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Imaging of acute anorectal conditions with CT and MRI

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Abstract

Anorectal disorders are a common cause of presentation to the emergency department (ED). While the most frequently encountered anorectal conditions, such as hemorrhoids and anal fissures, are relatively benign and do not require imaging for diagnosis or management, there are multiple potentially life threatening anorectal conditions for which imaging is an important component of evaluation, diagnosis, and management. Although computed tomography (CT) is the most commonly used imaging modality for evaluation of anorectal pathology in the ED, magnetic resonance imaging (MRI) has an increasingly important role in the detection, characterization and management of specific anorectal conditions. This pictorial essay will review the imaging anatomy of the anorectum, summarize imaging protocols, and discuss the clinical presentation, imaging appearance, and differential diagnosis of anorectal conditions that may present to the emergency department, including infectious, inflammatory, malignant and vascular conditions.

Key words: Anorectal—Perianal—Proctitis—Fistula—Emergency

Anal and rectal pain and rectal bleeding are frequent complaints among patients seeking care in the emergency department (ED). Anorectal complaints in the ED can be associated with great stress or embarrassment for the patient, leading to delayed presentation, with patients attempting to self-treat or cope with symptoms [1]. Anorectal conditions may be misdiagnosed on initial clinical evaluation, making familiarity with the imaging appearance of emergent anorectal pathology particularly important for the practicing radiologist [2]. In this pictorial essay, we will review the normal anatomy of the anorectum and discuss emergent anorectal disease with a focus on the usual clinical presentation and typical imaging appearance, as well as potential imaging pitfalls.

Anatomy of the anorectum

Anterior to the third sacral body, the taenia coli of the sigmoid colon fuse and the rectum begins. The rectum spans a length of approximately 15 cm and angles acutely as it passes through the puborectalis muscle to form the anal canal. The upper third of the rectum is covered by peritoneum anterolaterally, the middle third is covered anteriorly only, and the lower third has no peritoneal covering. Knowledge of the relationship of the rectum to the peritoneal reflection is important, as rectal processes may have intra or extraperitoneal manifestations depending upon the site of pathology. For example, perforation at the rectosigmoid junction leads to free intraperitoneal air, whereas low rectal perforations results in confined gas in the mesorectal fat or presacral space. Differentiation of intraperitoneal and extraperitoneal rectal injuries significantly alters clinical management [3].

Arterial supply to the rectum arises from the superior, middle, and inferior rectal arteries, which arise from the inferior mesenteric artery, internal iliac artery, and internal pudendal artery, respectively. The superior rectal artery terminal branches supply the anal canal above the dentate line. The middle and inferior rectal arteries supply the lower anal canal. Although this is the con-

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ventional vascular anatomy, the three branches of the rectal arteries anastomose with each other and have overlap.

The anal canal is approximately 3–4.5 cm in length. The dentate line, which divides the upper two thirds from the lower one third of the anal canal, marks the transition from columnar epithelium to stratified squamous epithelium. Although the dentate line is not visible on imaging, its position can be inferred by dividing the anal canal into thirds. Superior to the dentate line, the anal mucosa forms longitudinal folds, known as the columns of Morgagni, with crypts between the columns containing mucus-forming glands. These glands are generally subepithelial in location, but can extend through the internal sphincter, forming a pathway of communication between the anal lumen and the sphincter muscles [4]. The anal verge is defined as the junction between the anal epithelium and perianal skin.

The anal sphincter complex is formed by the internal and external sphincters, as well as the intersphincteric space. At the anorectal junction, the inner circular layer of the muscularis propria of the rectum becomes the internal anal sphincter. The external sphincter is continuous with the puborectalis muscle cranially, which is formed by the innermost fibers of the levator ani. The external anal sphincter has three parts: subcutaneous, superficial, and deep. The puborectalis muscle forms a sling around the anorectum. The components of the anal sphincter are well depicted on coronal and axial MRI (Fig. 1).

The ischiorectal fossae are paired pyramidal spaces bounded by the levator ani superiorly, the deep transverse perineal fascia inferiorly, the anal canal medially, the obturator fascia and obturator internus muscle laterally, and the gluteus maximus and sacrotuberous ligament posteriorly. Contents include adipose tissue and nerves, vessels, and lymphatics. Mesorectal fat surrounds the upper rectum and is bounded by the mesorectal fascia. Anteriorly the mesorectal fascia forms the Denonvilliers fascia while posteriorly it forms Waldeyer's fascia.

Imaging protocols

Although MRI provides superior diagnostic yield for most anorectal pathologies, CT is usually the first line imaging modality in patients with acute symptoms, especially in those patients presenting to the emergency department. The advantages of CT include greater availability, lower cost, rapid acquisition, high patient tolerance, excellent spatial resolution and delineation of even small amounts of free air, calcification or hemorrhage.

The appropriate CT protocol may vary depending upon patient presentation and differential diagnosis. Although rectal contrast is not routinely necessary, in patients with a history of rectal trauma, administration of rectal contrast may help to demonstrate perforation. Barium administration is contraindicated in patients with suspected bowel perforation; a water-soluble

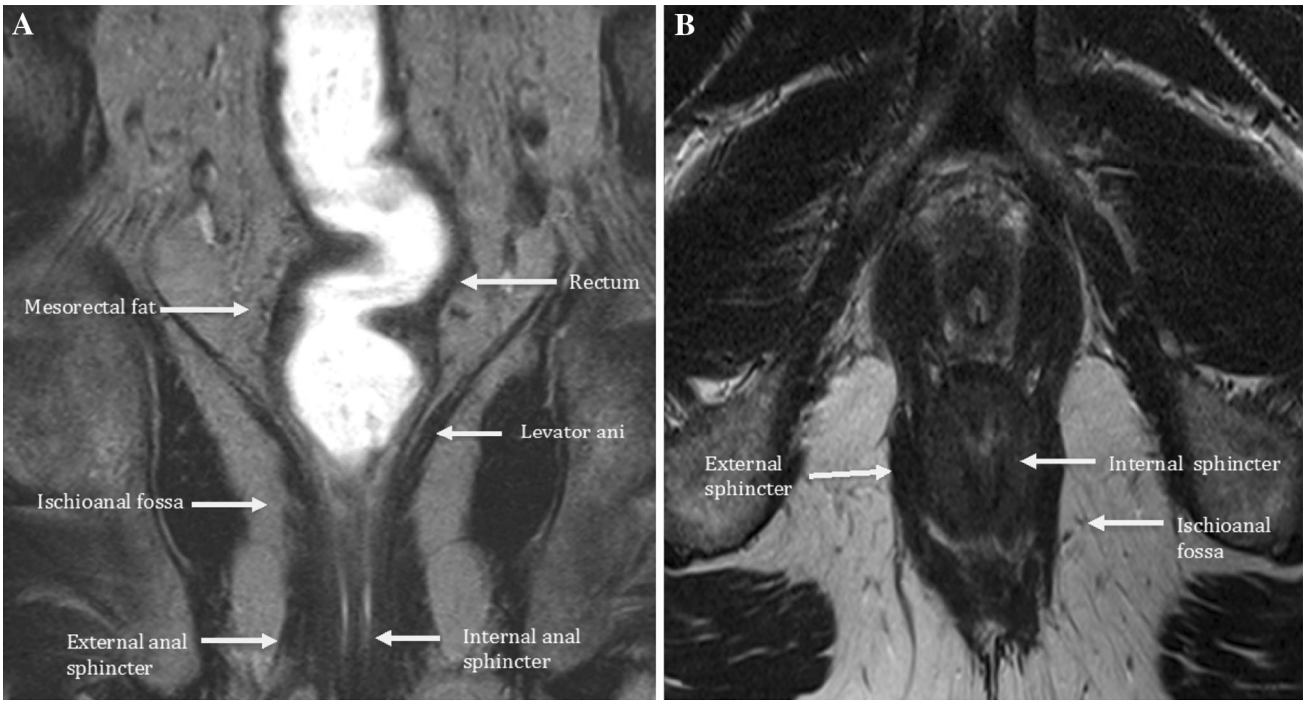

Fig. 1. Normal anatomy of the rectum and anus on MRI. Coronal T2 weighted turbo spin echo (T2 TSE) image of the rectum and anus demonstrates the normal anatomic structures (**A**). Axial small field of view (FOV) T2 TSE image demonstrates the anatomy of the perineum (**B**).

contrast such as dilute sodium-megluminediatrizoate (Gastrografin, Bracco Imaging) or other iodine based contrast agent should be used instead. Administration of intravenous contrast is much preferred to noncontrast examination, as it is helpful in elucidating small fluid collections and inflammatory changes, and in better delineating anatomic relationships. Creation of multiplanar reconstructions in CT (and acquisition of multiplanar imaging in MRI) can be crucial in both detection and characterization of anorectal pathology. In cases of suspected gastrointestinal bleeding, CT angiography is indicated, with an arterial phase obtained using an injection rate of at least 4 ml/sec with bolus triggering from a region of interest placed on the abdominal aorta. An unenhanced CT scan should be acquired immediately prior to CT angiography when evaluating for gastrointestinal bleeding to identify high attenuation material in the bowel lumen that might lead to a false positive interpretation. A delayed venous phase should also be acquired at 50–60 s to assess bowel wall enhancement and to evaluate for accumulating intraluminal contrast extravasation.

The primary disadvantages of CT are its inferior soft tissue contrast resolution compared to MRI and exposure to ionizing radiation. The superior soft tissue contrast resolution of MRI is advantageous in most clinical scenarios, but particularly for accurately diagnosing and depicting perianal fistulae and their relationship to the anal sphincter, demonstrating fistulae between pelvic organs, and in local staging of pelvic malignancies [5, 6]. In some disease processes, the two modalities are relatively equivalent, such as grading of inflammatory bowel disease, but MRI may be preferred because of the lack of ionizing radiation [7]. Radiation dose associated with CT is of particular concern in young patients and patients who present with acute manifestations of chronic illnesses such as Crohn disease, which may require repeated imaging. Patients should be screened for renal impairment prior to administration of intravenous contrast. In patients with compromised renal function, noncontrast MRI is a much preferable alternative to noncontrast CT given the superior contrast resolution achievable on non-contrast MRI examinations, except in the setting of acute traumatic injury where perforation is a concern and rectal contrast is used.

Patient selection is essential when considering MR imaging, as not all patients can safely or comfortably undergo MRI. Screening for safety is required in all patients undergoing MRI. Patients at risk for renal impairment should also be screened before administration of gadolinium-based contrast agents. In patients with claustrophobia or patients who have difficulty following instructions, the potential for poor image quality due to motion should be weighed against the benefits of MRI. Although artifacts from metal hip replacements can be problematic in both CT and MRI, better image quality can generally be obtained with MRI than with CT, even with advances in metal artifact reduction techniques.

High resolution T1 weighted GRE post contrast images and T2 weighted images with and without fat saturation are used for the detection and characterization of abscess or perianal fistulae (Table 1). Fat saturated T2 weighted images increase the conspicuity of a fistula or collection, while non fat-saturated images better depict

Fig. 2. Proctitis secondary to ulcerative colitis. Contrast enhanced CT image demonstrates thickening of the rectal wall with mucosal hyperemia (*black arrow*) and adjacent fat stranding (*asterisk*) with thickening of the mesorectal fascia (*black dashed arrow*), and engorgement of the perirectal vessels (*white dashed arrows*) compatible with active proctitis.

Table 1. Sample protocol for pelvic MRI for perianal abscess/fistula evaluation

Plane	Sequence	TE/TR	Flip angle	Bandwidth	FOV	Matrix size	Slice thickness/spacing (mm)
3 Plane localizer				473	38	320 × 320	5.5
Sagittal	T2W TSE	101/4200	90	127	18	320 × 192	3.2/0.4
Oblique axial	T2 W TSE	202/4200	90	127	18	320 × 192	3.2/0
Oblique axial	FS T2W TSE	101/3900	90	127	18	320 × 192	3.2/0
Coronal	T2W TSE	106/3720	90	127	18	320 × 224	3.2/0.4
Oblique axial	Small FOV HR T1W GRE +C	3.45/7.79	90	290	23.3	512 × 512	2.0
Oblique axial	Large FOV T1W 3D GRE +C	2.42/5.24	9	620	35.6	512 × 512	3.0
Coronal	T1W 3D GRE +C	1.94/4.23	9	620	35	384 × 314	3.0
Oblique axial	DWI	78/6100		1512	22	114 × 114	3.0

FOV, field of view; T2W, T2 weighted; TSE, turbo spin echo; T1W, T1 weighted; HR, high resolution; GRE, gradient recalled echo; 3D, three dimensional; DWI, Diffusion weighted imaging, +C, with intravenous contrast

the sphincter anatomy [8]. Post-contrast images are helpful in demonstrating pathology and differentiating drainable abscesses from phlegmon. Diffusion weighted imaging is also a useful technique for identifying inflammation in patients who have contraindications to intravenous contrast administration [9]. Although use of both external coils and an endoluminal coil can improve spatial resolution, in most institutions external coils are used alone, particularly in the setting of a suspected acute anal or rectal process, given that insertion of an endorectal coil is often poorly tolerated [10, 11].

