Abdominal Radiology (2019) 44:3581–3594
https://doi.org/10.1007/s00261-019-02045-9

SPECIAL SECTION: RECTAL CANCER

Beyond adenocarcinoma: MRI of uncommon rectal neoplasms and mimickers

David D. B. Bates[1] · Maria Clara Fernandes de Paula[2] · Natally Horvat[2] · Shannon Sheedy[3] · Chandana Lall[4] · Zahra Kassam[5] · Perry Pickhardt[6] · Neeraj Lalwani[7] · Dhakshinamoorthy Ganeshan[8] · Iva Petkovska[1]

Published online: 8 May 2019

Abstract

Objective To provide a review of rare rectal tumors beyond adenocarcinoma.

Results Rectal cancer is a common malignancy, both in the United States and abroad. In addition to adenocarcinoma, abdominal radiologists will encounter a variety of other less common rectal masses, both benign and malignant neoplasms as well as non-neoplastic mimickers. Familiarity with these conditions and their characteristic features on MRI is useful in clinical practice. In this article, a number of such conditions are discussed, with an emphasis on distinguishing features on MRI of the rectum.

Conclusion Familiarity with the MRI features of rare rectal tumors beyond adenocarcinoma, as well as a small number of non-neoplastic mimics, is important for abdominal imagers to make diagnostic differentials and to assist in treatment planning.

Keywords Rectal cancer · Neuroendocrine tumor · Anorectal melanoma · Gastrointestinal lymphoma · Carcinoid · Basidiobolomycosis · Rare tumors

Introduction

Rectal cancer is the fourth most common cancer in the United States, with an overall incidence of 11.7 cancers per 100,000 persons for all ages and 44 cancers per 100,000 persons for those over 65 years [1]. There has been a rapid increase in the incidence of rectal cancer in younger patients, as those born in 1990 have four times the risk of developing rectal cancer compared to those born in 1950 [2]. By far, adenocarcinoma is the most common histologic type of rectal cancer. MRI is the established imaging modality for local staging of rectal adenocarcinoma and has important implications for patient management and outcomes [3, 4].

In addition to adenocarcinoma, there are a variety of less common rectal neoplasms and non-neoplastic mimics. The practicing abdominal radiologist should be familiar with the imaging features of these rare rectal masses, as the management and prognosis of these masses can be significantly different compared to that of rectal adenocarcinoma.

The aim of this article is to review some of the rare rectal tumors beyond adenocarcinoma, with a particular emphasis on the MRI imaging features, local staging, standard treatment, and prognostic implications.

✉ David D. B. Bates
batesd@mskcc.org

1 Department of Radiology, Memorial Sloan Kettering Cancer Center, 1275 York Ave, New York, NY 10065, USA

2 Department of Radiology, Hospital Universitário Clementino Fraga Filho, Rio de Janeiro, Brazil

3 Department of Radiology, Mayo Clinic, Rochester, MN, USA

4 Department of Radiology, University of Florida, Jacksonville, FL, USA

5 Department of Medical Imaging, University of Western Ontario, London, ON, Canada

6 Department of Radiology, University of Wisconsin, Madison, WI, USA

7 Department of Radiology, Wake Forest University and Baptist Health, Winston-Salem, NC, USA

8 Department of Radiology, University of Texas MD Anderson Cancer Center, Houston, TX, USA

Intramural malignant tumors

Rectal lymphoma

Extra-nodal lymphoma arises most commonly in the gastrointestinal (GI) tract. GI tract lymphomas are most commonly non-Hodgkin's, B cell lymphomas [5, 6]. On the other hand, primary colorectal lymphoma is rare and accounts for only 0.1–0.4% of primary rectal neoplasms and only a small proportion of GI tract lymphomas. Colorectal lymphoma has a male predominance (a 2:1 male to female ratio) and is most often seen in the sixth or seventh decade of life [7, 8]. The risk is increased for patients with inflammatory bowel disease or immunosuppression [7]. Bleeding is an uncommon symptom at presentation (~20% of cases); abdominal pain and constitutional symptoms are more common [8, 9].

When the rectum is involved, it is usually in the context of widespread systemic disease and there is adenopathy outside the GI tract. In contrast, primary gastrointestinal lymphoma will be present without systemic disease. Rectal lymphoma tends to involve multiple segments and longer segments of colon; however, obstruction and perforation from the tumor is uncommon [10].

Rectal lymphoma can be protean in its appearance and can be polypoid, circumferential, ulcerated, or may simply be seen as mucosal nodularity, and its appearance can overlap with rectal adenocarcinoma [7]. On MRI, high T2 signal and intermediate T1 signal are the norm, and mild to moderate enhancement may be expected [6, 7]. Given the high cellularity of lymphoma, restricted diffusion is present [11] (Fig. 1).

Staging of GI tract lymphoma can be done using the Lugano classification system [12] (Table 1).

Neuroendocrine tumors of the rectum

Neuroendocrine tumors (NET) [13] of the GI tract are rare, with fewer than 20,000 cases diagnosed over a 33-year period beginning in 1975. The overall incidence has increased over that time, probably due to improved and more frequent investigation with endoscopic procedures, particularly for NETs arising from the stomach and rectum [13]. Although neuroendocrine cells are found in multiple organ systems, they are relatively high in concentration in the GI tract [14, 15]. NETs can become biologically active due to the overproduction of cytokines and/or hormones [14].

The most common locations for NETs arising from the GI tract are the small bowel and rectum. Although small bowel NETs are traditionally thought to be most common [15, 16], others have suggested that the incidence of rectal NETs has increased and is now greater than small bowel NETs [17, 18]. The reason for this is currently unknown [17] but may relate to the increased detection from the more widespread use of endoscopic imaging than in the past.

Patients with rectal NET are often in their sixth decade of life [7, 17, 19] and there is no difference in incidence between males and females [7, 14]. Rectal NETs are most

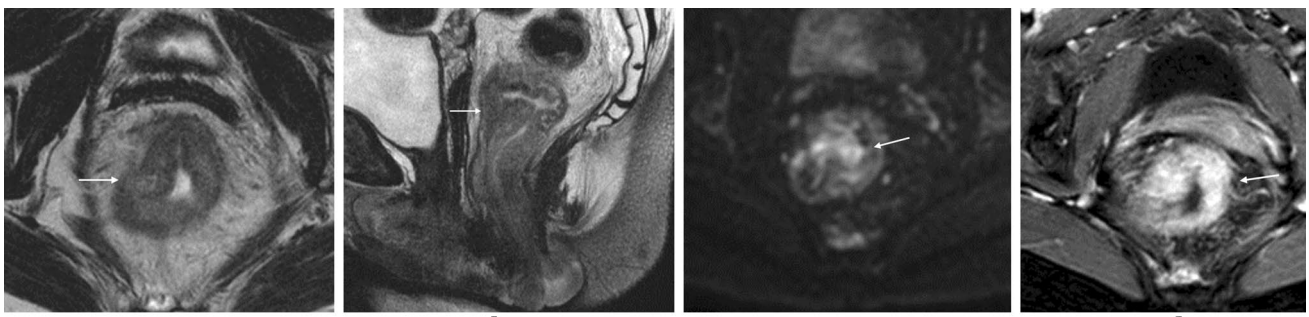

Fig. 1 Rectal lymphoma. Partially circumferential mass in the low rectum with intermediate T2 signal (**a**, **b**; *arrows*). There is restricted diffusion within the lesion (**c**, *arrow*), and avid post-contrast enhancement (**d**, *arrow*)

Table 1 GI lymphoma classification adopted at the Consensus Conference in Lugano

Stage I Tumor confined to gastrointestinal tract, single primary site, and multiple noncontiguous lesions
Stage II Tumor extends into the abdominal cavity from the primary gastrointestinal site
II1 Local nodal involvement
II2 Distant nodal involvement
Stage III Penetration through serosa to involve adjacent organs or tissues
Stage IV Disseminated extra-nodal involvement or a gastrointestinal tract lesion with supradiaphragmatic nodal involvement

often diagnosed on screening colonoscopy or incidentally, as they are often asymptomatic [14, 19]. When symptomatic, pain with defecation, rectal bleeding, and constipation are common [19, 20]. Rectal NETs almost never cause the traditional "carcinoid" syndrome.

On MRI, rectal NETs often present as a small, solitary submucosal mass or nodule. The majority are 1 cm in diameter or smaller [15], and only a small number (~ 5%) are larger than 2 cm [19]. The most common appearance is a single homogenously enhancing superficial rectal mass that is T1 isointense and T2 iso- to hyperintense [7, 21]. The superficial appearance can be attributed to the location of enteroendocrine cells in the muscularis mucosa or the submucosal layer of the bowel wall [22]. Less commonly, more aggressive imaging features that resemble rectal adenocarcinoma are seen, such as transmural extension or an irregular mass, particularly when the NET has a poorly differentiated histology [23] (Figs. 2, 3).

Because rectal NETs are usually low grade tumors, nodal metastases are uncommon (less than 10%) and distant metastases are even more rare [19]. The size of the primary tumor is important in predicting metastases in rectal NETs; tumors under 1 cm in size rarely metastasize [14]. Larger tumors, especially those larger than 2 cm, and tumors that have invaded beyond the rectal wall are at a higher risk for developing metastatic disease.

