ani muscle, which forms the ceiling of the ischiorectal fossa, is vital to surgical planning. The rectum is surrounded by fatty tissue that forms a structure known as the mesorectum. The mesorectum contains lymph nodes, vessels, and several fibrous septa and is surrounded by the mesorectal fascia, which represents the circumferential resection margin (CRM) when TME is used as the surgical approach. The rectal wall consists of three different layers that can be recognized at MR imaging (37,38). T2-weighted MR imaging sequences are the most suitable for depicting the rectal wall anatomy. MR imaging can help distinguish an inner hyperintense layer, which represents the mucosa and submucosa (no differentiation is possible between these two components); an intermediate hypoint-



3a.



3b.



4.

Figures 3, 4. (3) Normal anatomy of the mesorectum. (a) Axial turbo spin-echo T2-weighted MR image shows the mesorectal fascia as a thin, hypointense layer (white arrowheads) surrounding hyperintense mesorectal fat. On the anterior aspect, the mesorectal fascia appears more thickened and is difficult to differentiate from the Denonvillier fascia (black arrowheads). (b) Photograph of a section of the explanted rectum shows perirectal fat surrounded by the mesorectal fascia. (4) Coronal turbo spin-echo T2-weighted MR image obtained with a phased-array surface coil shows a normal anal sphincter complex. The levator ani muscle (straight arrows) appears as a funnel-shaped muscular layer that extends from the obturator ani muscle to the anal canal. The puborectalis muscle (arrowheads) is depicted at the insertion of the levator ani muscle onto the anal canal. The external (curved arrows) and internal (*) sphincter muscles are also seen.

tense layer, which represents the muscularis propria; and an outer hyperintense layer, which represents the perirectal fat tissue. The mesorectal fascia can also be identified as a thin, low-signal-intensity structure that envelops the mesorectum and the surrounding perirectal fat. The mesorectal fascia is clearly visible on the posterolateral view, although it is difficult to differentiate this entity from the Denonvillier fascia in the anterior wall (Fig 3) (37).

The anal canal is also visualized during MR imaging of the lower rectum. Even if the spatial resolution is low compared with endoanal coil imaging (39), all of the major anatomic structures (levator ani muscle, puborectal muscle, internal

and external anal sphincters, anal canal) can easily be evaluated with a phased-array surface coil (Fig 4). Indeed, phased-array surface coil MR imaging allows optimal visualization of the anal sphincter complex. The anal canal is seen as a cylindric structure that extends from the insertion of the levator ani muscle onto the rectum to the external anal margin. The most important component of the anal sphincter complex is the puborectal muscle. This muscle inserts into the funnel-shaped levator ani muscle, which in turn anchors the sphincter complex to the internal portion of the pelvis.

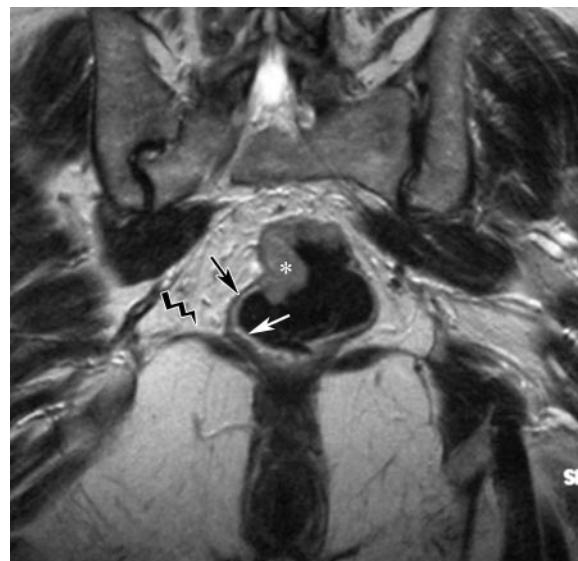


Figure 5. Rectal carcinoma. Coronal turbo spin-echo T2-weighted MR image shows a stage T1 tumor (*) of the rectum. The tumor has an intermediate signal intensity between the high signal intensity of the fat tissue (jagged line) and the low signal intensity of the muscular layer (black arrow). The inner layer of the rectal wall (white arrow) consists of mucosal and submucosal layers and has a high signal intensity.