The field of view (FOV) should be tailored to the anatomy that is to be imaged and to the patient's body habitus. Image acquisition should be performed in planes orthogonal to the area of interest, whether the rectum or the anus. For example, when evaluating perianal fistula, oblique axial and coronal images should be oriented orthogonal and parallel to the anal canal, respectively.

In addition to cross sectional imaging with CT and MRI, abdominal radiographs and contrast enema have limited but contributory roles in the imaging evaluation of anorectal conditions. Abdominal radiographs may demonstrate free intraperitoneal air or the presence and location of foreign bodies. Conventional fluoroscopic techniques have largely been replaced by CT with rectal contrast in the emergent setting, but can serve a supplementary role in the setting of rectal obstruction or perforation.

Anorectal conditions

Proctitis

Proctitis, defined as inflammation of the rectum and anus, has many causes with substantial overlap in both symptoms and imaging appearance. Potential etiologies include inflammatory bowel disease, including both

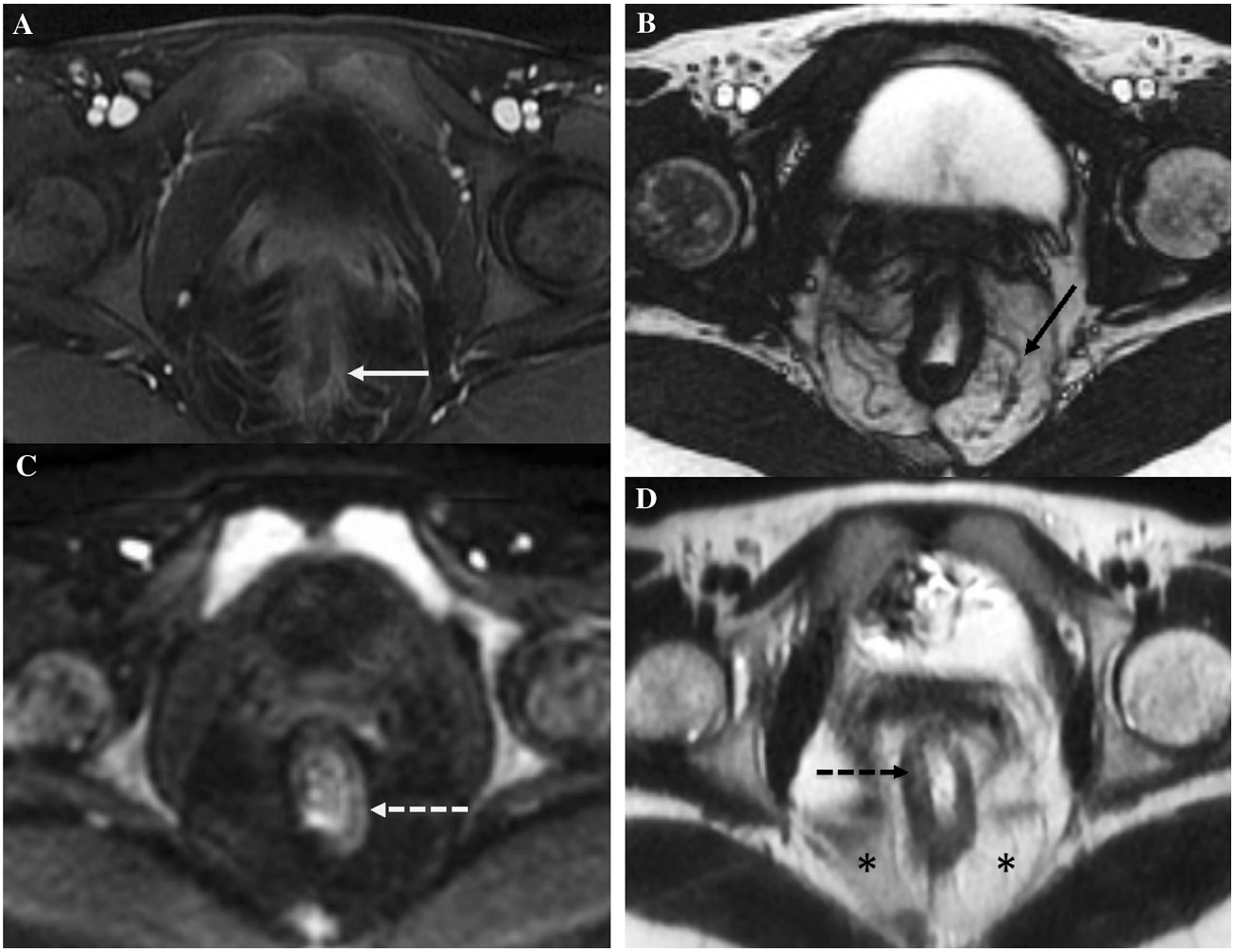

Fig. 3. Proctitis secondary to ulcerative colitis. Axial post-contrast T1 weighted GRE (**A**), balanced steady state gradient echo (**B**), DWI (**C**), and T2 TSE (**D**) images demonstrate rectal wall thickening, engorgement of the perirectal vessels (*black arrow*), mucosal hyperenhancement with mural stratification (*white arrow*), diffusion restriction (*white dashed arrow*), and intramural T2 hyperintensity (*black dashed arrow*), findings compatible with active proctitis. There is proliferation of the mesorectal fat (*asterisk*), suggesting acute on chronic disease.

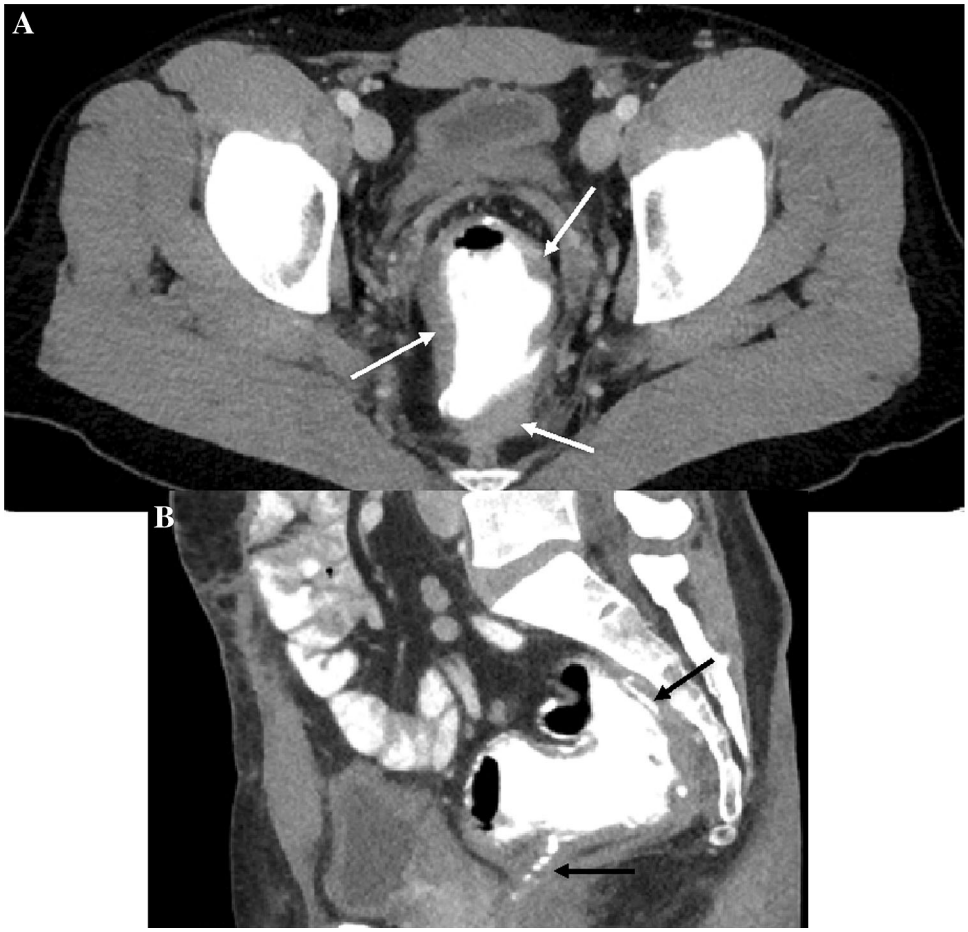

Fig. 4. Pouchitis in a patient with a history of colon cancer status post total colectomy with ileoanal anastomosis, presenting with pain and diarrhea. Axial (**A**) and sagittal (**B**) CT images with oral and intravenous contrast demonstrate diffuse wall thickening of the pouch (*white arrows*). Anastomotic suture is noted (*black arrows*).

Fig. 5. Rectal syphilis in a patient presenting with pain and bloody bowel movements. Contrast enhanced axial CT of the pelvis demonstrates circumferential rectal wall thickening (*arrow*). There is inflammatory fat stranding (*asterisk*) and reactive lymphadenopathy in the adjacent perirectal fat (*dashed arrow*).

Crohns disease and ulcerative colitis (UC), infection, stercoral colitis, radiation, and ischemia. The most common symptom of proctitis is the uncomfortable and frequent urge to have a bowel movement, but other symptoms include bloody bowel movements, rectal bleeding, a feeling of fullness and incomplete evacuation, pain or soreness, cramps or pain during defecation, discharge of mucus or pus, and diarrhea.

The imaging appearance of acute proctitis on CT (Fig. 2) typically includes circumferential, generally concentric wall thickening of the rectum, mucosal hyperemia and mural stratification, mesorectal fat stranding, mesorectal fluid, and lymphadenopathy. The same features can be seen on MRI, as well as T2 hyperintensity within the bowel wall, particularly evident on fat suppressed images, and diffusion restriction (Fig. 3). Chronically, proctitis may result in wall thickening with submucosal fat deposition and proliferation of the perirectal fat. Identifying the specific etiology of proctitis on imaging is often not possible given the significant overlap in appearance.

Inflammatory bowel disease

As mentioned, the radiologic findings of acute inflammatory proctitis overlap considerably with infectious and ischemic causes. The most helpful imaging feature in differentiating Crohn's disease from ulcerative colitis is the distribution of disease. Ulcerative colitis generally

Fig. 6. Spectrum of findings in stercoral colitis. Axial (**A**) image from a CT scan of the pelvis with intravenous contrast demonstrate wall thickening of the severely distended and stool filled anorectum with adjacent fat stranding, compatible with stercoral colitis (white arrow). Axial CT scan performed 3 days later (**B**, **C**) demonstrate perforation with intraperitoneal air (*black arrow*), extraluminal stool (*dashed arrow*) and ascites (*asterisk*), compatible with perforated stercoral colitis.

involves the rectum and extends proximally, whereas discontinuous or skip lesions are often seen in Crohns colitis. In patients with inflammatory bowel disease isolated to the rectum, Crohns disease and ulcerative colitis are often indistinguishable; however, wall thickening in ulcerative colitis is generally less pronounced and more symmetric than in Crohns disease [12]. In addition, extramural findings such as fistulous disease, perirectal abscess or severe surrounding inflammatory changes in the adjacent fat are much more common in Crohns disease than in ulcerative colitis. Although MRI and CT can both used to diagnose proctitis from inflammatory bowel disease, MRI is superior for differentiating active inflammation from fibrosis in patients with chronic disease. Diffusion restriction has been shown to correlate with active inflammation, while delayed enhancement correlates with fibrosis [13, 14].

Pouchitis is acute or chronic inflammation of the ileal pouch in patients who have undergone total proctocolectomy with ileal pouch anal anastomosis (IPAA), usually for ulcerative colitis, multiple colon cancers, familial adenomatous polyposis, or Lynch syndrome. Pouchitis is a very common complication of IPAA, occurring in up to half of patients, usually soon after surgery. The cause of pouchitis is not definitely known, but may be related to altered microflora. Symptoms of pouchitis are nonspecific and overlap with other postsurgical complications such as dehiscence and abscess, therefore imaging is generally indicated during evaluation. Imaging findings include wall thickening, luminal dilatation, lymphadenopathy, peripouch fat stranding, fluid accumulation around the pouch, and increased mucosal enhancement (Fig. 4). The majority of patients with pouchitis respond favorably to antibiotic therapy, particularly in the initial stages of disease, but some cases are refractory to medical treatment. Malignancy arising within the pouch has also been reported, particularly in patients with chronic pouchitis. Occasionally patients with ulcerative colitis undergo colectomy with ileorectal anastomosis rather than IPAA, in which case recurrent proctitis is a relatively common sequela.

Infectious proctitis

Infectious proctitis may be secondary to sexually transmitted infections or food borne pathogens, although the latter often presents with a more diffuse colitis. The incidence of sexually transmitted infectious proctitis appears to be rising, with gonorrhea, herpes, and chlamydia infection being the most common causes [15]. Immunosuppressed patients have an increased incidence of viral, bacterial and fungal infections. Clinical history and physical exam findings may be very helpful to distinguish between infectious and inflammatory causes of acute proctitis. Appropriate history should raise the suspicion of specific infections in patients with focal rectal masses that would otherwise be suggestive of neoplasm.