NETs are classified by both stage and World Health Organization grade (low/G1, intermediate/G2, or high/G3), based on mitotic count and Ki67 index [24], and both systems have prognostic implications. The 2017 TNM staging classification from the American Joint Cancer Commission (AJCC) for rectal NETs is summarized in Table 2 [25].

Melanoma

Primary anorectal melanoma is aggressive but extremely rare, accounting for less than 1% of all melanomas. Although rectal melanoma may originate from the columnar epithelium of the rectum, it is most often an extension of a primary anal neoplasm and hence the term anorectal melanoma is used [7]. It is typically seen in patients in their forties or fifties, but a wide age range has been reported, with some patients presenting younger than 30 years [21, 26, 27]. There

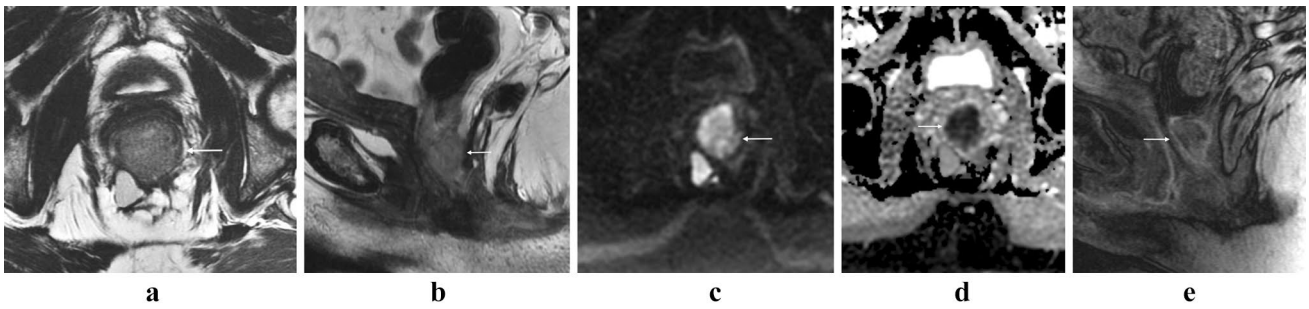

Fig. 2 Rectal neuroendocrine tumor. 60-year-old female with a T2 iso- to hyperintense mass in the low rectum (**a** and **b**, arrows), with marked restricted diffusion (c and d, arrows) and enhancement (**e**, arrow)

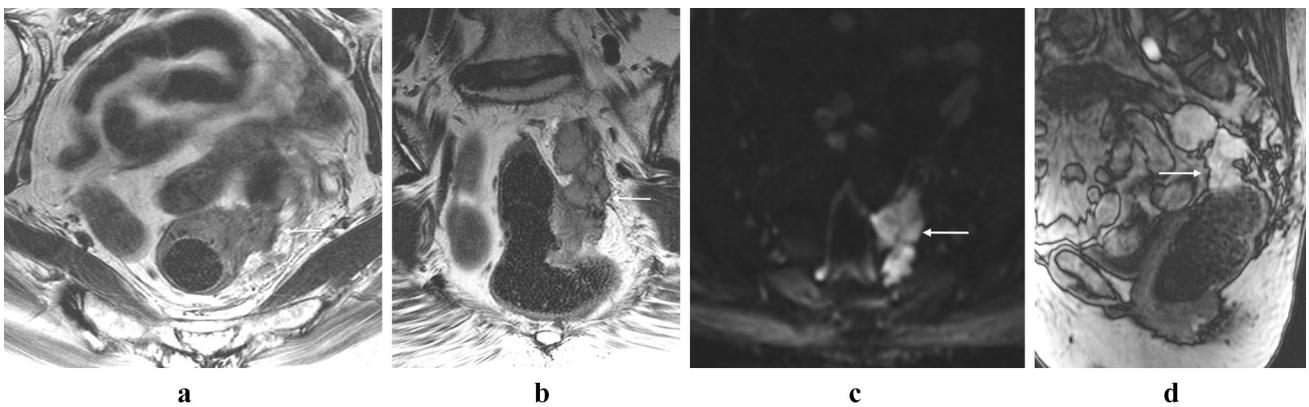

Fig. 3 Rectal neuroendocrine tumor. 79-year-old female with an atypical, locally aggressive neuroendocrine tumor. Axial oblique (**a**) and coronal oblique (**b**) T2 images show direct extension into the pelvis (arrows). Restricted diffusion (**c**, arrow) and avid homogenous enhancement (**d**, arrow), as is more typical of rectal NET

Table 2 AJCC 2017 TNM for rectal NET

T Category
TX Primary tumor cannot be assessed
T0 No evidence of primary tumor
T1 Tumor invades the lamina propria or submucosa and is <= 2 cm
T1a Tumor < 1 cm in greatest dimension
T1b Tumor 1–2 cm in greatest dimension
T2 Tumor invades the muscularis propria or is > 2 cm with invasion of the lamina propria or submucosa
T3 Tumor invades through the muscularis propria into subserosal tissue without penetration of overlying serosa
T4 Tumor invades the visceral peritoneum (serosa) or other organs or adjacent structures
N Category
NX Regional lymph nodes cannot be assessed
N0 No regional lymph node metastasis has occurred
N1 Regional lymph node metastasis
M Category
M0 No distant metastasis
M1 Distant metastasis
M1a Metastasis confined to liver
M1b Metastasis in at least one extrahepatic site (e.g., lung, ovary, nonregional lymph node, peritoneum, bone)
M1c Both hepatic and extrahepatic metastases

is a female predominance, with a female to male ratio of 2:1 [26, 28].

Symptoms of anorectal melanoma are similar to those of other rectal neoplasms; they include rectal bleeding, pain, and weight loss [21]. The mass is often near the anus or in the distal rectum and presents as an intraluminal polypoid mass [7, 21, 23]. It is sometimes discovered incidentally during surgery for hemorrhoids [29].

MRI in anorectal melanoma primarily concerns lesion characterization and local staging. A polypoid appearance, sometimes with ulceration, is the norm, while generalized wall thickening and exophytic growth are atypical. Most melanoma cells demonstrate high signal on T1-weighted images due to T1-shortening caused by paramagnetic free radicals within the melanin pigment [23]. The typical appearance is therefore T1 hyperintense, with high or mixed signal intensity on T2-weighted images [23]. Peri-tumoral desmoplasia is less common compared with adenocarcinoma. On endoscopy, the lesion appears darkly pigmented due to the presence of melanin (Fig. 4).

A minority of anorectal melanomas (~ 10–29%) are amelanotic variants. In these cases, the characteristic T1-shortening is not present but the tumors may be T1 hypointense on MRI similar to rectal adenocarcinoma [7, 23].

In addition to evaluation of the primary neoplasm, MRI is also useful for evaluation of the locoregional lymph nodes. Similar to the primary tumor, a metastatic lymph node from a T1-hyperintense mass may demonstrate high T1 signal [23]. Lymph node metastases are commonly

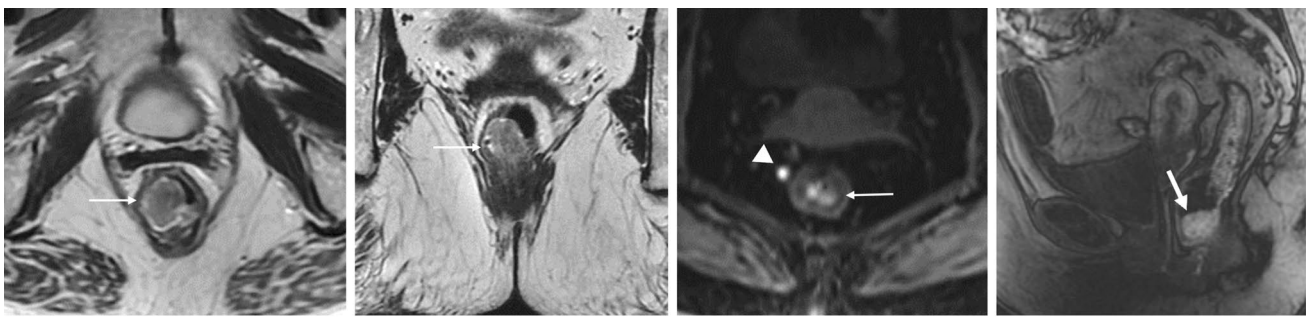

Fig. 4 Anorectal melanoma. Polypoid T2-hyperintense mass at the anorectal junction (**a** and **b**, arrows). The mass (arrow) and an adjacent lymph node (arrowhead) show intrinsic T1-shortening on the T1 fat saturated pre-contrast image (**c**), and the lesion shows heterogeneous enhancement with early perfusion (**d**, arrow)

seen at the initial presentation (60%) [30]. The location of nodal metastases reflects the complex lymphatic drainage of the anorectum. Tumor spread from the lower rectum often goes to mesorectal nodes and subsequently internal iliac nodes. Near the anorectal junction, drainage often goes to the inguinal nodes [31]. The size of primary lesion influences the rate of nodal metastases whereby the latter is more common especially when the primary mass is greater than 3 cm [32]. While the presence of locoregional nodal metastases may be evaluated on MRI, it has not been linked to prognostic outcomes such as recurrence or survival [33].