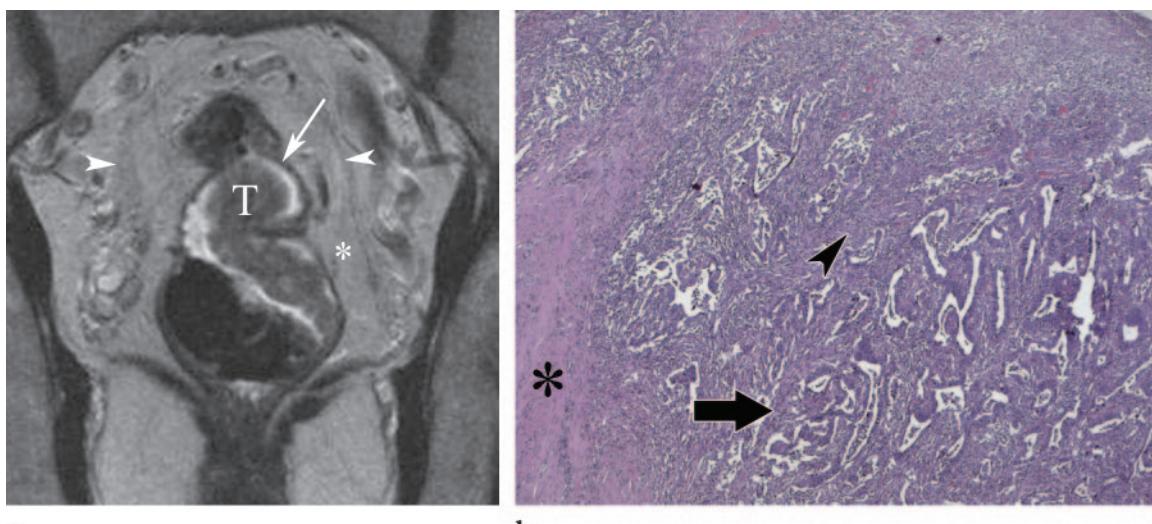


Figure 6. Stage T1 rectal carcinoma. (a) Coronal turbo spin-echo T2-weighted MR image shows a huge pedunculated tumor (T) on the left lateral rectal wall. The integrity of the muscular layer (arrow) appears not to be disrupted. The mesorectal fat (*) has a homogeneous appearance without tumoral involvement. The mesorectal fascia (arrowheads) is also well depicted. (b) Photomicrograph (original magnification, $\times 4$; hematoxylin-eosin [H-E] stain) shows neoplastic glands (arrow) disrupting the mucosal and submucosal layers of the rectal wall and the integrity of the muscular layer (*). A desmoplastic reaction (arrowhead) is visible near the neoplastic glands.

Correlation of MR Imaging Findings with Pathologic Findings

The identification and staging of rectal cancers at MR imaging is largely based on differences in T2 signal intensity between the tumor, the mucosa and submucosal layers, the muscular layer, the perirectal fat, and the mesorectal fascia. The peri-

rectal fat has high signal intensity on turbo spin-echo T2-weighted images and surrounds the low-signal-intensity muscularis propria. The tumor itself has an intermediate signal intensity between the high signal intensity of the fat tissue and the low signal intensity of the muscular layer. Furthermore, its signal intensity is higher than that of the mucosal and submucosal layers (Fig 5).

The mesorectal fascia appears as a thin, hypointense line surrounding the hyperintense perirectal fat. However, the spatial resolution of