Primary anorectal syphilis is another potential infectious cause of proctitis and is increasing in incidence, although still rare [16]. Anal lesions secondary to syphilis are more frequent than rectal lesions. Common anal lesions found in syphilis include ulcers, fissures and condylomata lata. Rectal lesions secondary to syphilis are usually asymptomatic and include proctitis, polypoid growths, pseudotumours, or ulcers [17]. The most com-

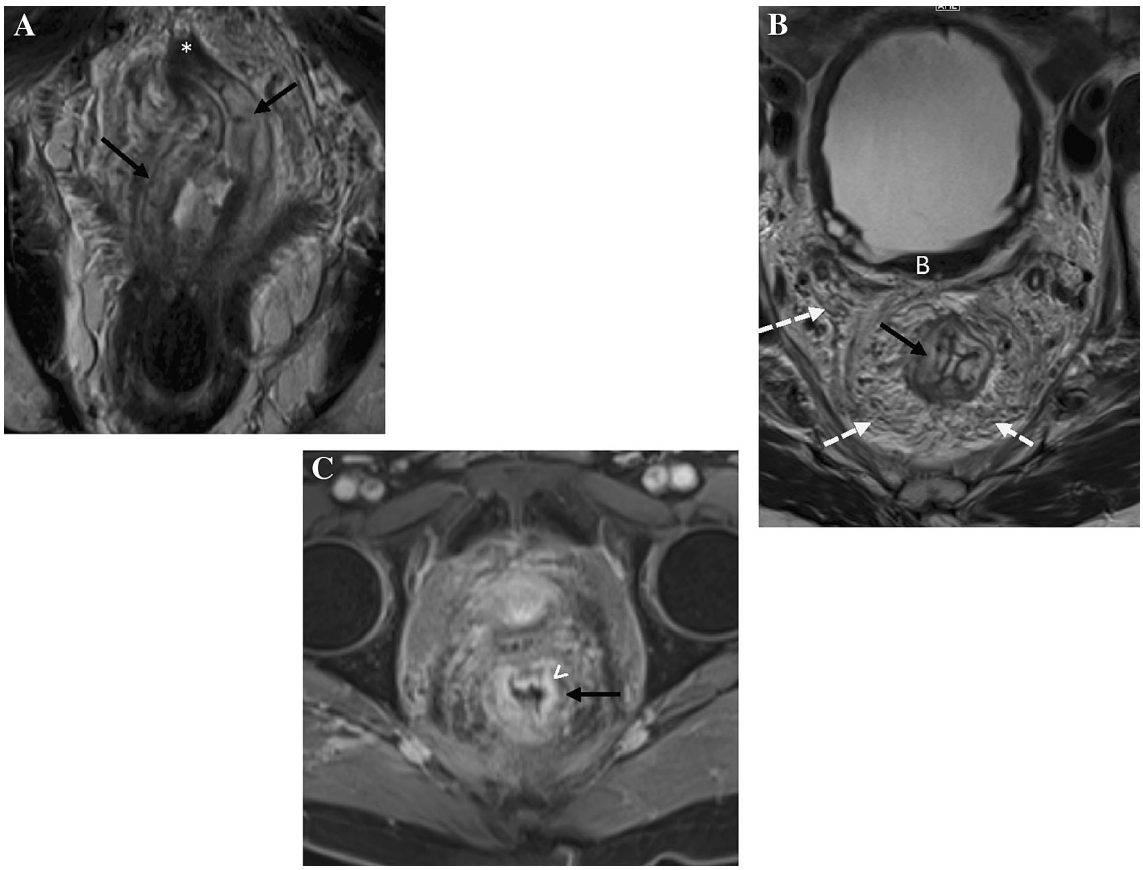

Fig. 7. Radiation proctitis in a man with history of prostate cancer status post radiation presenting with pain and constipation. Coronal (**A**) and axial T2 weighted SSFSE (**B**) and axial T1 postcontrast (**C**) images demonstrate marked rectal wall thickening with diffuse T2 hyperintensity of the rectal wall (*black arrows*). The sigmoid colon has normal T2 signal (*asterisk*). There is diffusion infiltration of the pelvic fat (*dashed arrows*) and wall thickening of the urinary bladder (B). Post contrast images demonstrate decreased enhancement of the rectal wall (*white arrow*) with increased mucosal enhancement (*less than symbol*).

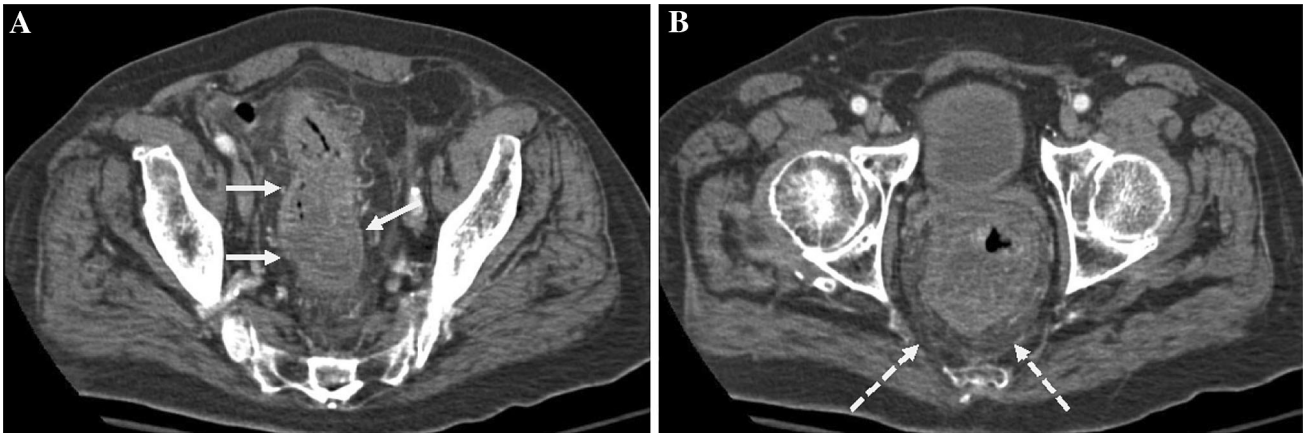

Fig. 8. Rectal ischemia in a 72 year old patient with hematochezia. Axial contrast enhanced CT images of the pelvis (**A**, **B**) demonstrate long segment severe rectal wall thickening and marked wall edema with heterogenous enhancement (*arrow*). Inflammatory changes including fat stranding and engorgement of the mesocolic vessels are also noted (*dashed arrow*). No pneumatosis is identified.

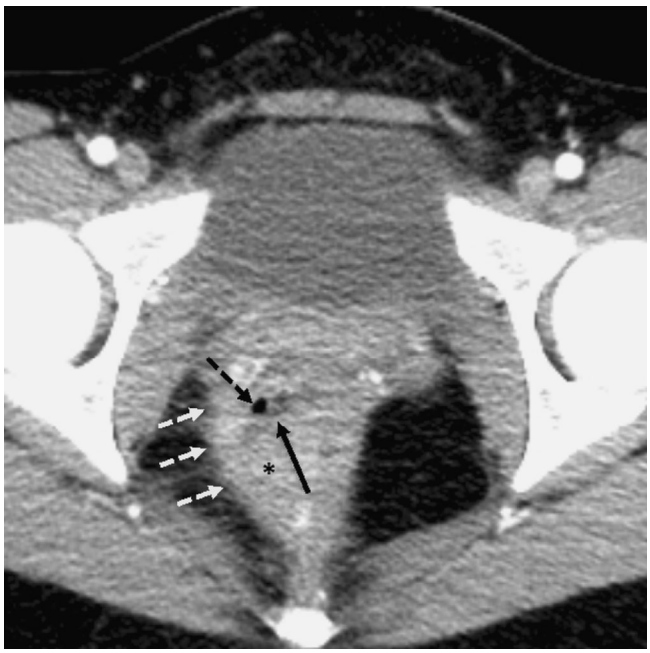

Fig. 9. Perianal abscess presenting with pelvic pain and fever. Axial contrast enhanced CT demonstrates soft tissue thickening along the right aspect of the anus (*asterisk*) with bulging of the right levator ani and external sphincter into the right ischioanal fossa. A small fluid collection (*black arrow*) containing air (*black dashed arrow*) is visualized, compatible with abscess.

mon macroscopic presentation of primary rectal syphilis is a mass with varying degrees of erosion and ulceration suggestive of cancer (Fig. 5) [16]. The diagnosis of anorectal syphilis is based primarily on serology and an endoscopic biopsy of anorectal lesions [18]. Treatment with penicillin generally results in rapid and complete regression of lesions over a few weeks. In addition to rectal syphilis, other infections which can simulate a rectal mass include lymphogranuloma venereum, mycobacterium tuberculosis, Actinomyces, and cytomegalovirus.

Stercoral colitis

Stercoral colitis refers to a colitis related to impacted fecal material causing increased luminal pressure and mucosal ischemia, resulting in ulceration. If not treated with fecal disimpaction, ulceration can result in colonic perforation, which has a high rate of mortality [19]. Fecal obstruction is seen primarily in elderly patients, often living in nursing homes, or neurologically impaired patients, as well as patients with slow transit time secondary to medications such as opiates. Fecal impaction is common and easy to diagnose, with CT showing a stool filled and distended colon with thinned rectal wall. In cases of stercoral colitis, there is often wall thickening and pericolonic stranding, potentially with mucosal irregularity representing ulceration (Fig. 6A) [19]. Rectal wall enhancement can be either increased or decreased, depending on the degree of ischemia [20]. Rectal perforation secondary to stercoral proctitis manifests with extraluminal gas or stool, the distribution of which depends on the rectal segment involved (Fig. 6).

Radiation proctitis

The rectum is commonly affected by pelvic radiotherapy, with over 50% of patients receiving pelvic radiotherapy experiencing rectal symptoms during treatment and almost 20% of patients developing chronic proctitis [21]. Acute radiation proctitis is generally self-limiting and does not require imaging [22]. In chronic radiation proctitis, imaging is primarily helpful for determining the extent of complications such as fistula or stricture, but the diagnosis of chronic radiation proctitis is based upon endoscopy and biopsy. The imaging appearance includes uniform bowel wall edema and thickening with low attenuation on CT or T2 hyperintensity on MRI, mucosal hyperenhancement, and, occasionally, luminal narrowing. Increased density of the mesorectal fat and thickening of the perirectal fibrous tissue are also common radiologic features (Fig. 7).

Ischemic proctitis

Ischemic injury to the rectum is very rare due to a rich collateral vascular supply. Unlike acute mesenteric ischemia, ischemic colitis is rarely due to macrovascular occlusion and is often self-limited [23]. Symptoms of bowel ischemia include rectal bleeding, diarrhea, crampy abdominal pain, fever, leukocytosis, and acidosis. Ischemic colitis typically affects the colon in a segmental fashion with the splenic flexure and descending colon most often involved, although any segment of the colon may be affected by ischemia. When ischemic colitis involves short and less typical segments, the diagnosis may be more challenging.