Distant metastases from anorectal melanoma are identified in up to 40% of patients at diagnosis and often involve the liver, brain, or lung [30, 33]. The reported five-year survival rates are from 10 to 15% [7, 30].

At present, no pathologic staging system exists that is specific to anorectal melanoma.

Gastrointestinal stromal tumor

Gastrointestinal stromal tumors (GISTs), the most common mesenchymal neoplasm of the rectum, can be either malignant or benign; these tumors arise from interstitial cells of Cajal that serve as a pacemaker for bowel peristalsis in the intestinal wall [7, 23]. GISTs are the most common mesenchymal tumors of the GI tract, but the rectum is the least common location (3%–5%). The stomach and small intestine are much more common sites for GIST, accounting for approximately 60–70% and 20–30% of GIST tumors, respectively [7, 23, 25]. All GIST tumors have some degree of malignant potential, depending in part on the tumor size and the number of mitoses [23].

GISTs most commonly occur between the fifth and seventh decades of life and are more common in males than in females [7, 34]. Approximately one in four GISTs are incidentally diagnosed on imaging; others are found due to symptoms such as bleeding and abdominal pain [7, 34, 35]. At immunohistochemical evaluation, most GISTs express CD117 [13], allowing them to be differentiated from other mesenchymal neoplasms such as leiomyoma and leiomyosarcoma.

A GIST will usually be a well-circumscribed, smooth submucosal mass, but it can occasionally ulcerate [34]. MRI has a distinct role in localizing the lesion and in determining the relationship of the lesion to the surrounding anatomy for surgical planning [34]. An exophytic component is characteristic of GISTs, and presents much more often than adenocarcinoma [7]. Many GISTs have a pseudocapsule that can limit infiltration into adjacent structures which tend to be displaced rather than infiltrated [25]. Invasion of the adjacent organs, bowel obstruction and lymph node metastases are much less common than with adenocarcinoma.

Additionally, smaller GISTs may show homogeneous arterial enhancement, whereas larger tumors have milder, heterogeneous enhancement [35, 36]. Large GISTs have some unique features, including a "dumb-bell' shape. They may have central necrosis and can communicate with the bowel lumen [35, 37] (Figs. 5, 6).

Nodal metastases are rare for GISTs, even with large tumors; metastases tend to occur in the liver and peritoneum [25, 34]. Other than metastases or the lack of local invasion, no imaging features can reliably differentiate benign from malignant GIST and this distinction must be made through pathology.

TNM staging of GISTs is relatively straightforward. T-staging is determined by only tumor size since the

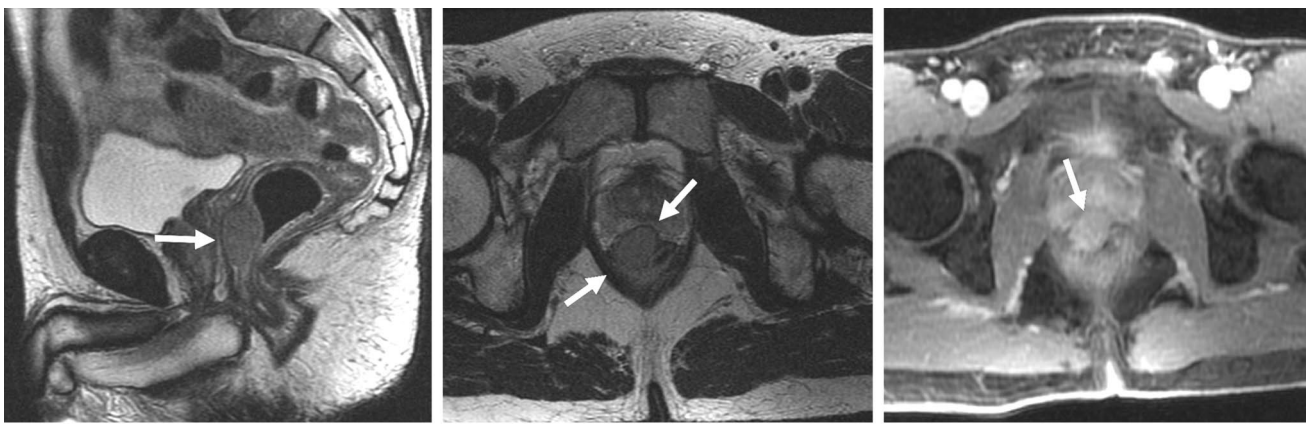

Fig. 5 Rectal gastrointestinal stromal tumor. 56-year-old male with a round mural mass with well defined tumor margins on T2 weighted images (arrows; **a** and **b**), and the tumor indents the posterior aspect of the prostate gland (**b**, anterior arrow). There is avid homogeneous enhancement (arrow, **c**). There is no adenopathy

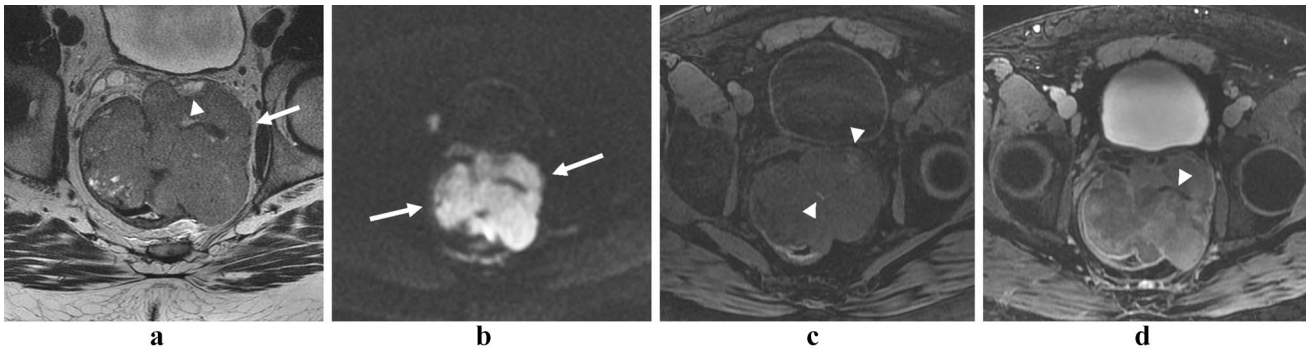

Fig. 6 Rectal gastrointestinal stromal tumor. 46-year-old male with a bulky lobulated mass in rectum with 'dumbbell-like' appearance (**a**, arrow), protruding both into the lumen and growing exophytically. The lesion contact and indents bilateral seminal vesicles (**a**, arrowhead). Restricted diffusion is present (**b**, arrows). There are small internal areas of hemorrhage on the T1 fat saturated pre-contrast image (**c**, arrowhead), and necrosis or cystic degeneration on post-contrast imaging (**d**, arrowhead)

Table 3 AJCC 2017 TNM for GISTs

T Category
TX Primary tumor cannot be assessed
T0 No evidence of primary tumor
T1 Tumor ≤ 2 cm
T2 Tumor > 2 cm but not more than 5 cm
T3 Tumor > 5 cm but not more than 10 cm
T4 Tumor > 10 cm in greatest dimension
N Category
N0 No regional lymph node metastasis or unknown lymph node status
N1 Regional lymph node metastasis
M Category
M0 No distant metastasis
M1 Distant metastasis

Table 4 NIH-Fletcher criteria for GIST risk assessment

Risk category	Primary tumor size (cm)	Mitotic count (per 50 high-power fields)
Very low risk	< 2	< 5
Low risk	2–5	< 5
Intermediate risk	< 5	6–10
	5–10	< 5
High risk	> 5	> 5
	> 10	Any mitotic rate
	Any size	>10

majority of these tumors have a transmural component [25]. The National Institutes of Health (NIH) GIST Consensus Criteria (25) classifies patients as having a very low, low, intermediate or high risk of recurrence. The reason for this classification is that the biologic behavior of a GIST can be hard to predict, as even histologically "benign" tumors can recur or metastasize. The two factors in this determination are the size of the tumor and mitotic rate (Tables 3 and 4).

Table 5 AJCC 2017 TNM for soft tissue sarcomas of the abdomen visceral organs

T Category
T1 Organ confined
T2 Tumor extension into tissue beyond organ
T2a invades serosa or visceral peritoneum
T2b extension beyond serosa (mesentery)
T3 Invades another organ
T4 Multifocal involvement
N Category
N0 no lymph node involvement or unknown lymph node status
N1 lymph node involvement present
M Category
M0 No metastasis
M1 Metastasis present

Leiomyosarcoma/leiomyoma

Benign and malignant smooth muscle tumors can also occur in the rectum. They are uncommon, but a limited review is useful. There is no specific staging system for rectal sarcomas. TNM staging classifications for other soft tissue sarcomas may be useful (Table 5) [25]. Common sites of metastases include the liver, lung, and peritoneal cavity [25].