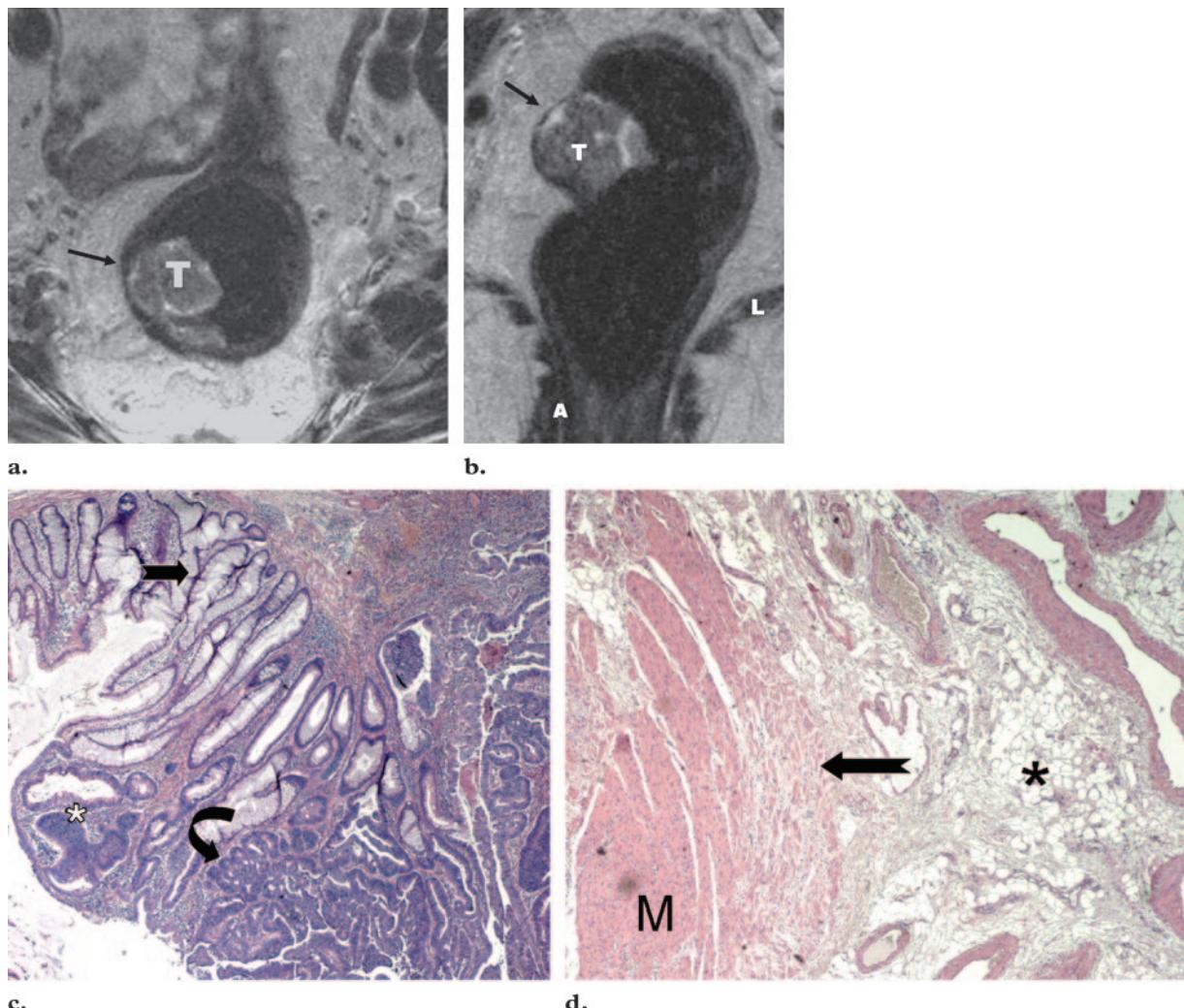


Figure 7. Stage T1 rectal carcinoma. **(a)** Axial turbo spin-echo T2-weighted MR image shows a polypoid tumor (*T*) on the right lateral aspect of the rectal wall protruding into the rectal lumen. It is difficult to determine whether the muscular layer (arrow), which appears thinned, is infiltrated or spared. **(b)** Coronal turbo spin-echo T2-weighted MR image shows the tumor (*T*) invading the rectal wall without infiltrating the perirectal fat (arrow). In this imaging plane, the distance of the tumor from the plane of the levator ani muscle (*L*) and from the anal sphincter complex (*A*) can easily be evaluated. **(c)** Photomicrograph (original magnification, $\times 4$; H-E stain) reveals multiple neoplastic glands (curved arrow) confined to the submucosal layer. The border between normal bowel mucosal glands (straight arrow) and the neoplastic glands is clearly visible (*). **(d)** Photomicrograph (original magnification, $\times 4$; H-E stain) shows that the integrity of the muscular layer (*M*) and the perirectal fat (*) has not been disrupted. The boundary between the muscular layer and fat tissue is evident (arrow).

phased-array surface coil MR imaging is not adequate to allow differentiation between the mucosal and submucosal layers of the inner layer.

At histopathologic analysis, a stage T1 tumor is characterized by infiltration of the submucosal layer and sparing of the muscularis propria (Fig 6); at phased-array MR imaging, differentiation between stage T1 and stage T2 tumors is rather difficult owing to low spatial resolution (Fig 7).

Transanal endoscopic microsurgery with a full-thickness excision represents a safe and effective

treatment for adenomatous polyps, tumor *in situ*, and stage T1 rectal tumors.

Stage T2 tumors are generally characterized by involvement of the muscular layer, with loss of the interface between this layer and the submucosa. The muscular layer is partially reduced in thickness, although the outer border between the muscularis propria and the perirectal fat remains