Findings of ischemic colitis will vary based on the degree of severity and acuity of ischemia. The most common finding in ischemia is bowel wall thickening, but additional findings include hypo or hyperattenuation of a thickened wall, dilatation, abnormal or absent wall enhancement, mesenteric stranding, vascular engorgement, and ascites and in severe cases of ischemia, pneumatosis or portal venous gas (Fig. 8). In mild cases where only wall thickening and stranding are present on CT, differentiation between ischemic proctocolitis and inflammatory or infectious causes may not be possible based upon imaging findings alone [24]. In severe cases, ischemia may progress to transmural bowel necrosis and subsequent perforation. Colonoscopic findings, including submucosal hemorrhage, superficial ulcerations, and dusky purple mucosa, provide a more definitive diag-

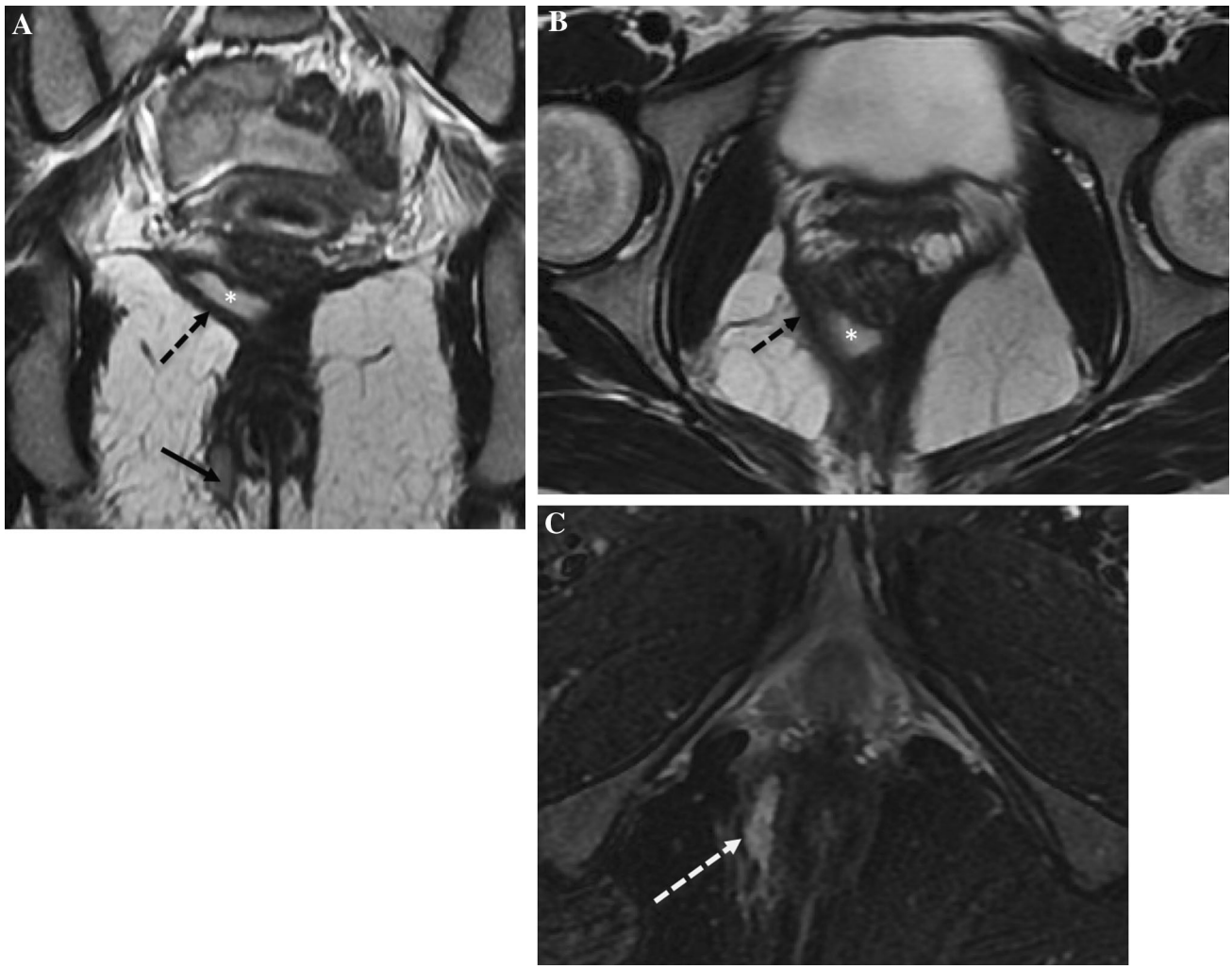

Fig. 10. MRI performed the following day in the same patient. Coronal T2 TSE (**A**), axial T2 TSE (**B**), and axial T2 TSE with fat saturation (**C**) demonstrate an intersphincteric abscess (*white dashed arrow*). There is caudal component extending towards the right gluteal fold (*black arrow*) and cranial component (*asterisk*) resulting in rightward and downward bulging of the right levator ani (*black dashed arrow*) and external sphincter.

nosis. Chronic ischemic colitis affecting the deep layers of the bowel wall may result in stricture formation [25].

Anorectal abscess and fistulae

Anorectal abscesses are purulent collections, typically arising from an infection in the epithelium of the anal canal. They are most commonly (up to 90%) primary, from obstruction of anal glands which leads to stasis and infection [26, 27]. Patients often present with dull aching pain and fever, but can also present with sepsis in severe cases. Digital rectal examination may demonstrate fluctuance compatible with abscess, potentially obviating the need for imaging. In cases where there is induration, erythema or warmth, but no clear fluid collection, imaging may be useful to demonstrate the presence of a drainable fluid collection. Although CT is often used to evaluate for perianal abscess due to cost and time considerations, MRI is more sensitive and specific due to superior tissue contrast, and therefore is the imaging method of choice. One study reports overall sensitivity of CT in identifying perianal abscess to be only 77% [28]. Findings on CT include a low attenuation rim enhancing collection in the peri-rectal area with adjacent inflammatory fat stranding, and occasionally gas (Fig. 9). On MRI, an abscess is T2 hyperintense with peripheral enhancement and central diffusion restriction, with T2 hyperintense changes in the surrounding fat (Fig. 10).

There are several conditions that can mimic perirectal or perianal abscess, including thrombosed hemorrhoids, ruptured Bartholin gland cysts, dermal or epidermal infections such as furuncles and folliculitis, and pilonidal sinuses or cysts. Pilonidal sinuses or cysts occur at the upper part of the natal cleft, overlying the lower sacrum

and coccyx, but are occasionally misdiagnosed as perirectal abscess given proximity to the anal region (Fig. 11). Necrotic or mucinous anorectal tumors can also be mistaken for perirectal abscess (Fig. 12). Not uncommonly, anal tumors coexist with inflammatory conditions such as proctitis and abscesses. For example, there is an increased risk of anus and lower rectum carcinomas associated with long-standing perianal fistulising Crohn's disease. For all of these conditions, MRI has superior diagnostic performance compared to CT.

Hemorrhoids are vascular cushions that become congested with increased abdominal or anorectal pressures, and are ubiquitous in the general population. Patients often present with rectal bleeding and possibly mucous like discharge, as well as a dull discomfort and often a mass protruding from the anus, which worsens with straining. Acutely thrombosed hemorrhoids can result in severe pain. Particularly in older patients, clinicians may misattribute rectal bleeding to hemorrhoids and thereby overlook more proximal causes such as malignancy or inflammatory bowel disease. Nonthrombosed hemorrhoids are generally bright on T2 weighted images, and may fill with contrast on delayed imaging. Thrombosed hemorrhoids are often less intense on T2 weighted imaging and have a slightly thicker wall with surrounding inflammation, thereby mimicking an abscess (Fig. 13). In differentiating a thrombosed hemorrhoid from abscess on imaging, it is important to note the typical locations of hemorrhoids in the right posterior, right anterior, and left lateral anorectum, thin wall, and presence of a vascular stalk [29].

Fig. 11. Inflamed pilonidal cyst. Axial contrast enhanced CT through the pelvis shows 4.0 cm rim enhancing low attenuation structure (*asterisk*) located in the soft tissues between the coccyx and medial natal cleft with adjacent fat stranding, consistent with inflamed pilonidal cyst. Note the lack of continuity with the anus and rectum, distinguishing it from a perianal abscess.

Patients with perianal fistulae may have a similar clinical presentation to those with abscesses, including purulent perianal discharge and pain. Although perianal fistulae most commonly arise from perianal abscesses, they can also be iatrogenic, secondary to inflammatory bowel disease, or result from infection or malignancy. Although CT can be used to assess perianal fistulae, MR is a superior imaging modality to accurately detect both abscesses and fistulous tracts, particularly complex tracts (Fig. 14) [30]. MRI identifies more secondary tracts and is more accurate in identification of complex fistulae than either digital rectal examination alone or surgical exploration [31]. Three dimensional post contrast images are particularly valuable in demonstrating the relationship of fistulous tracts to the sphincter complex. Fluid, pus, and granulation tissue appear hyperintense on fat suppressed T2 weighted images while fibrous tissue within the wall of a fistulous tract and chronic scarring are hypointense on T2 weighted imaging. Diffusion weighted imaging has also been shown to improve conspicuity of fistulous tracts and abscesses [9].

Although fistulae may potentially be confused for small veins, differentiating features include tortuous course of veins, thin wall, and continuity with other veins, while fistulae have a relatively straight course, thick fibrous wall, and internal opening [32]. Acquisition of both late arterial and venous phase postcontrast

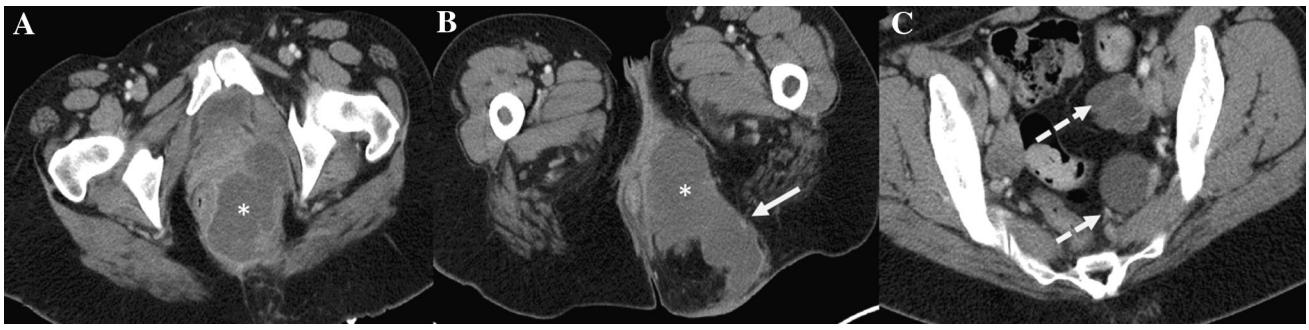

Fig. 12. Mucinous adenocarcinoma with mucinous lymph node metastases mimicking perirectal and perianal abscess. Contrast enhanced axial CT demonstrates a complex rim enhancing lesion is identified in the left perianal location (*arrow*) (**A**). Images through the perineum show extension of the lesion into the ischioanal soft tissues and to the overlying skin surface (*arrow*) (**B**). Centrally cystic metastatic lymph nodes are identified in the pelvis (*dashed arrows*) (**C**).

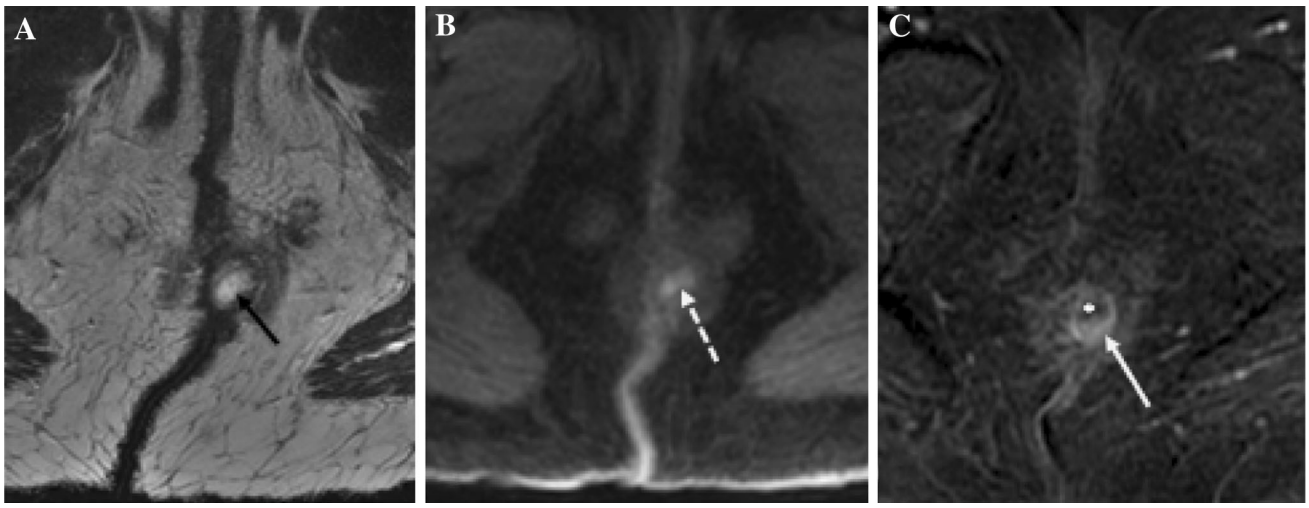

Fig. 13. Mass-like anal lesion in an immunocompromised patient presenting with severe anal pain. Axial T2 weighted image with fat saturation (**A**) demonstrates a focal ovoid centrally T2 hyperintense lesion along the left posterior aspect of the anus (*black arrow*). Axial T1 weighted image with fat saturation (**B**) demonstrates central T1 hyperintensity (*dashed arrow*). Axial post contrast T1 weighted image with subtraction (**C**) demonstrates rim enhancement of the lesion (*white arrow*) with nonenhancement centrally (*asterisk*). Subsequent physical examination demonstrated a thrombosed external hemorrhoid.