Leiomyosarcoma [38] is the most common sarcoma of the rectum [39, 40]. LMS is less common than its benign counterpart, the leiomyoma, and the two lesions can be hard to distinguish on biopsy. There is a female predominance in LMS [7, 41], and prior pelvic radiation is a known risk factor [7, 42, 43].

Rectal LMS is usually a polypoid intraluminal and may invade adjacent structures [44]. Nodal metastases are

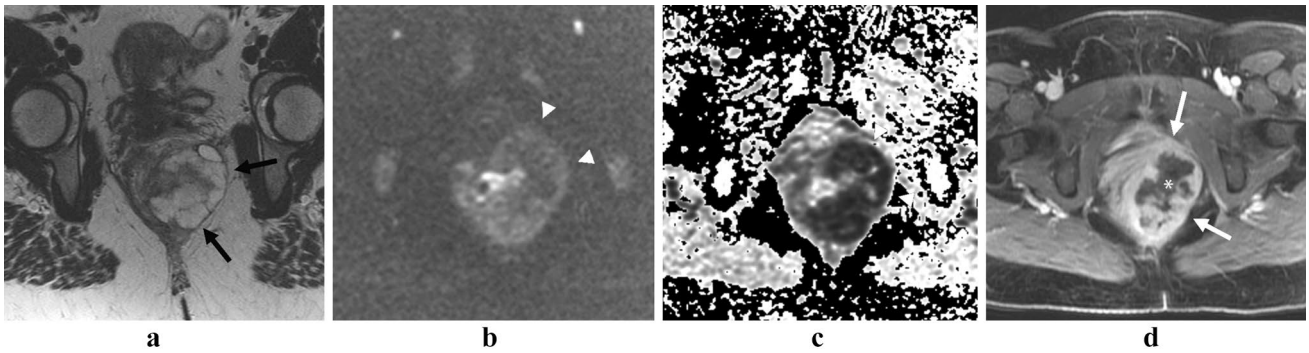

Fig. 7 Rectal leiomyosarcoma. 41-year-old woman with a lobulated, T2 hyperintense mass (arrows, **a**) with restricted diffusion (arrowheads; **b**, **c**). The lesion demonstrates internal areas of necrosis (* in **d**). The mass was a pathology proven leiomyosarcoma with extensive myxoid changes

uncommon. On MRI, rectal LMS may be very similar in appearance to rectal GIST. The mass is often isointense to skeletal muscle on T1-weighted images and heterogeneously hyperintense on T2-weighted images; degrees of enhancement and necrosis are variable, with the latter being more common in larger tumors [7, 44] (Fig. 7).

Prognosis is poor for these tumors and they tend to develop early hematogenous metastases; 5-year survival rates are between 20 and 40% [44].

Rectal angiosarcoma

Rectal angiosarcoma (AS) originates in the lymphatic and vascular endothelium [45]. These tumors are very rare and only a handful of case reports and series have been described [45–47]; thus, their natural history is unknown.

MRI findings have not been described for rectal AS. Case reports have described CT findings of rectal AS as a heterogeneously enhancing, eccentric bowel wall mass [46] or as a spiculated mass in rectal wall [47]. The example shown here is an infiltrative, partially circumferential mass with intermediate signal in T2- and T1-weighted images, restricted diffusion, and early enhancement (Fig. 8).

Metastatic lesions of the rectum

Although rare, the rectum can be the site of metastases arising from cancers in another organ, e.g., the stomach, ovary, and uterine cervix [48–50]. Metastases to the rectum have been reported as an intramural lesion [50], a polypoid mass [49], or circumferential thickening [48]. When there is a history of prior cancer or when in the presence of other metastases, it is important to remember that a mass in the rectum may in fact not be a primary lesion.

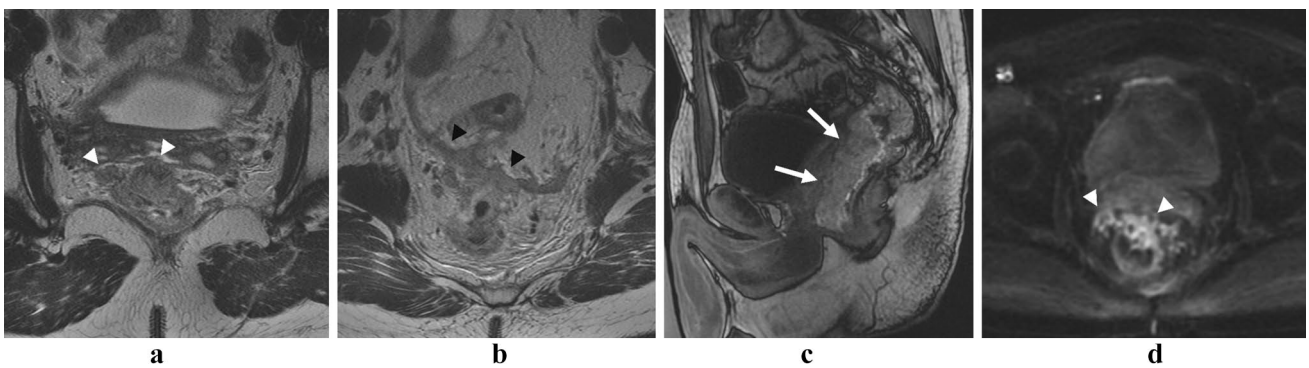

Fig. 8 Rectal angiosarcoma secondary to radiotherapy. 27-year-old man with Li-Fraumeni syndrome and history of multiple malignancies. Axial T2-weighted (**a** and **b**), sagittal dynamic arterial phase T1-weighted (**c**) and diffusion-weighted (**d**) MR images show a large partially circumferential and infiltrative mass along anterior rectal wall. The mass invades the prostate, seminal vesicles (white arrowheads in a and arrows in **c**) and anterior pelvic peritoneal reflection (black arrowheads in **b**). There is an intense early enhancement (arrows, **c**) and restricted diffusion (arrowheads, **d**)

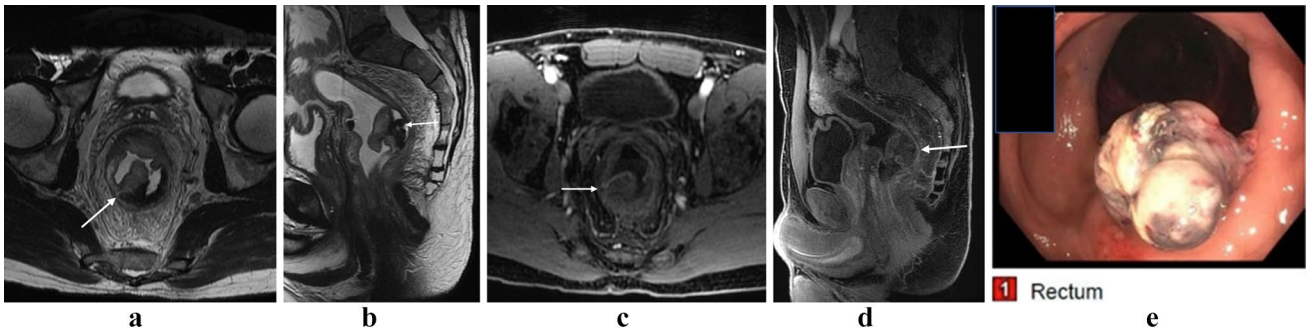

Fig. 9 Solitary rectal ulcer syndrome. 49-year-old male with rectal mass, presumed to be malignant on initial presentation. Axial (**a**, arrow) and sagittal (**b**, arrow) T2 images show rectal thickening with a polypoid mass. Post-contrast imaging shows enhancement within the lesion (**c** and **d**, arrows). Endoscopy shows an aggressive lesion arising from the rectal wall (**e**). Case courtesy of Perry Pickhardt, MD

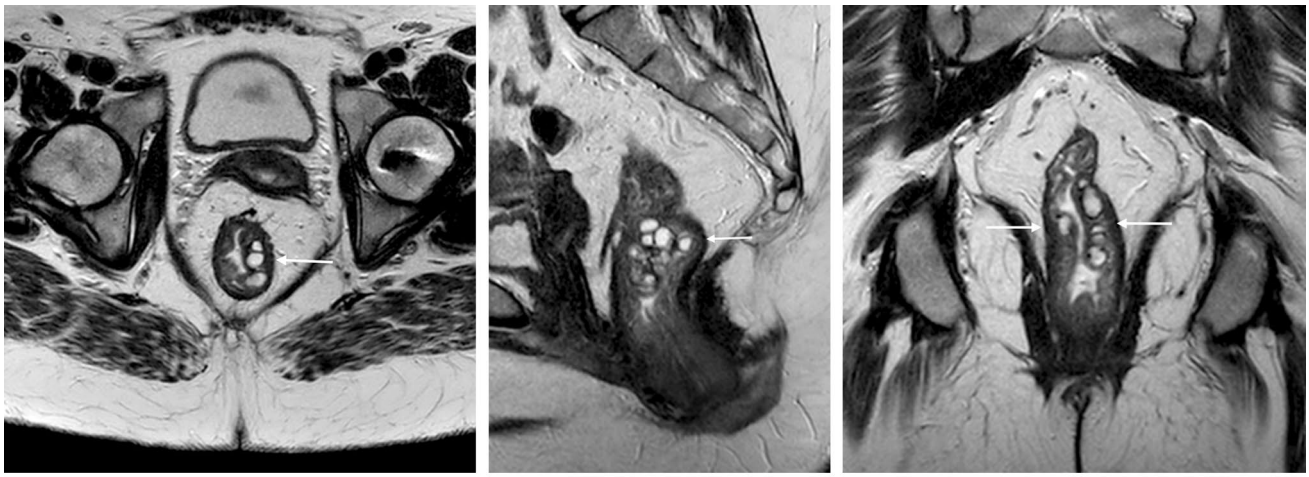

Fig. 10 Colitis cystica profunda. A variant of solitary rectal ulcer syndrome in which there is cystic dilatation of the mucous glands of the colon. Multiplanar T2-weighted images (a-c, arrows) show multiple submucosal cysts in the rectum measuring up to 2 cm. There is an association with rectal prolapse, diarrhea, andemia, and abdominal pain. Case courtesy of Perry Pickhardt, MD