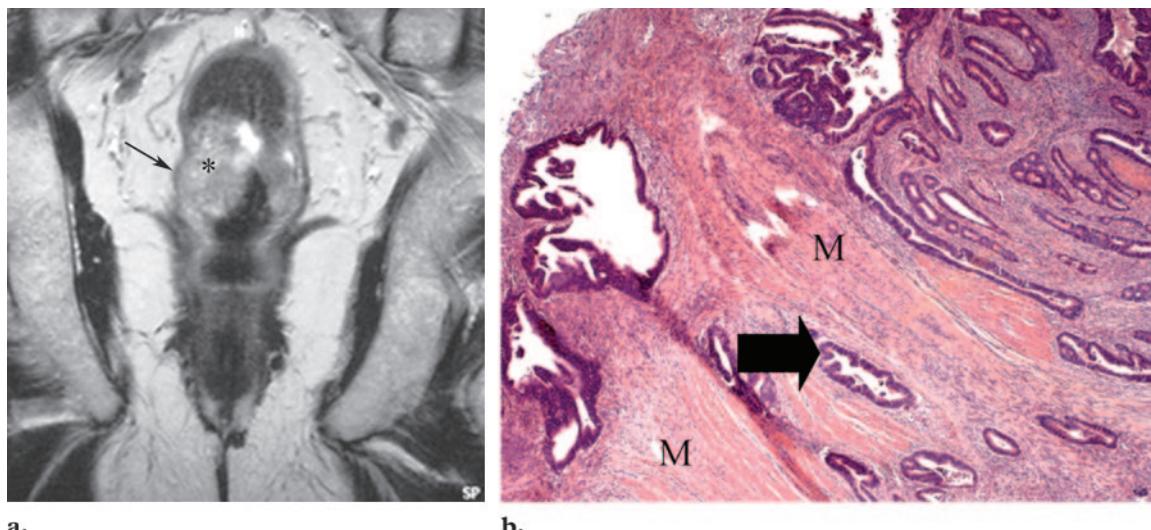
**a.****b.**

Figure 8. Stage T2 rectal carcinoma. **(a)** Coronal turbo spin-echo T2-weighted MR image shows a stenosing neoplastic lesion (*) of the rectal lumen involving the mucosal, submucosal, and muscular layers. The muscular layer is visible as a continuous hypointense line, and no neoplastic spread into the mesorectal fat (arrow) is seen. The major criterion for differentiating between stage T2 and stage T3 tumors is the presence of neoplastic tissue within the mesorectal fat. **(b)** Photomicrograph (original magnification, $\times 4$; H-E stain) shows complete infiltration of the muscular layer (*M*) by neoplastic glands (arrow).

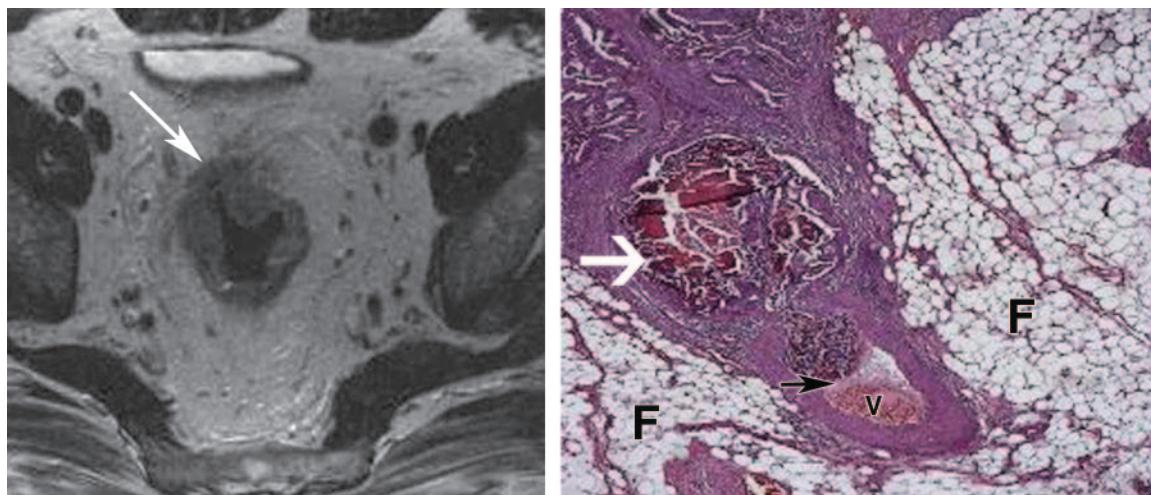
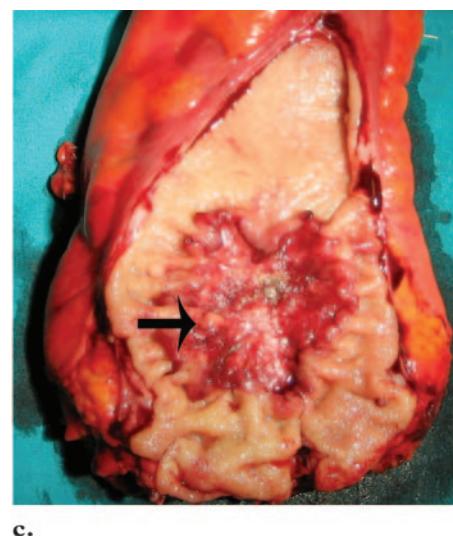
**a.****b.**

Figure 9. Stage T3 rectal carcinoma without involvement of the mesorectal fascia. **(a)** Axial turbo spin-echo T2-weighted MR image shows a neoplastic rectal lesion (arrow) disrupting the integrity of the muscular layer and invading the surrounding mesorectal fat. **(b)** Photomicrograph (original magnification, $\times 4$; H-E stain) shows neoplastic involvement of the perirectal fat (*F*). A necrotic area (white arrow) as well as arterial vessel infiltration (black arrow) are evident.