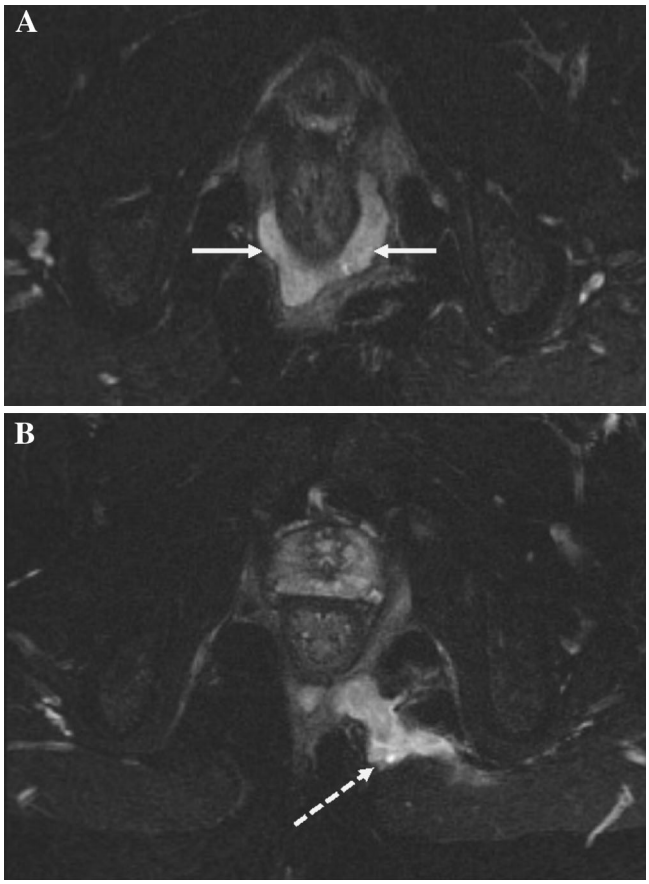

Fig. 14. Perianal fistula in a patient with Crohn's disease presenting with fever, severe pain, and purulent discharge. Axial T2 weighted imaging with fat saturation (**A**, **B**) demonstrates a grade 4 transsphincteric perianal fistula with intersphincteric abscess and tract extending into the left ischioanal fossa (*dashed arrow*).

images can be helpful, as the former show greater contrast between the fistula and surrounding structures, and the latter better demonstrates inflammation. Acquisition of multiple post contrast phases can also help differentiate vessels from fistulae.

The most widely used classification systems for perianal fistula are the Parks Classification and the St James Classification (Table 2), both containing important anatomic details that radiologists must include when characterizing fistulae. Conventional nomenclature for description of fistulae includes the position of the mucosal opening on axial images, using clock position, and distance of the mucosal defect to the skin surface on coronal images, as well as the description of any secondary fistulous tracts or abscesses. Description should also include whether a fistula is fluid or air containing, or is collapsed consisting only of granulation tissue. Treatment of perianal fistulae includes fistulotomy, fistulectomy, and seton placement. Accurately characterizing the perianal process prior to therapy, including secondary tracts, reduces the risk of incomplete healing, a recurrent fistula, or inadvertent sphincter injury.

Table 2. Classification schemes for characterization of perianal fistulas

Grade/type	St James classification	Parks classification
1	Simple linear intersphincteric fistula	Intersphincteric
2	Intersphincteric fistula with abscess or secondary tract	Intersphincteric
3	Simple transsphincteric fistula	Transsphincteric
4	Transsphincteric fistula with abscess or secondary tract	Transsphincteric
5	Supralevator and translevator disease	Extra/suprasphincteric

In addition to perianal fistulae, fistulous connections between the rectum and vagina can develop as a result of prolonged labor or obstetric injury, anorectal abscesses, Bartholin gland infections, malignancy (rectal, uterine, cervical or vaginal), history of radiation therapy, inflammatory bowel disease, and rectal ulcers [33]. Patients may present with dyspareunia, perineal pain, vaginal flatus, liquid stool, malodorous discharge from the vagina, or recurrent vaginitis. Imaging plays an important role in the detection of a rectovaginal fistula and characterization of fistulous tracts. Although fluoroscopic examination with contrast and endoanal ultrasound are sometimes used to evaluate for rectovaginal fistulae, cross sectional imaging with CT and MRI can better demonstrate disease adjacent to the fistula. An enteric contrast agent and/or air within the vagina can be demonstrated on CT scans in the majority of cases (Fig. 15) [34].

Fig. 15. Rectovaginal fistula in a 46 year old female with Crohns disease presenting with stool per vagina. Sagittal reformatted image from a contrast enhanced CT with rectal contrast (*dashed arrow*) shows opacification of the vaginal with rectally administered contrast (*arrows*). A discrete fistulous tract was difficult to delineate, although inferred from these findings.

Fistulae between the rectum and the bladder may develop in patients with tumors of the bladder or rectum, history of radiation therapy, trauma, or history of pelvic surgery [35]. Patients may present with fecaluria, abdominal pain, fever, or recurrent urinary tract infections. Several imaging modalities can be used to evaluate rectovesical fistulae including CT, cystoscopy, fluoroscopic studies, and MRI. CT has demonstrated 80%–90% sensitivity for diagnosis and is often the first test performed, particularly in the emergency department [35, 36]. Findings on CT which can suggest the diagnosis include air within the bladder without recent instrumentation, discontinuity of the bladder wall, focal bladder wall thickening, and extraluminal masses connecting the bladder to the adjacent rectum [37]. Although the fistula itself may not be seen on CT, the presence and location can generally be inferred from secondary findings [37]. Sensitivity of CT for rectovesical fistula can be

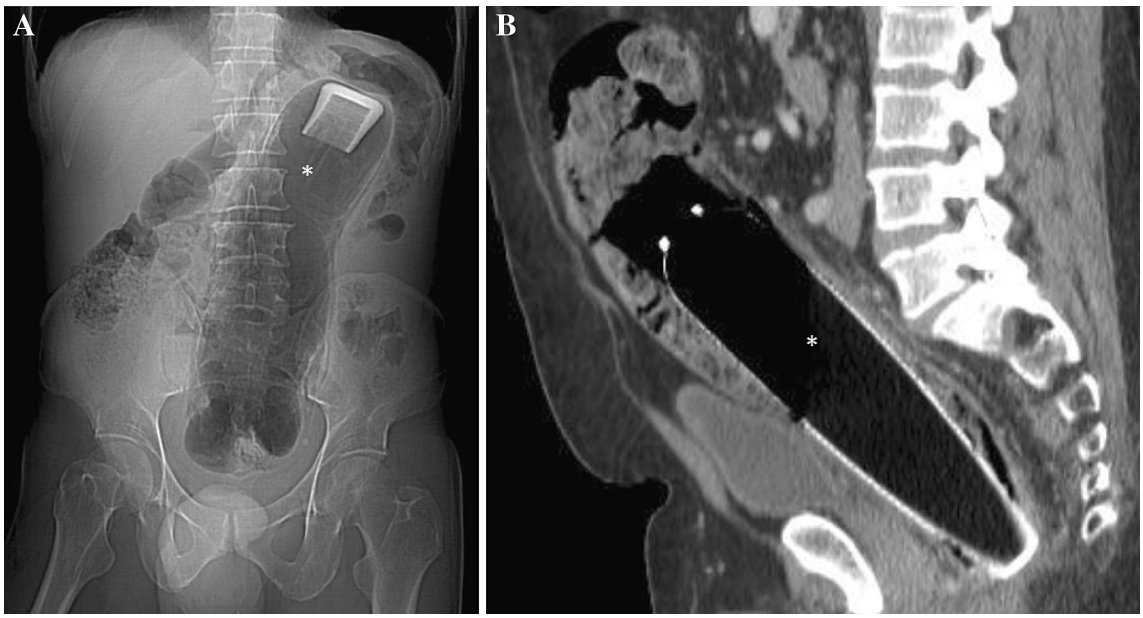

Fig. 16. Rectal foreign body. Abdominal radiograph (**A**) and sagittal CT reformatted image (**B**) show a foreign body (*asterisk*) within the rectum. Attempted transanal extraction was unsuccessful and complicated surgical removal of the rectal foreign body was required.

increased further with administration of rectal contrast or bladder contrast (CT cystogram). Rescanning after active urination and defecation may also be useful when a suspected fistula is not demonstrated on the initial scan. MRI is more sensitive than CT for depiction of the fistulous tract itself. Two studies have demonstrated 100% sensitivity of MRI for detection of colovesical fistula [38, 39].

Obstruction

Causes for anorectal obstruction include fecal impaction, benign and malignant anorectal masses and strictures, extrinsic processes with mass effect on the anorectum, rectal prolapse or intussusception, and foreign bodies. Although fecal impaction is the most common cause of partial rectal obstruction, complete large bowel obstruction is most commonly caused by colorectal cancer [40]. Frequent presenting symptoms include progressive constipation, abdominal distension, and pain. Although abdominal radiographs are relatively sensitive and specific for large bowel obstruction (82% and 83% respectively), CT is the imaging modality of choice for diagnosing the level of obstruction, the etiology of obstruction, the viability of bowel loops, and any other complications [40]. Delay in treatment of large bowel obstruction can result in perforation or ischemia.

Foreign body

Most anorectal foreign bodies are inserted through the anal canal, although foreign bodies are occasionally the result of an orally ingested object that becomes impacted (Fig. 16). Embarrassment on the part of the patient may cause both delay in presentation and inaccurate history. Patients are often reluctant to fully disclose their situation and instead may complain of anorectal or abdominal pain, blood per rectum, or mucus discharge rather than volunteering the presence of a foreign body. The need for imaging depends upon the location of the foreign body and presenting symptoms. Plain radiographs

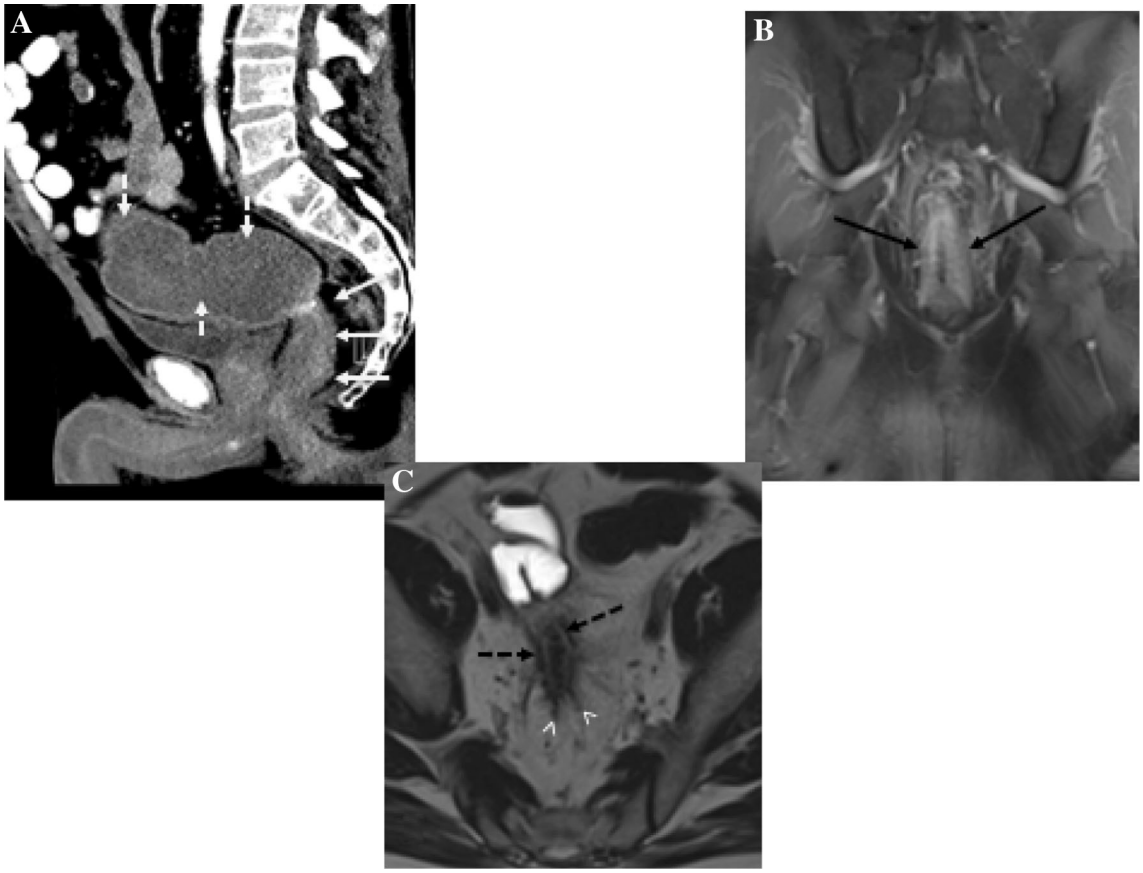

Fig. 17. Rectal stricture in a patient with Crohns disease presenting with constipation and pain. Sagittal reformatted image from a contrast enhanced CT (**A**) shows long segment rectal wall thickening and luminal narrowing (*white arrows*). Upstream distention of the rectosigmoid colon is present (*white dashed arrows*). Coronal T1 post contrast VIBE (**B**) and axial T2 weighted SSFSE (**C**) images show smooth rectal wall thickening and increased enhancement (*black arrow*) and intramural T2 hyperintensity (*black dashed arrow*), consistent with inflammatory stricture. There is proliferation of the mesorectal fat with inflammatory changes in the fat increased number of small mesorectal lymph nodes (>) compatible with chronic inflammatory bowel disease.