Intramural benign lesions

Solitary rectal ulcer syndrome

Solitary rectal ulcer syndrome (SRUS) is a rare condition predominantly seen in young women, in which the lamina propria is replaced by fibrous tissue. Clinically, it can present with hematochezia and rectal prolapse, and on endoscopy it may appear as erythematous or ulcerated mucosa, sometimes with a polypoid or circumferential mass. Because of the clinical and endoscopic features, it is often initially thought to be a rectal cancer [51, 52].

MRI features of SRUS have been described in the literature [51, 52]. The MR appearance of SRUS may be variable, as either a polypoid or circumferential mass. Submucosal cysts within the mass have been described, but they are not consistently present [52]. Ultimately, histopathology is the reliable modality to make this rare diagnosis (Figs. 9, 10).

Rectal lipoma

Colonic lipomas are the most common benign non-epithelial tumors in the GI tract [7]. In the rectum, however, lipomas are very rare [53]. They may be submucosal (90%) or subserosal (10%) [7]. Patients are usually asymptomatic, but when the lipoma is > 2 cm, bleeding or constipation can occur [7, 53, 54]. On MRI, lipomas demonstrate signal loss with fat

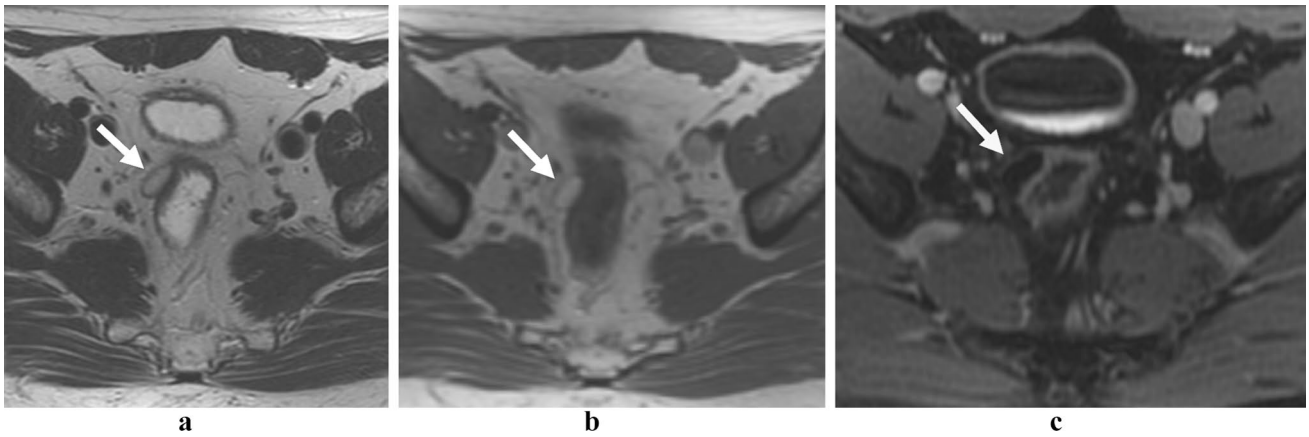

Fig. 11 Rectal lipoma. 33-year-old male with an incidental mass. Axial T2-weighted (**a**), T1-weighted (**b**), and fat-suppressed T1-weighted (**c**) MR images show small exophytic lesion on rectal wall (**a**–**c**, arrows) with high signal intensity on T1-weighted (**b**) and T2-weighted (**a**) images and signal loss on fat-suppression sequence (**c**)

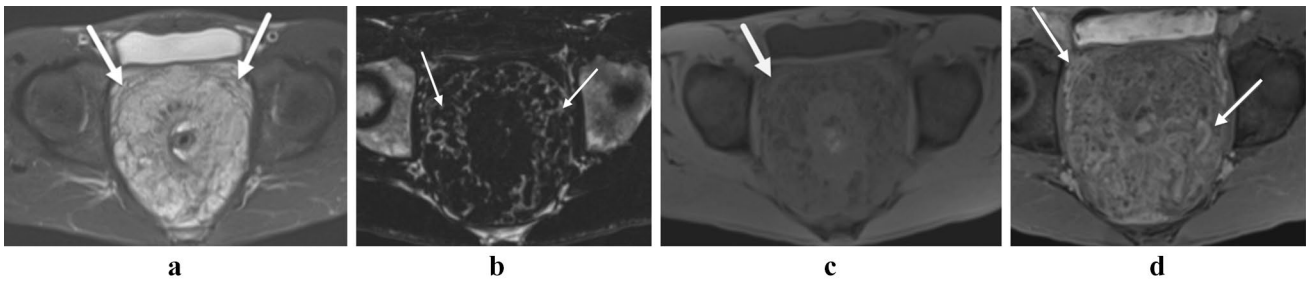

Fig. 12 Rectal hemangioma. Axial T2-weighted fat-suppressed (**a**), Dixon fat-suppressed (**b**), pre-contrast T1-weighted fat-suppressed, and post-contrast T1-weighted fat-suppressed (**d**) MR images show markedly thickened rectosigmoid (arrows). There are serpiginous vessels (arrows in **d**) and intralesional fat within the bulky lesion (arrows in **b**)

suppression and minimal or no enhancement [7] (Fig. 11). If the patient is asymptomatic, no treatment is required [55].

Rectal hemangioma

Rectal hemangiomas are also rare, but in the colon the rectosigmoid region is the most common location [56]. Hemangiomas in the GI tract may be single or multiple and have syndrome associations (i.e., Maffucci, Klippel–Trénaunay) [22]. Recurrent, painless bleeding is common, and these lesions can be diagnosed at any age [22, 57, 58]. MRI may show a submucosal, pedunculated, polypoid, or infiltrative lesion with very high T2-signal and adjacent serpiginous vessels [57]. Other clues that the lesion may be a hemangioma include the presence of pelvic phleboliths, often better seen on CT, and increased T2 signal intensity in the perirectal fat. Pre-operative embolization can be used to reduce the blood flow and reduce intraoperative bleeding if surgical resection is planned [59] (Fig. 12).

Infection

Occasionally, infectious processes can mimic a colon or rectal mass. One such entity is basidiobolomycosis, a fungus that is present in arid climates. In the abdomen, it most commonly presents as focal bowel thickening and is often mistaken for a colonic mass or inflammatory bowel disease.