**c.**

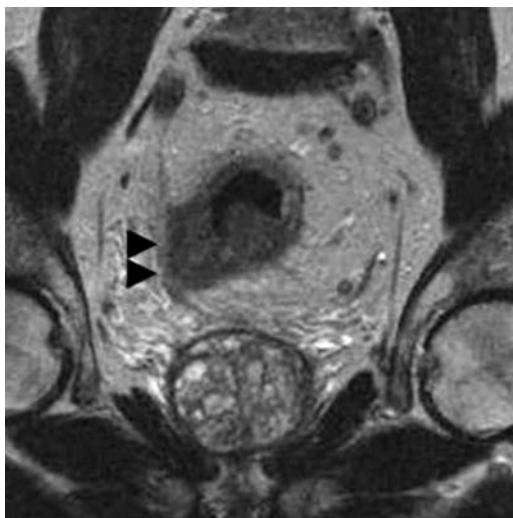


Figure 10. Stage T3 tumor with involvement of the mesorectal fascia. Coronal turbo spin-echo T2-weighted MR image shows a neoplastic rectal lesion infiltrating the mesorectal fat and involving the mesorectal fascia (arrowheads), which appears thickened. The mesorectal fascia represents the surgical resection margin. Patients with this kind of tumor benefit from preoperative neoadjuvant therapy to reduce the postoperative local recurrence rate.

intact (Fig 8). In differentiating between stage T2 and stage T3 tumors, the crucial criterion is involvement of the perirectal fat, which is characterized by the inability to visualize the interface between the muscular layer and the perirectal fat, with a rounded or nodular advancing margin. In stage T3 tumors, the muscularis propria is totally disrupted and cannot be clearly distinguished from the perirectal fat (Fig 9).

In the evaluation of stage T3 tumors, one parameter is particularly important: the minimum distance between the tumor and the mesorectal fascia. This measurement is important for the stratification of cases on the basis of potential recurrence after TME. Indeed, despite good-quality TME surgery, 15%–20% of TME specimens have a positive CRM (40). In such cases, the CRM consists of the mesorectal fascia itself. Even if tumor–mesorectal fascia distance has not yet been included in the TNM staging system, there is strong evidence that neoplastic involvement of the CRM is closely related to a high recurrence rate after surgery (Fig 10) (1,40–42). In patients with suspected tumoral involvement of the mesorectal fascia, neoadjuvant treatments are advo-

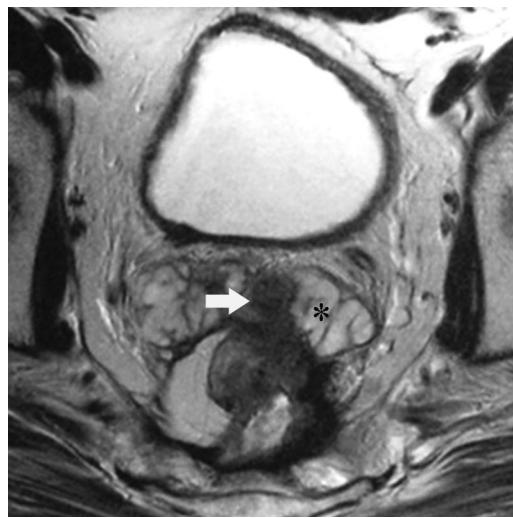


Figure 11. Stage T4 tumor. Axial turbo spin-echo T2-weighted MR image shows a neoplastic rectal lesion (arrow) disrupting the mesorectal fascia. Tumoral infiltration of the seminal vesicles (*) is also evident.

cated to reduce the risk of postsurgical recurrence (7). **MR imaging is a highly accurate and reliable technique for the prediction of CRM infiltration and thus represents a noninvasive tool for identifying those patients who may benefit from preoperative chemotherapy or radiation therapy and those who should undergo TME.**

A valid criterion for predicting CRM infiltration is thought to be a cutoff distance of 6 mm between a tumor and the mesorectal fascia. This criterion was established by Beets-Tan et al (43), who observed that it was highly accurate in predicting CRM involvement. In their experience, a distance of at least 5 mm between a tumor and the mesorectal fascia at MR imaging helped predict an uninvolved CRM of 1 mm at histologic analysis with 97% confidence. Although not fully discussed in the literature, the usefulness of MR imaging in the evaluation of the CRM may be limited in (a) thin patients with little perirectal fat and (b) tumors of the anterior wall of the rectum, due to the poor visualization of the mesorectal fat.