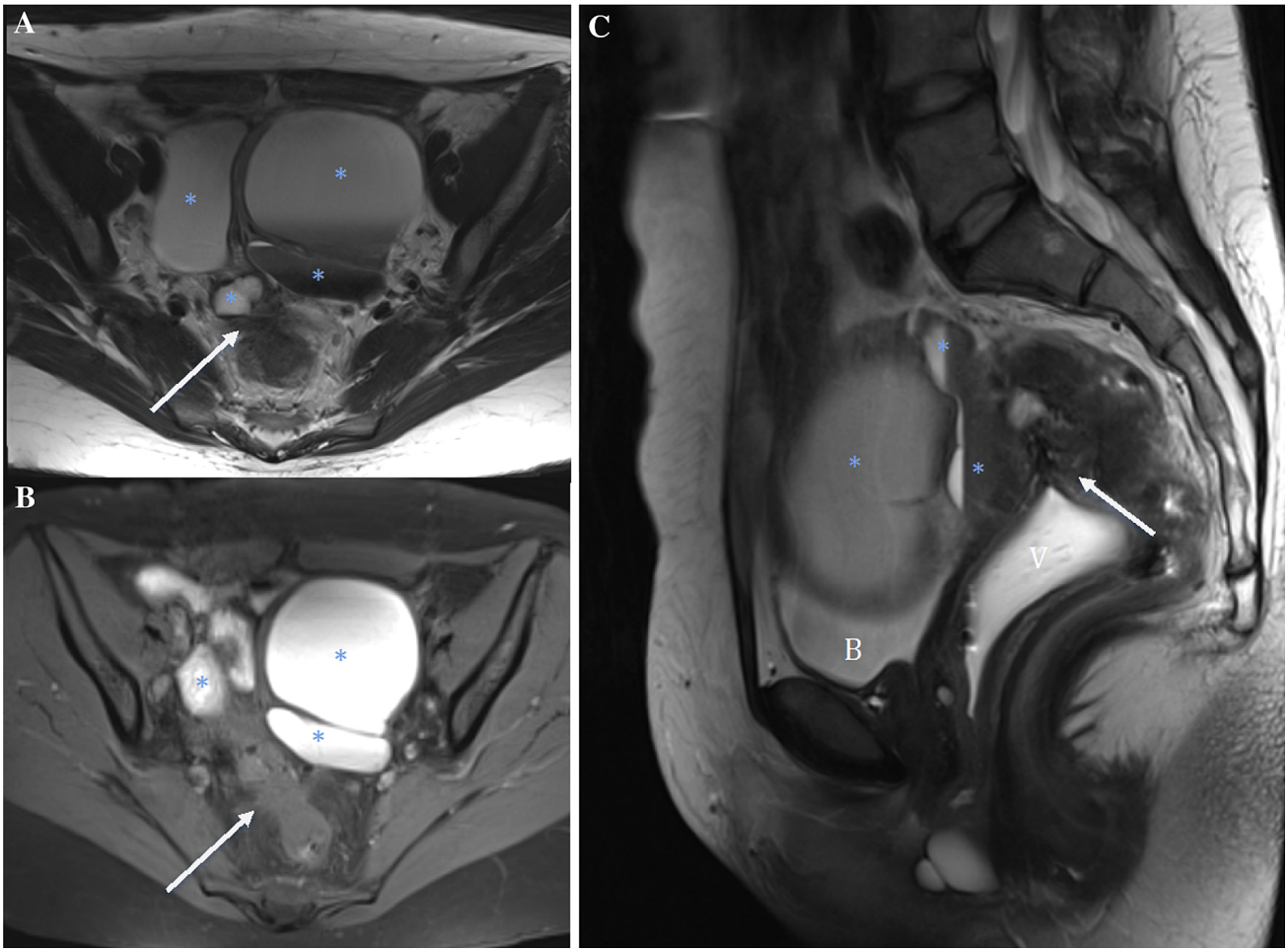

Fig. 18. Rectal stricture caused by endometriosis. Axial SSFSE (**A**) and axial T1 weighted GRE images with fat suppression (**B**) demonstrate multiple T1 hyperintense lesions in the pelvis with decreased signal intensity and "shading" on T2 weighted imaging, compatible with endometriomas (*asterisk*). Sagittal SSFSE image (**C**) demonstrates adjacent T1 and T2 isointense tissue extending to the rectal serosa compatible with fibrosis (*arrows*) resulting in rectal stricture. Ultrasound gel is seen within the vagina (V). There is mass effect upon the urinary bladder (B).

are generally sufficient, unless there is a reason for CT, such as concern for bowel perforation. Foreign bodies may lead to variable degrees of local trauma to the surrounding tissues and can be associated with perforation or delayed injury, manifesting as extraluminal air and perirectal stranding.

Strictures

Anorectal strictures may be postsurgical, radiation induced, post-inflammatory, post-infectious, or neoplastic in etiology. Symptoms vary depending upon the cause and degree of stenosis, but may include pain and bleeding, fecal impaction, overflow incontinence, abdominal pain, or large bowel obstruction. Although strictures above the anorectal junction are most commonly secondary to malignancy, inflammatory bowel disease, endometriosis and radiation are other potential causes (Figs. 17, 18). CT and MRI are beneficial for assessing the extent of mural and extramural disease of a malignant rectal stricture. Malignancy is suggested by the presence of asymmetric, nodular soft tissue thickening and invasion of surrounding structures. The degree of soft tissue thickening or enhancement has not been shown to be a useful for differentiating between inflammatory and malignant strictures. Peritoneal disease can be seen in both in both inflammatory and malignant processes, but it is generally more pronounced in the setting of malignancy [41]. Diffusion weighted imaging can be valuable in differentiating malignant from benign stricture when no focal mass is identified. Although they may be benign, newly diagnosed rectal strictures should be assessed endoscopically to evaluate for an underlying malignancy.

Rectal masses

Primary anorectal masses, both benign and malignant, may cause large bowel obstruction by occluding the

anorectal lumen, infiltrating the bowel wall, or provoking intussusception (Fig. 19). Above the dentate line, most anorectal masses are adenocarcinomas or polyps. Other more rare tumors include gastrointestinal stromal tumor (GIST), neuroendocrine tumor, metastatic disease, primary rectal lymphoma, schwannoma, and leiomyoma (Fig. 20). Although CT is more commonly used in the acute setting, MR imaging is superior for characterization and staging of nearly all pelvic tumors. Extrinsic pelvic masses can also obstruct the anorectum via mass effect. Examples include metastatic deposits in the pelvis, or direct extension of malignancies of the prostate, cervix, ovaries, or uterus. Benign extrarectal causes such as retrorectal cystic lesions, endometriosis, and pelvic abscesses, can also cause mass effect upon the rectum resulting in obstruction.

Perforation

Etiologies of rectal perforation include trauma, iatrogenic injury, foreign bodies, or spontaneous in the setting of predisposing conditions such as stercoral colitis, inflammatory bowel disease, malignancy, or radiation. Clinical manifestations are varied and may include asymptomatic cases, rectal bleeding, abdominal pain, peritonitis and abdominal sepsis. Iatrogenic causes of traumatic rectal perforation include colon/sigmoidoscopy, barium enema, CT colonography, deep rectal biopsy, polypectomy, cleansing enema or rectal thermometer placement.

Injury to the rectum in the setting of blunt or penetrating trauma is relatively rare, but can be difficult to diagnose clinically because of absent, delayed, or nonspecific clinical signs. Delayed diagnosis can result in high morbidity and mortality due to the development of sepsis. In blunt trauma, rectal injuries are most commonly associated with pelvic fractures. In penetrating trauma, it is important to identify the trajectory in order to identify all potential injuries, as direct signs of injury may be absent or subtle.

Imaging findings in rectal trauma are similar to those seen in other bowel injuries, and include focal wall thickening, extraluminal gas, contrast, or fecal material, perirectal/presacral fluid collections or fat stranding, and focal discontinuity of the rectal wall (Figs. 21, 22). Visualization of a focal wall discontinuity is a highly specific finding for perforation but is relatively insensitive when the perforation is small. The amount of free air can vary from a few foci of gas adjacent to the perforation to large amounts of free air and/or stool. Reviewing CT examinations with lung window settings may help to

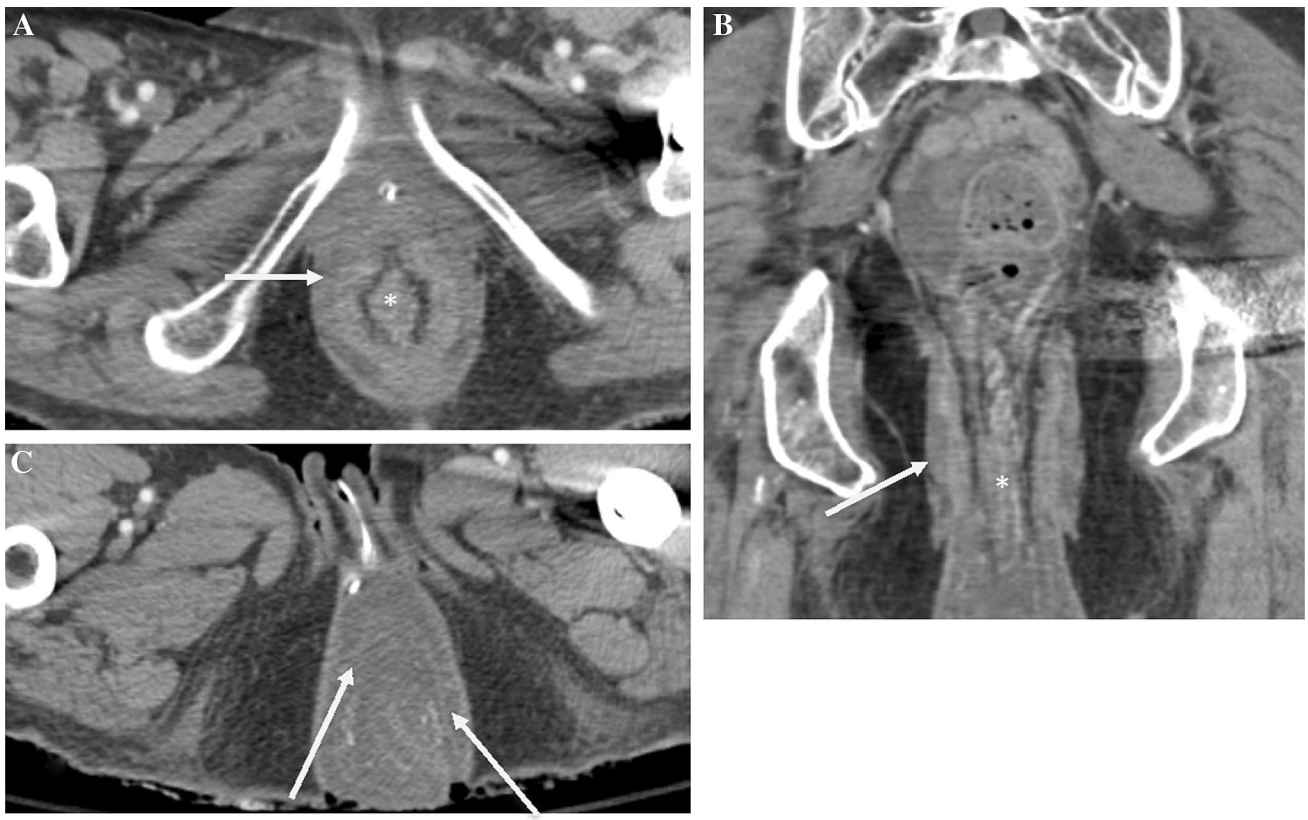

Fig. 19. Incarcerated rectal prolapse in a patient with pain and rectal bleeding. Axial (**A**, **B**) and corona (C) CT images with intravenous contrast demonstrate severe rectal prolapse (*arrows*) with rectorectal intussusception (*asterisk* = intussusceptum). Note the hypoenhancement of the rectal wall (*arrows*), compatible with incarceration and ischemia.