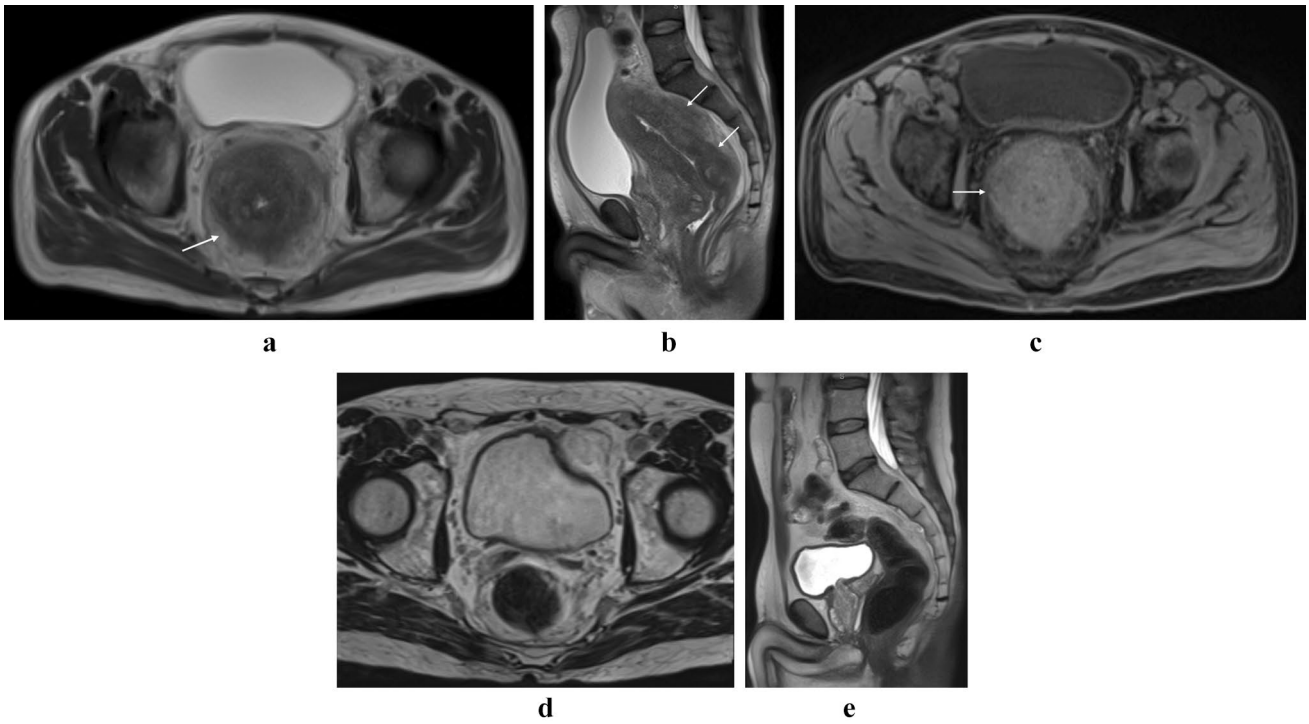

Fig. 13 Basidiobolomycosis. A rare fungal infection, more common in the south-west US, mimicking a circumferential rectal mass. Axial and sagittal T2-weighted images show the mass before treatment (**a** and **b**, arrows), with avid enhancement (**c**, arrow). After anti-fungal therapy, the mass has completely resolved, shown here on T2 images (**d** and **e**). Case courtesy of Bobby Kalb, MD

It can also affect the liver and may be a cause of misdiagnosis. Biopsy should confirm the diagnosis [60] (Fig. 13).

Extramural lesions

Endometriosis

In female patients, deep bowel invasive pelvic endometriosis can mimic a rectal mass clinically and on imaging [61]. The mass can be extrinsic or present with nodular thickening and most often involves the rectosigmoid colon. It can cause obstruction, and patients may present with bleeding and rectal pain [61]. The symptoms may be cyclic, related to the menstrual cycle.

Other features of deep pelvic endometriosis on MRI may provide clues that it is in fact not a conventional rectal mass, including the presence of an ovarian endometrioma, T2 hypointense thickening or nodularity of the pelvic ligaments, thickening of the torus uterine or a "kissing" morphology of the ovaries. An intermediate signal on T2-weighted images with foci of T1-hyperintensity is a classic finding. Restricted diffusion can be seen as well but does not distinguish deep pelvic endometriosis from other neoplasms [61, 62]. When deep pelvic endometrial implants invade through the serosa into the muscular layer of the rectum or colon, it forms a classic "mushroom cap sign," wherein low signal endometrial implants in the rectal wall are covered by a higher signal thickened mucosa that forms a "cap" [63] (Fig. 14).

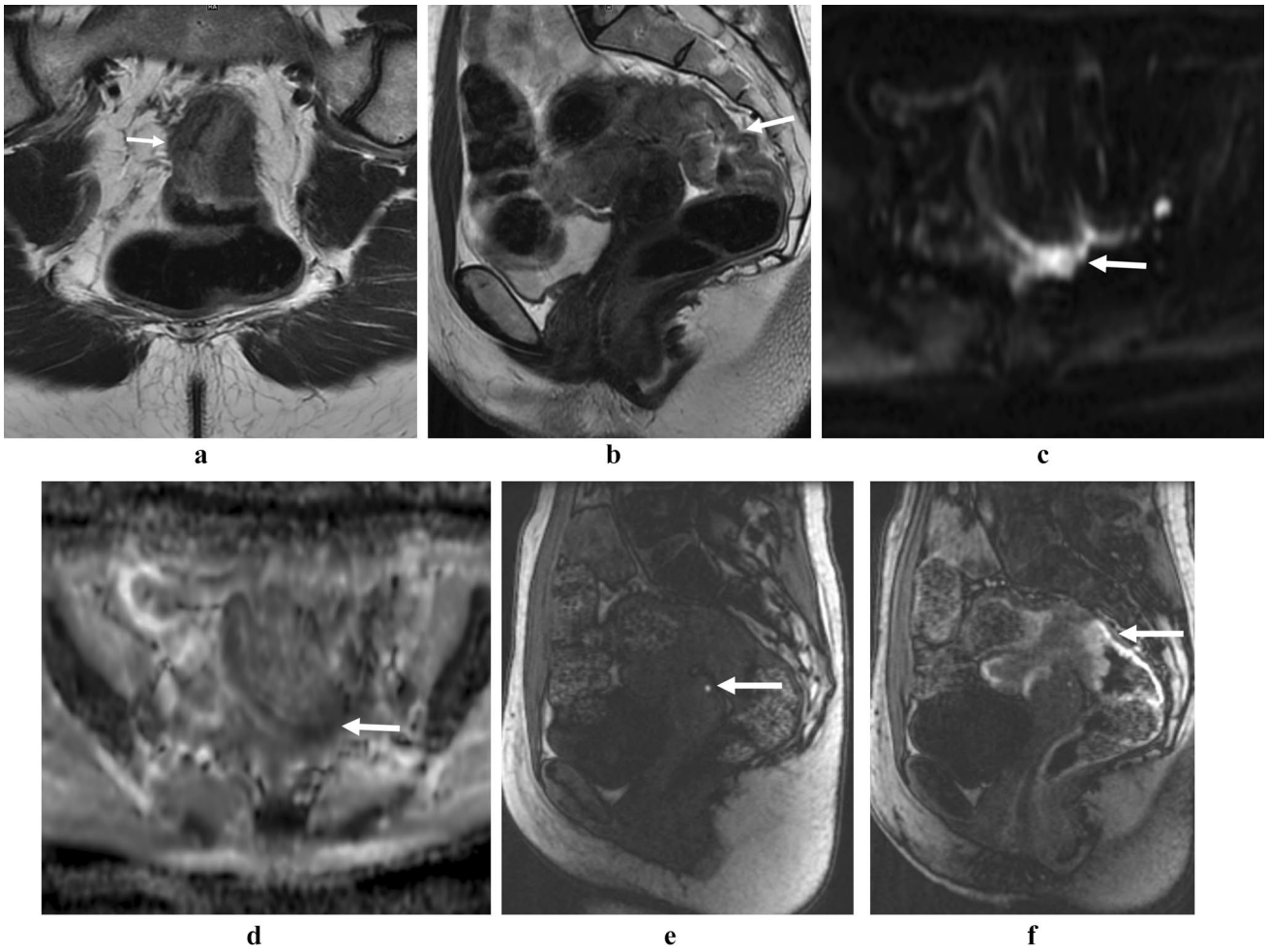

Fig. 14 Deep pelvic endometriosis mimicking a rectal mass. Axial (**a**) and sagittal (**b**) T2-weighted images show intermediate signal rectal thickening (arrows), with areas of corresponding restricted diffusion in the deep pelvis (**c** and **d**, arrows). Pre-contrast T1-weighted image (**e**, arrow) shows intrinsic hyperintense signal, consistent with endometriosis. Post-contrast the mass-like thickening of the rectum enhances (**f**, arrow)

Local rectal invasion from an adjacent malignancy

Other primary malignancies in the pelvis can invade the rectum locally, and it can be difficult to ascertain the primary lesion. Other pelvic organs such as the uterus, ovaries, and prostate may have aggressive biology with local rectal invasion.

Conclusion

The most common histological type of rectal neoplasms is adenocarcinoma; however, other histological types may occur within the rectum. Their characteristics are different, including risk factors, clinical manifestations, imaging findings, staging, treatment, and prognosis. Familiarity with the MRI appearance of these uncommon rectal neoplasms is useful for abdominal radiologists (Table 6).