In stage T4 tumors, the signal intensity of the tumor is seen infiltrating surrounding structures (ie, other organs and muscular structures of the pelvic wall) (Fig 11).

Teaching Point

Clinical Impact of MR Imaging

Recently, MR imaging has been advocated as a problem-solving technique for therapeutic planning in patients with rectal carcinoma. Initial results have been disappointing due to technical limitations. However, advances in terms of imaging equipment, coils, and sequences have progressively improved the technique, with a parallel increase in accuracy. Because of its high-contrast spatial resolution and large field of view, MR imaging has now fulfilled the requirements for becoming the ideal imaging technique for the preoperative staging of locally advanced rectal cancer, although transrectal US still offers some advantages in terms of spatial resolution for differentiating between stage T1 and stage T2 tumors. MR imaging also consistently allows accurate measurement of the depth of extramural tumor spread, determination of mesorectal involvement, and prediction of CRM involvement (Fig 12).

With use of external coils (eg, phased-array surface coils), the overall accuracy of MR imaging for the T staging of rectal cancer varies from 65% to 86% (8,26,43–46), with considerable interobserver variability. In recent studies, the reported accuracy has varied from 86% to 100% (8,35, 45,46). This variability in clinical results reflects the difficulties in staging borderline lesions as either stage T2 or stage T3 tumors. Sometimes, the overstaging of stage T2 lesions is caused by a desmoplastic reaction of the peritumoral tissues (28); in such cases, MR imaging allows the identification of spicular hypointense areas through the mesorectal fat surrounding the tumor that can be caused by fibrosis alone, without containing any malignant cells at histologic analysis (Fig 13).

Nevertheless, the truly relevant feature that helps in the clinical decision-making process is the assessment of the CRM. In other words, like stage T3 lesions, stage T2 lesions require the use of TME as a surgical approach. With this approach, the mesorectal fascia represents the CRM, and it has been well established that tumoral infiltration of the CRM is related to a high recurrence rate (47).

Therefore, the goal of staging rectal tumors with MR imaging is to identify patients with stage T3 lesions, a subset with potential CRM involvement who might benefit from neoadjuvant treatment (radiation therapy, chemotherapy). In recent studies, high-spatial-resolution MR imaging has demonstrated an accuracy of 100% in the

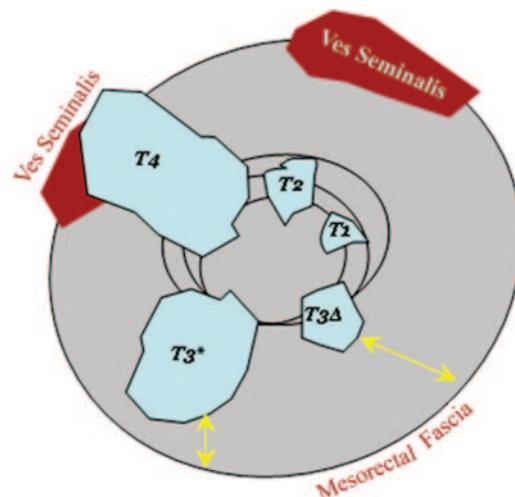
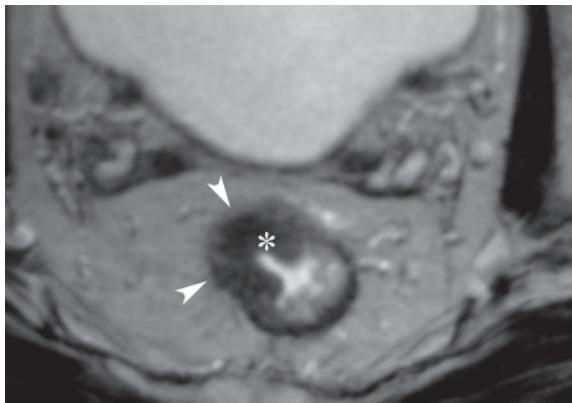


Figure 12. Drawing illustrates the relationship between the CRM and rectal tumors of various stages (8). The local recurrence rate is strictly dependent upon CRM infiltration; thus, the most important predictor of local recurrence is a short tumor–mesorectal fascia distance (double-headed arrows). The actual T staging system does not differentiate between tumors with a wide CRM ($T3\Delta$) and those with a narrow CRM ($T3^*$). Of these stage T3 tumors, the latter poses a higher risk for recurrence. At MR imaging, it is important to be able to identify patients with infiltrating tumors that have a narrow CRM or that infiltrate the mesorectal fascia who might benefit from neoadjuvant treatment. $T1$ = stage T1 tumor, $T2$ = stage T2 tumor, $T4$ = stage T4 tumor, Ves = vesicle.