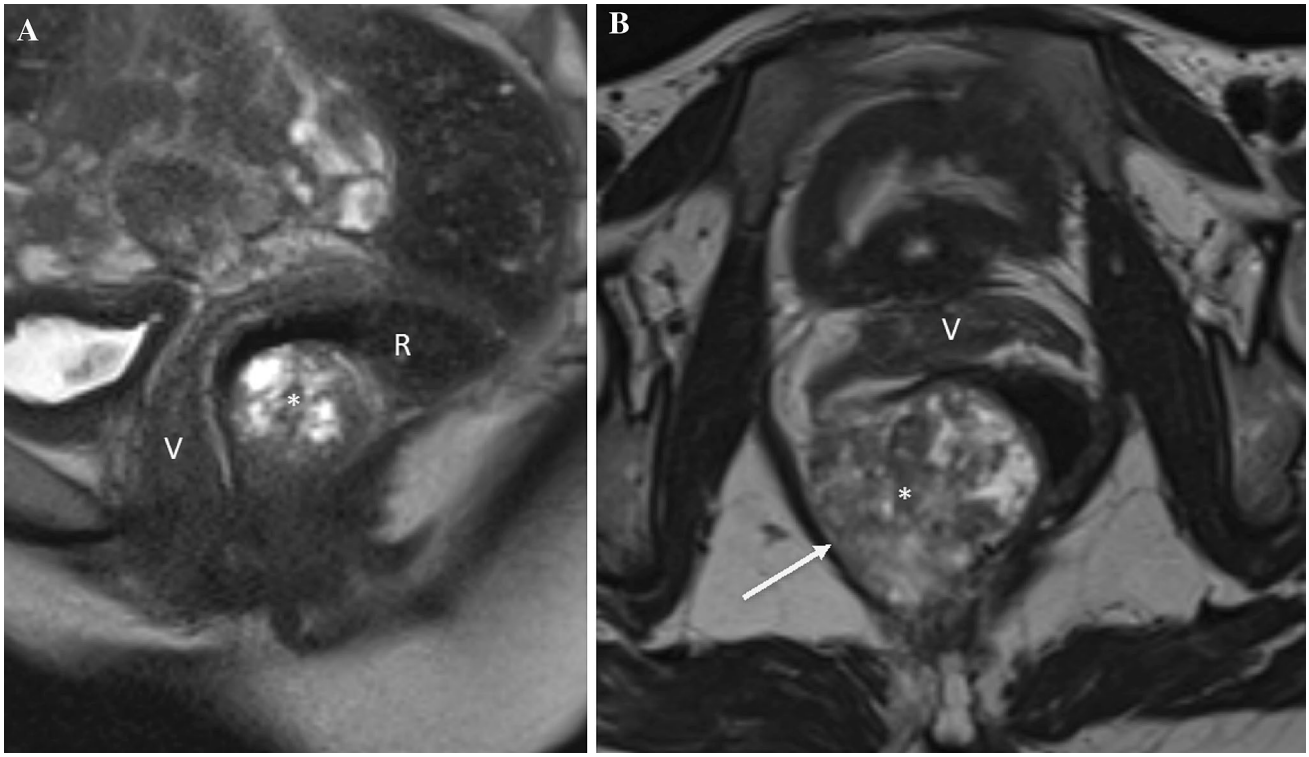

Fig. 20. Rectal GIST in a 38 year old female patient presenting with 7 years of progressive constipation, rectal fullness and palpable mass. Sagittal SSFSE MR image shows a T2 hyperintense heterogeneous mass (*asterisk*) in the rectum (R) exerting mass effect upon the vagina (V) (**A**). Axial SSFSE MR (**B**) shows that the mass arises from the right lateral wall of the rectum and causes bulging and mass effect upon the right puborectalis muscle (*arrow*). The rectum proximal to the mass is stool filled.

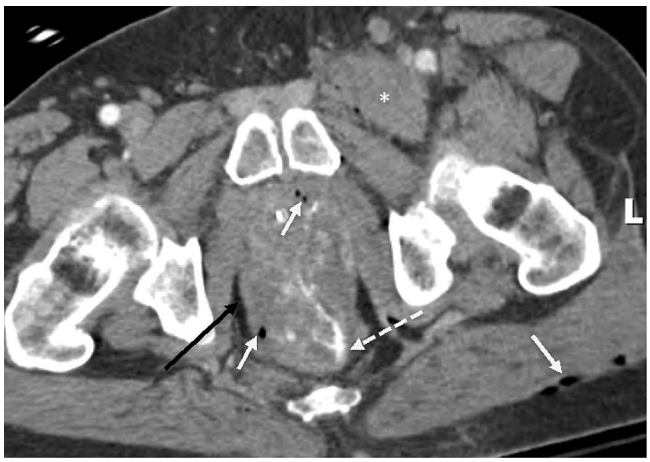

Fig. 21. Severe rectal injury secondary to penetrating trauma (*gunshot wound*). Axial contrast enhanced pelvic CT with rectal contrast shows multiple linear areas of contrast extravasation (*dashed arrow*) and small bubbles of extraluminal air (*arrows*), consistent with multifocal transmural rectal wall injury. Circumferential rectal wall thickening is also noted (*black arrow*). A hematoma is seen adjacent to the left femoral vein (*asterisk*).

detect small amounts of extraluminal air (Fig. 23). Extraluminal air can be seen without bowel injury in the setting of barotrauma, pneumothorax, pneumomediastinum, penetrating injury, or following diagnostic peritoneal lavage. Appropriate use of oral, rectal, and intravenous contrast maximizes the diagnostic accuracy of CT for diagnosis of rectal injury.

From the surgical perspective, the distinction between intraperitoneal and extraperitoneal rectal injury is key. Injuries to the serosalized anterior and lateral sidewalls of the upper one third of the rectum are classified as intraperitoneal. Conversely, lesions involving the distal two thirds of the rectum circumferentially and the upper one third of the rectum posteriorly are considered extraperitoneal.

Rectal tumors can result in bowel perforation, either from necrosis of the tumor or perforation of the colon proximal to the tumor as a result of obstruction. Tumor perforation can either occur spontaneously or after treatment with chemotherapy and/or radiation (Fig. 24). Formation of an abscess can mask the underlying malignancy, simulating a primary inflammatory process such as diverticulitis. The presence of concentric wall thickening and enhancement adjacent to the rectal wall defects suggests the presence of underlying malignancy [42]. Metastases may also present with rectal perforation, either at the time of diagnosis or after treatment [43].

Anastomotic leak after colorectal surgery is a relatively common and serious complication. Although

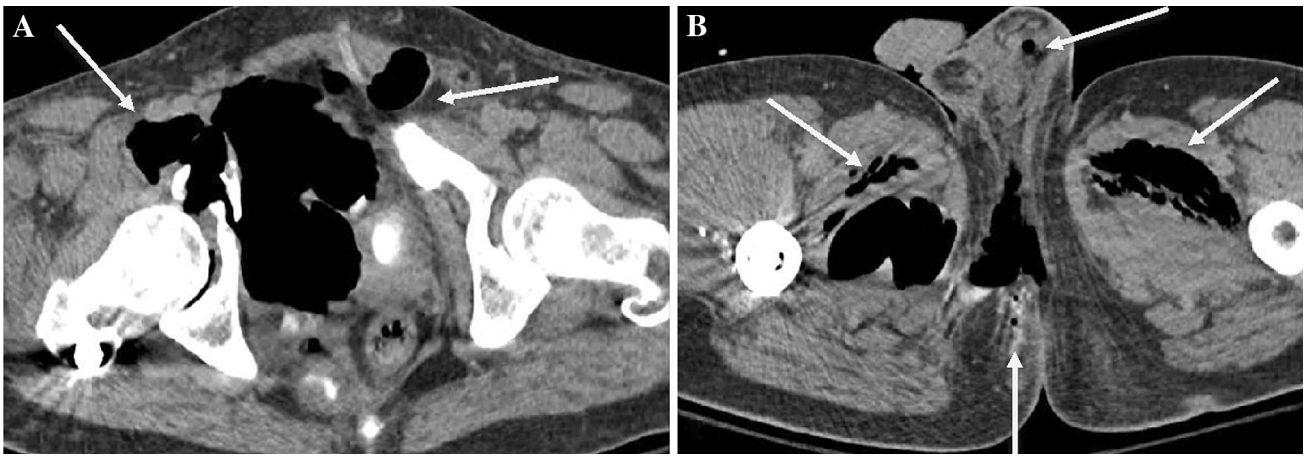

Fig. 22. Rectal perforation secondary to blunt trauma sustained during a motor vehicle collision. Axial CT images at the level of the interior pelvis (**A**) and ischioanal fossa (**B**) demonstrate extraluminal gas dissecting into the perineum, inguinal canal, scrotum, and thigh musculature (*arrows*) caused by a surgically-proven rectal injury.

Fig. 23. Rectal perforation during CT colonography. CT topogram image demonstrates extraluminal gas underneath the diaphragm and in the retroperitoneum (*white arrows*) (**A**). Axial CT images viewed using lung window settings delineate the extent and location of extraluminal air in the retroperitoneum (*black arrows* in **B**) and in the perirectal and perivesical fat in the pelvis (*black arrows* in **C**) due to rectal perforation.

clinical symptoms such as gas, purulent or fecal discharge from the drain, purulent discharge from the rectum, pelvic abscess or peritonitis may alert the clinician to a potential leak, radiologic confirmation is generally needed given that symptoms are nonspecific [44]. The diagnosis of anastomotic leak can be made confidently

when CT demonstrates frank extravasation of bowel contrast material with air or possibly stool (Fig. 25). Less definitive but suggestive signs of anastomotic leak include extraluminal air in a higher proportion relative to fluid in the newly formed postoperative spaces [45]. In patients status post Hartmann's procedure, in which a rectal stump is closed off, post operative leaks are often seen. Complete disruption of the stump can also occur, and is potentially life threatening [46]. The presence of an air containing fluid collection after low anterior resection can mimic the true rectum and has been described as the "double rectum" sign. If a balloon catheter is inflated in the rectum to instill contrast, it may seal off a distal anastomotic leak, particularly if the anastomosis is low.

Hemorrhage

Rectal hemorrhage can result from a variety of conditions including rectal vascular malformations, varices, stercoral colitis, inflammatory bowel disease, radiation proctopathy, infectious colitis, malignancy, and trauma. Patients often present with hematochezia or passage of clots from the rectum. Previously, radionuclide scintigraphy and catheter angiography were the primary radiologic methods of evaluating lower gastrointestinal

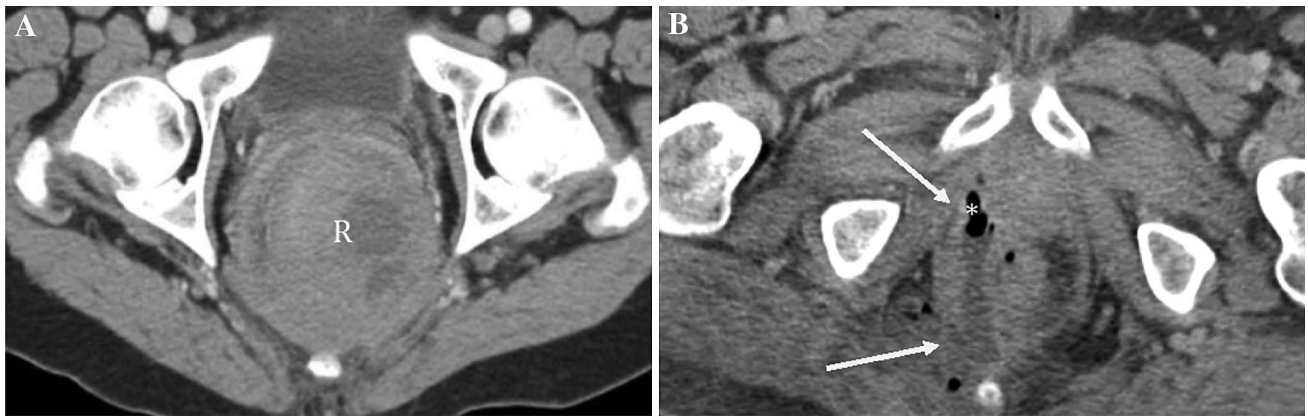

Fig. 24. Perforated rectal lymphoma. Axial contrast enhanced CT of the pelvis prior to treatment demonstrates diffuse and heterogeneous enlargement of the rectum (R). Rectal lymphoma was diagnosed at biopsy (**A**). Following subsequent radiation therapy, the patient presented with acute pain and fever. Contrast enhanced CT scan demonstrated rectal perforation with air (*asterisk*) containing abscess in the right ischiorectal soft tissues (*arrows* in **B**).