Table 6 Important features of uncommon rectal tumors on imaging

Tumor type	Imaging features
NET	Superficial submucosal mass Smaller than 1 cm Intense contrast enhancement
Melanoma	High SI on T1WI (rectal lesion and lymph node) Very low in the rectum Less perirectal desmoplasia
GIST, leiomyosarcoma and leiomyoma	Submucosal mass, may have peritoneal or liver mets, without nodal metastases Endophytic/exophytic configuration for GIST Well-circumscribed lesion Without local invasion No lymphadenopathy Larger lesions may be heterogeneous Radiological differentiation is difficult
Angiosarcoma	Irregular wall thickening Heterogeneous enhancement Prominent vessels
Lipoma	High SI on T1WI and T2WI Signal loss on fat-suppression sequences
Lymphoma	Heterogeneous high SI on T2WI Homogeneous intermediate SI on T1WI Mild to moderate enhancement Often large without obstruction
Hemangioma	Very high SI on T2WI Progressive enhancement Vascular engorgement/changes in perirectal fat from increased vascularity Phleboliths (better seen on CT)

References

1. SEER Cancer Statistics Review, 1975-2015, National Cancer Institute. (2018). https://seer.cancer.gov/csr/1975_2015/. Accessed October 2018
2. Siegel RL, Fedewa SA, Anderson WF, Miller KD, Ma J, Rosenberg PS, Jemal A (2017) Colorectal Cancer Incidence Patterns in the United States, 1974-2013. J Natl Cancer Inst 109 (8). https://doi.org/10.1093/jnci/djw322
3. Patel UB, Taylor F, Blomqvist L, George C, Evans H, Tekkis P, Quirke P, Sebag-Montefiore D, Moran B, Heald R, Guthrie A, Bees N, Swift I, Pennert K, Brown G (2011) Magnetic resonance imaging-detected tumor response for locally advanced rectal cancer predicts survival outcomes: MERCURY experience. J Clin Oncol 29 (28):3753-3760. doi:https://doi.org/10.1200/JCO.2011.34.9068
4. Shihab OC, Taylor F, Salerno G, Heald RJ, Quirke P, Moran BJ, Brown G (2011) MRI predictive factors for long-term outcomes of low rectal tumours. Ann Surg Oncol 18 (12):3278-3284. doi:https://doi.org/10.1245/s10434-011-1776-2
5. Levine MS, Rubesin SE, Pantongrag-Brown L, Buck JL, Herlinger H (1997) Non-Hodgkin's lymphoma of the gastrointestinal tract: radiographic findings. AJR Am J Roentgenol 168 (1):165-172. doi:https://doi.org/10.2214/ajr.168.1.8976941
6. Ghai S, Pattison J, Ghai S, O'Malley ME, Khalili K, Stephens M (2007) Primary gastrointestinal lymphoma: spectrum of imaging findings with pathologic correlation. Radiographics 27 (5):1371-1388. doi:https://doi.org/10.1148/rg.275065151
7. Purysko AS, Coppa CP, Kalady MF, Pai RK, Leao Filho HM, Thupili CR, Remer EM (2014) Benign and malignant tumors of the rectum and perirectal region. Abdom Imaging 39 (4):824-852. doi:https://doi.org/10.1007/s00261-014-0119-8
8. Stanojevic GZ, Nestorovic MD, Brankovic BR, Stojanovic MP, Jovanovic MM, Radojkovic MD (2011) Primary colorectal lymphoma: An overview. World J Gastrointest Oncol 3 (1):14-18. doi:https://doi.org/10.4251/wjgo.v3.i1.14
9. Quayle FJ, Lowney JK (2006) Colorectal lymphoma. Clin Colon Rectal Surg 19 (2):49-53. doi:https://doi.org/10.1055/s-2006-942344
10. Lee WK, Lau EW, Duddalwar VA, Stanley AJ, Ho YY (2008) Abdominal manifestations of extranodal lymphoma: spectrum of imaging findings. AJR Am J Roentgenol 191 (1):198-206. doi:https://doi.org/10.2214/AJR.07.3146
11. Lin C, Itti E, Luciani A, Haioun C, Meignan M, Rahmouni A (2010) Whole-body diffusion-weighted imaging in lymphoma. Cancer Imaging 10 Spec no A:S172-178. https://doi.org/10.1102/1470-7330.2010.9029
12. Cheson BD, Fisher RI, Barrington SF, Cavalli F, Schwartz LH, Zucca E, Lister TA, Alliance AL, Lymphoma G, Eastern Cooperative Oncology G, European Mantle Cell Lymphoma C, Italian Lymphoma F, European Organisation for R, Treatment of Cancer/Dutch Hemato-Oncology G, Grupo Espanol de Medula O, German High-Grade Lymphoma Study G, German Hodgkin's Study G, Japanese Lymphorra Study G, Lymphoma Study A, Group NCT, Nordic Lymphoma Study G, Southwest Oncology G, United Kingdom National Cancer Research I (2014) Recommendations for initial evaluation, staging, and response assessment of Hodgkin and non-Hodgkin lymphoma: the Lugano classification. J Clin Oncol 32 (27):3059-3068. doi:https://doi.org/10.1200/JCO.2013.54.8800
13. Tsikitis VL, Wertheim BC, Guerrero MA (2012) Trends of incidence and survival of gastrointestinal neuroendocrine tumors in the United States: a seer analysis. Journal of Cancer 3:292-302. doi:https://doi.org/10.7150/jca.4502
14. Chung TP, Hunt SR (2006) Carcinoid and neuroendocrine tumors of the colon and rectum. Clin Colon Rectal Surg 19 (2):45-48. doi:https://doi.org/10.1055/s-2006-942343
15. Kim JY, Hong SM (2016) Recent Updates on Neuroendocrine Tumors From the Gastrointestinal and Pancreatobiliary Tracts. Arch Pathol Lab Med 140 (5):437-448. doi:https://doi.org/10.5858/arpa.2015-0314-RA
16. Mocellin S, Nitti D (2013) Gastrointestinal carcinoid: epidemiological and survival evidence from a large population-based study (n = 25 531). Ann Oncol 24 (12):3040-3044. doi:https://doi.org/10.1093/annonc/mdt377
17. Yao JC, Hassan M, Phan A, Dagohoy C, Leary C, Mares JE, Abdalla EK, Fleming JB, Vauthey JN, Rashid A, Evans DB (2008) One hundred years after "carcinoid": epidemiology of and prognostic factors for neuroendocrine tumors in 35,825 cases in the United States. J Clin Oncol 26 (18):3063-3072. doi:https://doi.org/10.1200/JCO.2007.15.4377
18. Weinstock B, Ward SC, Harpaz N, Warner RR, Itzkowitz S, Kim MK (2013) Clinical and prognostic features of rectal neuroendocrine tumors. Neuroendocrinology 98 (3):180-187. doi:https://doi.org/10.1159/000355612
19. Rodrigues A, Castro-Pocas F, Pedroto I (2015) Neuroendocrine Rectal Tumors: Main Features and Management. GE Port J Gastroenterol 22 (5):213-220. doi:https://doi.org/10.1016/j.jpge.2015.04.008
20. Baxi AJ, Chintapalli K, Katkar A, Restrepo CS, Betancourt SL, Sunnapwar A (2017) Multimodality Imaging Findings in Carcinoid Tumors: A Head-to-Toe Spectrum. Radiographics 37 (2):516-536. doi:https://doi.org/10.1148/rg.2017160113