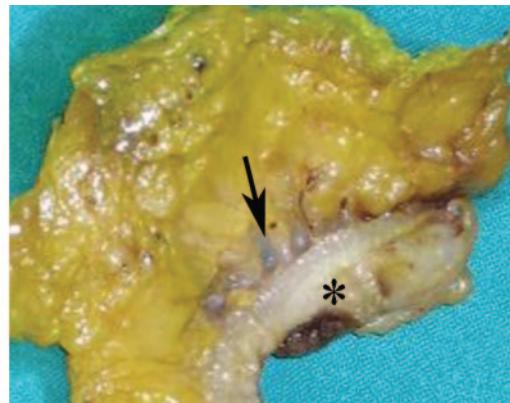
identification of CRM involvement. Moreover, this evaluation has shown good reproducibility, with complete agreement among those interpreting MR images for the prediction of mesorectal fascia involvement. This fact indicates that high-resolution phased-array MR imaging is highly accurate in predicting CRM involvement, although it is less accurate and less consistent in predicting the correct T stage.

One important variable in surgical planning is the distance between the inferior margin of the tumor and the anal sphincter complex. Coronal MR imaging can easily show infiltration of the latter (Fig 14).

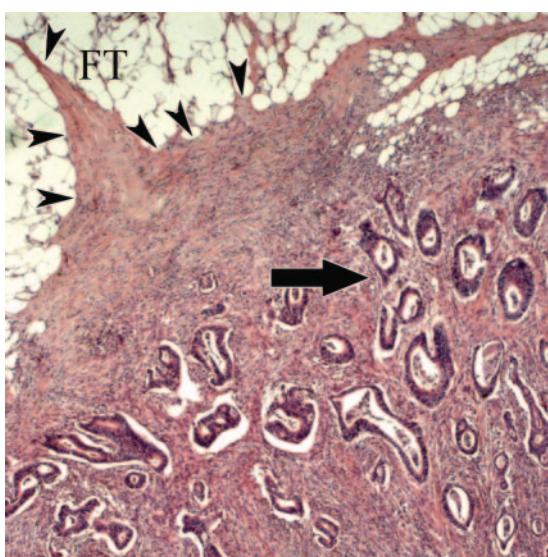
In locally advanced rectal cancers, MR imaging can help determine the relationship between the tumor and the surrounding pelvic structures. The best survival rate is seen with radical en bloc resection of the tumor and of the involved surrounding organs performed after neoadjuvant chemotherapy and radiation therapy administered to achieve tumor shrinkage (48).



a.



c.

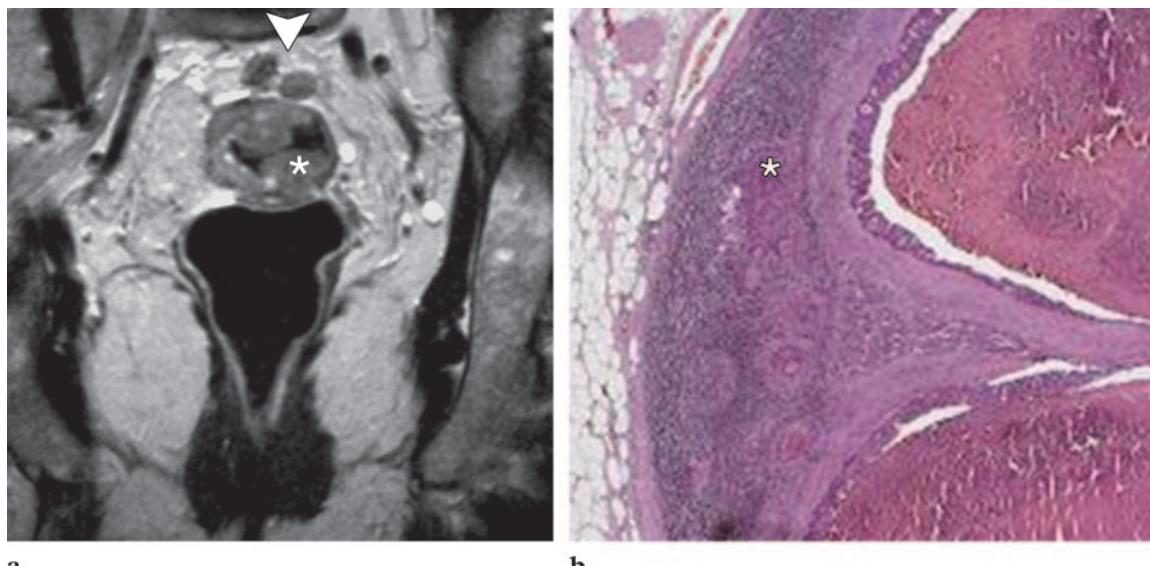


b.