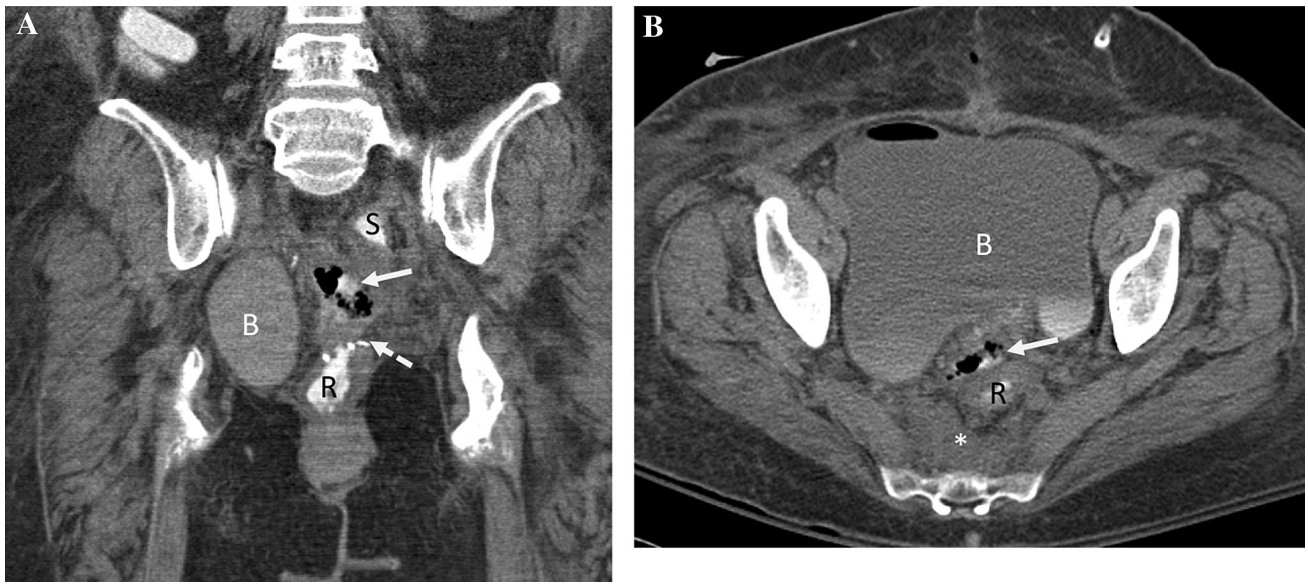

Fig. 25. Anastomotic leak 6 days after low anterior resection with diverting loop ileostomy in a patient with feculent output from surgical drain. Coronal (**A**) and axial (**B**) CT images of the pelvis with intravenous and rectal contrast demonstrate anastomotic suture line from low anterior resection (*dashed arrows*). Adjacent to the anastomosis there is an extraluminal collection containing air and contrast, compatible with leak (*arrows*). Fluid is also seen in the presacral space (*asterisk*). Air in the urinary bladder (>) is likely from recent instrumentation. B, bladder; S, sigmoid colon; R, rectum.

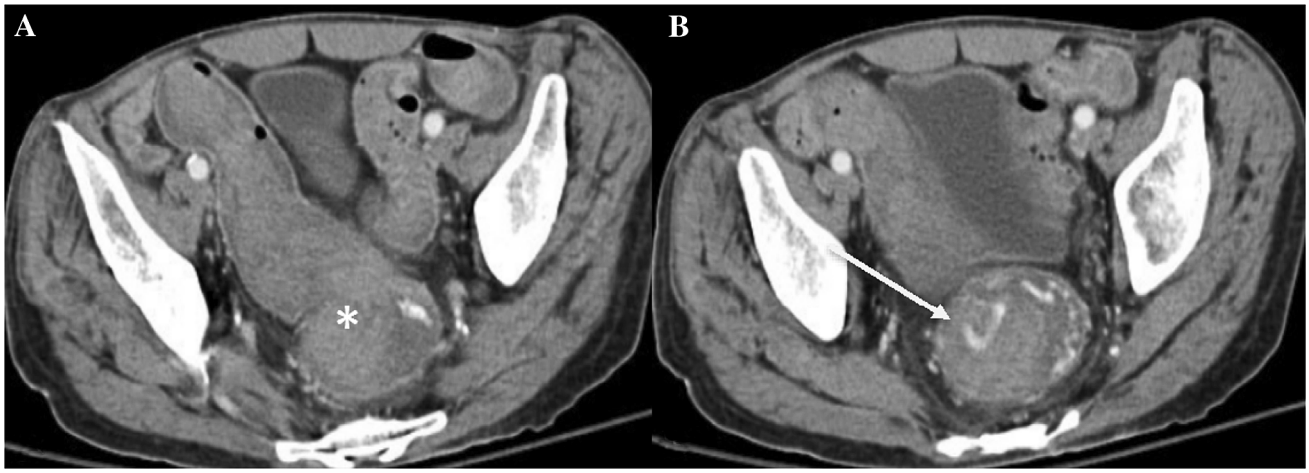

Fig. 26. Rectal hemorrhage in a 65 year old male patient presenting with hematochezia. Axial contrasted enhanced CT images of the pelvis obtained during arterial phase demonstrate distention of the rectosigmoid colon with hyperdense clot (*asterisk*) (A). Curvilinear areas of active contrast extravasation in the rectum consistent with acute hemorrhage are seen caudally (*arrow*) (B).

bleeding. CT angiography, however, has been shown to have good correlation with catheter angiography in identifying the source of lower gastrointestinal bleeding, and has become widely accepted as the initial method of evaluation, given availability and noninvasiveness. Active extravasation is best seen on arterial phase images and may appear as a linear, jet-like, swirled, or pooled focal area of high attenuation that increases on portal venous images (Fig. 26). Noncontrast images are helpful in differentiating intraluminal contrast extravasation from ingested bowel contents.

Conclusions

Acute anorectal conditions often present to the emergency department and include a variety of conditions such as infectious, inflammatory, benign, malignant, post-traumatic, and vascular disease processes. Radiologists play an essential role in selecting an appropriate imaging modality and protocol for detection, characterization, and delineation of acute anorectal disease. CT and MRI are increasingly being used for this purpose; therefore, it is essential that radiologists be aware of the spectrum of imaging findings of acute anorectal disease. Synthesis of history, clinical exam findings, and imaging findings is essential for making an accurate diagnosis in patients presenting to the emergency department with acute anorectal symptoms.

Compliance with ethical standards

Funding No funding was received for this study.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Statement of informed consent was not applicable since the manuscript does not contain any patient data.

References

1. Tupe CL, Pham TV (2016) Anorectal complaints in the emergency department. Emerg Med Clin N Am 34:251–270
2. Grucela A, et al. (2010) Prospective analysis of clinician accuracy in the diagnosis of benign anal pathology: comparison across specialties and years of experience. Dis Colon Rectum 53:47–52
3. Weinberg JA, et al. (2006) Penetrating rectal trauma: management by anatomic distinction improves outcome. J Trauma 60:508–513 ((discussion 513–514))
4. Parks AG (1961) Pathogenesis and treatment of fistuila-in-ano. Br Med J 1:463–469
5. de Miguel Criado J, et al. (2012) MR imaging evaluation of perianal fistulas: spectrum of imaging features. RadioGraphics 32:175–194
6. MERCURY Study Group (2007) Extramural depth of tumor invasion at thin-section MR in patients with rectal cancer: results of the MERCURY study. Radiology 243:132–139
7. Puylaert CAJ, Tielbeek JAW, Bipat S, Stoker J (2015) Grading of Crohn's disease activity using CT, MRI, US and scintigraphy: a meta-analysis. Eur Radiol 25:3295–3313
8. Szyszko TA, Bush J, Gishen P, Sellu D, Desouza NM (2005) Endoanal magnetic resonance imaging of fistula-in-ano: a comparison of STIR with gadolinium-enhanced techniques. Acta Radiol 1987(46):3–8
9. Dohan A, et al. (2014) Diffusion-weighted MR imaging for the diagnosis of abscess complicating fistula-in-ano: preliminary experience. Eur Radiol 24:2906–2915
10. Halligan S, Stoker J (2006) Imaging of fistula in ano [1]. Radiology 239:18–33
11. deSouza NM, Gilderdale DJ, Coutts GA, Puni R, Steiner RE (1998) MRI of fistula-in-ano: a comparison of endoanal coil with external phased array coil techniques. J Comput Assist Tomogr 22:357–363
12. Horton KM, Corl FM, Fishman EK (2000) CT evaluation of the colon: inflammatory disease1. RadioGraphics 20:399–418
13. Hordonneau C, et al. (2014) Diffusion-weighted magnetic resonance imaging in ileocolonic Crohn's disease: validation of quantitative index of activity. Am J Gastroenterol 109:89–98
14. Tielbeek JAW, et al. (2014) Evaluation of conventional, dynamic contrast enhanced and diffusion weighted MRI for quantitative Crohn's disease assessment with histopathology of surgical specimens. Eur Radiol 24:619–629

15. Davis TW, Goldstone SE (2009) Sexually transmitted infections as a cause of proctitis in men who have sex with men. Dis Colon Rectum 52:507–512
16. Pisani Ceretti A, et al. (2015) The great pretender: rectal syphilis mimic a cancer. Case Rep Surg 2015:1–4
17. Akdamar K, Martin RJ, Ichinose H (1977) Syphilitic proctitis. Am J Dig Dis 22:701–704
18. Cha JM, Choi SI, Lee JI (2010) Rectal syphilis mimicking rectal cancer. Yonsei Med J 51:276
19. Heffernan C, Pachter HL, Megibow AJ, Macari M (2005) Stercoral colitis leading to fatal peritonitis: CT findings. Am J Roentgenol 184:1189
20. Wittenberg J, Harisinghani MG, Jhaveri K, Varghese J, Mueller PR (2002) Algorithmic approach to CT diagnosis of the abnormal bowel wall 1. Radiographics 22:1093
21. Sarin A, Safar B (2013) Management of radiation proctitis. Gastroenterol Clin N Am 42:913–925
22. Kennedy G, Heise C (2007) Radiation colitis and proctitis. Clin Colon Rectal Surg 20:064–072
23. Sharif S, Hyser M (2006) Ischemic proctitis: case series and literature review. Am Surg 72:1241–1247
24. Wiesner W, et al. (2002) CT findings in isolated ischemic proctosigmoiditis. Eur Radiol 12:1762
25. Wiesner W, Khurana B, Ji H, Ros PR (2003) CT of acute bowel ischemia1. Radiology 226:635
26. Parks AG (1963) Etiology and surgical treatment of fistulain-ano. Dis Colon Rectum 6:17
27. Whiteford M (2007) Perianal abscess/fistula disease. Clin Colon Rectal Surg. 20:102
28. Caliste X, et al. (2011) Sensitivity of computed tomography in detection of perirectal abscess. Am Surg 77:166–168
29. Lohsiriwat V (2012) Hemorrhoids: from basic pathophysiology to clinical management. World J Gastroenterol 18:2009
30. O'Malley RB, et al. (2012) Rectal imaging: part 2, perianal fistula evaluation on pelvic MRI–what the radiologist needs to know. Am J Roentgenol 199:W43–W53
31. Beckingham IJ, et al. (1996) Prospective evaluation of dynamic contrast enhanced magnetic resonance imaging in the evaluation of fistula in ano. Br J Surg 83:1396–1398
32. Stoker J, Rociu E, Zwamborn AW, Schouten WR, Laméris JS (1999) Endoluminal MR imaging of the rectum and anus: technique, applications, and pitfalls. RadioGraphics 19:383–398
33. Stoker J, Rociu E, Schouten WR, Laméris JS (2002) Anovaginal and rectovaginal fistulas: endoluminal sonography versus endoluminal MR imaging. Am J Roentgenol 178:737–741
34. Kuhlman JE, Fishman EK (1990) CT evaluation of enterovaginal and vesicovaginal fistulas. J Comput Assist Tomogr 14:390–394
35. Muñoz M, et al. (1998) Management of acquired rectourinary fistulas: outcome according to cause. Dis Colon Rectum 41:1230–1238
36. Kavanagh D, et al. (2005) Diagnosis and treatment of enterovesical fistulae. Colorectal Dis 7:286–291
37. Pickhardt PJ, Bhalla S, Balfe DM (2002) Acquired gastrointestinal fistulas: classification, etiologies, and imaging evaluation1. Radiology 224:9–23
38. Tang YZ, et al. (2012) Imaging features of colovesical fistulae on MRI. Br J Radiol 85:1371–1375
39. Ravichandran S, Ahmed HU, Matanhelia SS, Dobson M (2008) Is there a role for magnetic resonance imaging in diagnosing colovesical fistulas? Urology 72:832–837
40. Jaffe T, Thompson WM (2015) Large-bowel obstruction in the adult: classic radiographic and CT findings, etiology, and mimics. Radiology 275:651–663
41. Low RN, Chen SC, Barone R (2003) Distinguishing benign from malignant bowel obstruction in patients with malignancy: findings at MR imaging1. Radiology 228:157–165
42. Kim SW, Kim HC, Yang DM (2012) Perforated tumours in the gastrointestinal tract: CT findings and clinical implications. Br J Radiol 85:1307–1313
43. Abdelrazeq AS, et al. (2008) The impact of spontaneous tumour perforation on outcome following colon cancer surgery. Colorectal Dis 10:775–780
44. Kirchhoff P, Clavien P-A, Hahnloser D (2010) Complications in colorectal surgery: risk factors and preventive strategies. Patient Saf Surg 4:5
45. Weinstein S, Osei-Bonsu S, Aslam R, Yee J (2013) Multidetector CT of the postoperative colon: review of normal appearances and common complications. RadioGraphics 33:515–532
46. Cherukuri R, et al. (1998) Hartmann's pouch: radiographic evaluation of postoperative findings. Am J Roentgenol 171:1577–1582