21. Kim KW, Ha HK, Kim AY, Kim TK, Kim JS, Yu CS, Park SW, Park MS, Kim HJ, Kim PN, Kim JC, Lee MG (2004) Primary malignant melanoma of the rectum: CT findings in eight patients. Radiology 232 (1):181-186. doi:https://doi.org/10.1148/radiol.2321030909
22. Lee NK, Kim S, Kim GH, Jeon TY, Kim DH, Jang HJ, Park DY (2010) Hypervascular subepithelial gastrointestinal masses: CT-pathologic correlation. Radiographics 30 (7):1915-1934. doi:https://doi.org/10.1148/rg.307105028
23. Kim H, Kim JH, Lim JS, Choi JY, Chung YE, Park MS, Kim MJ, Kim KW, Kim SK (2011) MRI findings of rectal submucosal tumors. Korean J Radiol 12 (4):487-498. doi:https://doi.org/10.3348/kjr.2011.12.4.487
24. Araujo PB, Cheng S, Mete O, Serra S, Morin E, Asa SL, Ezzat S (2013) Evaluation of the WHO 2010 grading and AJCC/UICC staging systems in prognostic behavior of intestinal neuroendocrine tumors. PLoS One 8 (4):e61538. doi:https://doi.org/10.1371/journal.pone.0061538
25. Amin MBE, S.B.; Greene, F.L.; et. al (2017) AJCC Cancer Staging Manual. Springer 8th Edition
26. Chae WY, Lee JL, Cho DH, Yu CS, Roh J, Kim JC (2016) Preliminary Suggestion about Staging of Anorectal Malignant Melanoma May Be Used to Predict Prognosis. Cancer Res Treat 48 (1):240-249. doi:https://doi.org/10.4143/crt.2014.305
27. Li P, Liu J (2016) Diagnostic value of MRI and computed tomography in anorectal malignant melanoma. Melanoma Res 26 (1):46-50. doi:https://doi.org/10.1097/CMR.0000000000000198
28. Postow MA, Hamid O, Carvajal RD (2012) Mucosal melanoma: pathogenesis, clinical behavior, and management. Curr Oncol Rep 14 (5):441-448. doi:https://doi.org/10.1007/s11912-012-0244-x
29. Ologun GO, Stevenson Y, Shen A, Rana NK, Hussain A, Bertsch D, Cagir B (2017) Anal Melanoma in an Elderly Woman Masquerading as Hemorrhoid. Cureus 9 (11):e1880. doi:https://doi.org/10.7759/cureus.1880
30. Kohli S, Narang S, Singhal A, Kumar V, Kaur O, Chandoke R (2014) Malignant melanoma of the rectum. J Clin Imaging Sci 4:4. doi:https://doi.org/10.4103/2156-7514.126031
31. Matalon SA, Mamon HJ, Fuchs CS, Doyle LA, Tirumani SH, Ramaiya NH, Rosenthal MH (2015) Anorectal Cancer: Critical Anatomic and Staging Distinctions That Affect Use of Radiation Therapy. Radiographics 35 (7):2090-2107. doi:https://doi.org/10.1148/rg.2015150037
32. Wang M, Zhang Z, Zhu J, Sheng W, Lian P, Liu F, Cai S, Xu Y (2013) Tumour diameter is a predictor of mesorectal and mesenteric lymph node metastases in anorectal melanoma. Colorectal Dis 15 (9):1086-1092. doi:https://doi.org/10.1111/codi.12250
33. Bello DM, Smyth E, Perez D, Khan S, Temple LK, Ariyan CE, Weiser MR, Carvajal RD (2013) Anal versus rectal melanoma: does site of origin predict outcome? Dis Colon Rectum 56 (2):150-157. doi:https://doi.org/10.1097/DCR.0b013e31827901dd
34. Jiang ZX, Zhang SJ, Peng WJ, Yu BH (2013) Rectal gastrointestinal stromal tumors: imaging features with clinical and pathological correlation. World J Gastroenterol 19 (20):3108-3116. doi:https://doi.org/10.3748/wjg.v19.i20.3108
35. Yasui M, Tsujinaka T, Mori M, Takahashi T, Nakashima Y, Nishida T, Kinki GSG (2017) Characteristics and prognosis of rectal gastrointestinal stromal tumors: an analysis of registry data. Surg Today. https://doi.org/10.1007/s00595-017-1524-8
36. Yu MH, Lee JM, Baek JH, Han JK, Choi BI (2014) MRI features of gastrointestinal stromal tumors. AJR Am J Roentgenol 203 (5):980-991. doi:https://doi.org/10.2214/AJR.13.11667
37. Levy AD, Remotti HE, Thompson WM, Sobin LH, Miettinen M (2003) Gastrointestinal stromal tumors: radiologic features with pathologic correlation. Radiographics 23 (2):283-304, 456; quiz 532. https://doi.org/10.1148/rg.232025146
38. Gaskin CM, Helms CA (2004) Lipomas, lipoma variants, and well-differentiated liposarcomas (atypical lipomas): results of MRI evaluations of 126 consecutive fatty masses. AJR Am J Roentgenol 182 (3):733-739. doi:https://doi.org/10.2214/ajr.182.3.1820733
39. Nassif MO, Trabulsi NH, Bullard Dunn KM, Nahal A, Meguerditchian AN (2013) Soft tissue tumors of the anorectum: rare, complex and misunderstood. J Gastrointest Oncol 4 (1):82-94. doi:https://doi.org/10.3978/j.issn.2078-6891.2012.042
40. Thiels CA, Bergquist JR, Krajewski AC, Lee HE, Nelson H, Mathis KL, Habermann EB, Cima RR (2017) Outcomes of Primary Colorectal Sarcoma: A National Cancer Data Base (NCDB) Review. J Gastrointest Surg 21 (3):560-568. doi:https://doi.org/10.1007/s11605-016-3347-0
41. Hoshino N, Hida K, Kawada K, Sakurai T, Sakai Y (2017) Transanal total mesorectal excision for a large leiomyosarcoma at the lower rectum: a case report and literature review. Surg Case Rep 3 (1):13. doi:https://doi.org/10.1186/s40792-017-0289-z
42. Oruc MT, Mayir B, Bilecik T, Sakar A, Erinekci AR (2015) Rectal leiomyosarcoma, late complication of pelvic radiotherapy. Int J Colorectal Dis 30 (4):571-572. doi:https://doi.org/10.1007/s00384-014-2020-x
43. Futuri S, Donohoe K, Spaccavento C, Yudelman I (2014) Rectal leiomyosarcoma: a rare and long-term complication of radiation therapy. BMJ Case Rep 2014. https://doi.org/10.1136/bcr-2014-205240
44. Ouh YT, Hong JH, Min KJ, So KA, Lee JK (2013) Leiomyosarcoma of the rectum mimicking primary ovarian carcinoma: a case report. J Ovarian Res 6 (1):27. doi:https://doi.org/10.1186/1757-2215-6-27
45. Gaballah AH, Jensen CT, Palmquist S, Pickhardt PJ, Duran A, Broering G, Elsayes KM (2017) Angiosarcoma: clinical and imaging features from head to toe. Br J Radiol 90 (1075):20170039. doi:https://doi.org/10.1259/bjr.20170039
46. Brown CJ, Falck VG, MacLean A (2004) Angiosarcoma of the colon and rectum: report of a case and review of the literature. Dis Colon Rectum 47 (12):2202-2207. doi:https://doi.org/10.1007/s10350-004-0698-5
47. Tardio JC, Najera L, Alemany I, Martin T, Castano A, Perez-Regadera JF (2009) Rectal angiosarcoma after adjuvant chemoradiotherapy for adenocarcinoma of the rectum. J Clin Oncol 27 (27):e116-117. doi:https://doi.org/10.1200/JCO.2008.21.1979
48. Derin D, Eralp Y, Guney N, Ozluk Y, Topuz E (2008) Ovarian carcinoma with simultaneous breast and rectum metastases. Onkologie 31 (4):200-202. doi:https://doi.org/10.1159/000119121
49. Tural D, Selcukbiricik F, Ercaliskan A, Inanc B, Gunver F, Buyukunal E (2012) Metachronous rectum metastases from gastric adenocarcinoma: a case report. Case Rep Med 2012:726841. doi:https://doi.org/10.1155/2012/726841
50. Wu YC, Yang CF, Hsu CN, Hsieh TC (2013) Intramural metastases of rectum from carcinosarcoma (malignant mullerian mixed tumor) of uterine cervix. Clin Nucl Med 38 (2):137-139. doi:https://doi.org/10.1097/RLU.0b013e318266d4bd
51. Amaechi I, Papagrigoriadis S, Hizbullah S, Ryan SM (2010) Solitary rectal ulcer syndrome mimicking rectal neoplasm on MRI. The British journal of radiology 83 (995):e221-224. doi:https://doi.org/10.1259/bjr/24752209
52. Blanco F, Frasson M, Flor-Lorente B, Minguez M, Esclapez P, Garcia-Granero E (2011) Solitary rectal ulcer: ultrasonographic and magnetic resonance imaging patterns mimicking rectal cancer. European journal of gastroenterology & hepatology 23 (12):1262-1266. doi:https://doi.org/10.1097/MEG.0b013e32834b0dee
53. Martellucci J, Civitelli S, Tanzini G (2011) Transanal resection of rectal lipoma mimicking rectal prolapse: description of a case and review of the literature. ISRN Surg 2011:170285. doi:https://doi.org/10.5402/2011/170285

54. Fernandes J, Libanio D, Giestas S, Araujo T, Martinez-Ares D, Certo M, Lopes L (2018) Giant symptomatic rectal lipoma resected by endoscopic submucosal dissection. Endoscopy 50 (3):E63-E64. doi:https://doi.org/10.1055/s-0043-123876
55. Arora R, Kumar A, Bansal V (2011) Giant rectal lipoma. Abdom Imaging 36 (5):545-547. doi:https://doi.org/10.1007/s00261-010-9668-7
56. Levy AD, Abbott RM, Rohrmann CA, Jr., Frazier AA, Kende A (2001) Gastrointestinal hemangiomas: imaging findings with pathologic correlation in pediatric and adult patients. AJR Am J Roentgenol 177 (5):1073-1081. doi:https://doi.org/10.2214/ajr.177.5.1771073
57. Yoo S (2011) GI-Associated Hemangiomas and Vascular Malformations. Clin Colon Rectal Surg 24 (3):193-200. doi:https://doi.org/10.1055/s-0031-1286003
58. Tan MC, Mutch MG (2006) Hemangiomas of the pelvis. Clin Colon Rectal Surg 19 (2):94-101. doi:https://doi.org/10.1055/s-2006-942350
59. Carvalho RGFMRU, G.; Guzela, V.R.; Joviliano, E.E; Féres, O.; Rocha, J.J.R. (2014) Preoperative embolization of a cavernous hemangioma of the rectum. Journal of Coloproctology 34 (1):52-54. doi:http://doi.org/10.1016/j.jcol.2013.12.008
60. Flicek KT, Vikram HR, De Petris GD, Johnson CD (2015) Abdominal imaging findings in gastrointestinal basidiobolomycosis. Abdom Imaging 40 (2):246-250. doi:https://doi.org/10.1007/s00261-014-0212-z
61. Ganguly A, Meredith S, Probert C, Kraecevic J, Anosike C (2016) Colorectal cancer mimics: a review of the usual suspects with pathology correlation. Abdominal Radiology 41 (9):1851-1866. doi:https://doi.org/10.1007/s00261-016-0771-2
62. Siegelman ES, Oliver ER (2012) MR Imaging of Endometriosis: Ten Imaging Pearls. RadioGraphics 32 (6):1675-1691. doi:https://doi.org/10.1148/rg.326125518
63. Arevalo N, Mendez R (2018) "Mushroom cap" sign in deep rectosigmoid endometriosis. Abdom Radiol (NY) 43 (11):3201-3203. https://doi.org/10.1007/s00261-018-1596-y