Figure 13. Stage T2 tumor with a peritumoral desmoplastic reaction. (a) Axial turbo spin-echo T2-weighted MR image shows a neoplastic lesion (*). The muscular layer is not recognizable, and neoplastic tissue seems to have spread into the mesorectal fat (arrowheads), a finding that represents one of the most frequent causes of overstaging. The perirectal fat stranding is actually due to a peritumoral desmoplastic reaction. (b) Photomicrograph (original magnification, $\times 4$; H-E stain) shows neoplastic glands (arrow) disrupting the muscular layer. A strong desmoplastic reaction (arrowheads) involving the fat tissue (FT) is also evident. (c) Photograph of a section of the explanted mesorectum shows the neoplastic lesion (*) and desmoplastic involvement of the perirectal fat (arrow).



Figure 14. Rectal adenocarcinoma with involvement of the sphincter. Coronal turbo spin-echo T2-weighted MR image shows a tumor (T) of the rectal ampulla causing stenosis of the rectal lumen and infiltrating the sphincter plane, which is composed of the internal muscular sphincter (*) and the external sphincter (ES). The levator ani muscle (L) is also evident and appears to be uninvolving.



a.

b.

Figure 15. Rectal adenocarcinoma with metastatic lymphadenopathy. **(a)** Coronal turbo spin-echo T2-weighted MR image demonstrates a rectal tumor (*) and two enlarged lymph nodes within the mesorectal fat (arrowhead). **(b)** Photomicrograph (original magnification, $\times 4$; H-E stain) shows neoplastic involvement of one lymph node (*), a finding that confirmed suspicions raised at radiologic evaluation.

With regard to N staging (Fig 15), the advantage of a phased-array surface coil is that it provides a larger field of view, thus including the lymph nodes outside the field of view of an endorectal coil. However, with lymph node size being the most reliable predictor of nodal involvement, results with phased-array surface coil MR imaging have been disappointing, with a reported accuracy of only 43%–85%. Moreover, there is currently no consensus about lymph node size vis-à-vis nodal involvement: Some authors report any detectable lymph node, whereas others report only those lymph nodes that are larger than a given size (eg, 3 mm, 5 mm, or 10 mm) (49).

More recently, other authors proposed that nodal involvement be determined on the basis of irregular borders and signal intensity characteristics. They concluded that the presence of spiculated or indistinct node borders and a mottled heterogeneous signal intensity pattern might help predict nodal involvement (49,50).

However, real improvement in lymph node characterization will come with the use of ultra-small iron-based particles. These particles are selectively taken up by the reticuloendothelial cells in normal lymph nodes, which thus have low signal intensity on proton-density-weighted and T2-weighted MR images. Pathologic lymph

nodes, with reticuloendothelial cells replaced by neoplastic cells, will not take up the contrast agent and thus will have a relatively bright signal intensity. Preliminary results are promising, although further studies in larger series are needed to assess the real diagnostic value of lymph node-specific agents (51,52).

Conclusions

The use of MR imaging with a phased-array surface coil has an undeniable role in the therapeutic management of rectal cancer. Furthermore, the results of recent surgical trials indicate that evaluation of the involvement of the mesorectal fat and mesorectal fascia is more important than T staging for treatment planning (surgery, radiation therapy and chemotherapy). At present, phased-array MR imaging best fulfills the clinical requirements for preoperative staging of rectal cancer. However, preoperative detection of the other prognostic factor, nodal status, is still a problem, and further studies are needed.

Teaching Point

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Preoperative Staging of Rectal Cancer with MR Imaging: Correlation with Surgical and Histopathologic Findings

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Page 702

Adenocarcinomas account for the vast majority (98%) of rectal cancers.

Page 702

Preoperative staging techniques for rectal cancer should allow identification of (a) patients with extrarectal spread, who might benefit from preoperative radiation therapy; and (b) patients with minimal or no sphincter involvement, who might be suitable for sphincter-sparing surgery.

Page 703

Rectal MR imaging with a phased-array surface coil yields high-spatial-resolution images, thereby providing a full evaluation of the rectal wall layers, and has the additional advantage of a large field of view.

Page 709

MR imaging is a highly accurate and reliable technique for the prediction of CRM infiltration and thus represents a noninvasive tool for identifying those patients who may benefit from preoperative chemotherapy or radiation therapy and those who should undergo TME.

Page 712

The use of MR imaging with a phased-array surface coil has an undeniable role in the therapeutic management of rectal cancer.