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ABDOMINAL IMAGING

PICTORIAL ESSAY

MRI evaluation of anal and perianal diseases

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ABSTRACT

Anal and perianal region is a commonly affected area in the course of several inflammatory, infectious, and neoplastic diseases. Several imaging modalities may be used in imaging evaluation of this area and magnetic resonance imaging (MRI) emerges as the imaging modality of choice due to its superb soft tissue resolution. MRI is not only useful for initial detection of anal/perianal pathologies but also in the follow-up of these disorders. In this article, we aimed to illustrate MRI findings of several diseases affecting this area including perianal fistula as well as anal fissure, hypertrophic myopathy of internal anal sphincter, hidradenitis suppurativa, pilonidal sinus, rectovaginal/anovaginal fistula and anal canal carcinoma. We think that this article will serve to familiarize the imaging specialists to the MRI findings of these diseases.

Anal canal is anatomically defined as the distalmost portion of the gastrointestinal tract; the anal canal begins at the plane in which the rectum passes through the pelvic diaphragm at the level of anal rectal ring and extends about 4 cm to the anal verge. Anal canal has two muscular layers: internally located muscle layer which is the continuation of circular gastrointestinal musculature is called the internal sphincter, while externally located muscle layer as a continuation of levator ani is called the external sphincter.

Magnetic resonance imaging (MRI), with its superb soft tissue resolution, is the imaging modality of choice for anal and perianal abnormalities (1). Pelvic phased array coils allow more comfortable and tolerable scans with higher signal-to-noise ratios and wider field of view. Parallel imaging techniques result in shorter scan durations (2). T2-weighted images obtained with and without fat saturation as well as postcontrast T1-weighted images with fat suppression are the most helpful sequences (3, 4). Postcontrast images are helpful, mainly for differentiating postoperative changes and chronic granulation or fibrotic tissue from active inflammation and abscess formation (3). Axial and coronal oblique images of the anal canal should be acquired with proper and accurate multiplanar prescription in order to get ideal images which are perpendicular and coronal to the anal canal (3, 5). Levator ani muscles and supralevator planes should also be included in the field of view as these anatomic sites may also be affected in the clinical course of anal disorders.

Perianal fistula

By definition, perianal fistula is an abnormal communication between the anal canal and rectum and the perineal skin. Perianal fistula is usually a disease of the young adults, more common in men than women (6). Secretory discharge from the cutaneous opening of the tract is the most common presenting symptom (5). Obstruction of the anal crypts with subsequent infection is the most credible mechanism proposed in the pathogenesis of perianal fistula. The infection initially takes place in the intersphincteric space as it offers the pathway of least resistance and, from this location infection may spread relatively quickly into adjacent anatomical compartments. Perianal fistula is generally a primary process without any predisposing condition; however, several other diseases such as Crohn disease, prior pelvic surgery, tuberculosis and pelvic malignancies may all be considered as predisposing diseases.

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Conventional contrast material-enhanced fistulography was the first modality used in the diagnosis of perianal fistula. The inability to evaluate the anal sphincter complex, secondary extensions of the fistula as well as relevant anatomic compartments and musculature stand as the major drawbacks of this technique.

Computed tomography (CT) may be useful in demonstrating the associated intraabdominal findings, which are particularly valuable in patients with Crohn disease (6). The accuracy of CT is much better compared to MRI when it comes to detection of air within fistulous tracts as well as the abscess cavities. However, MRI is superior to CT for evaluation of secondary extensions from the fistulous tract and differentiating it from adjacent pelvic soft tissue structures.

MRI is the imaging modality of choice for initial evaluation and follow-up of perianal fistulas (7, 8). Its sensitivity is 100% and specificity is 86% with respect to detection of perianal fistulas (9). MRI is also extremely helpful in the preoperative planning by outlining the extent and secondary ramifications of the fistula tract as well as detecting the anal and cutaneous openings and associated abscesses (4, 5). It is reported that detailed preoperative evaluation of MRI findings may result with additional essential information for surgery in 12 of 56 patients (21%) (9). MRI can differentiate isolated active inflammation from associated fistulous tracts, both appear the same on palpation (10).

The fistulous tracts are generally visualized as linear hyperintense structures on fat saturated T2-weighted images. Fat suppression is required as surrounding normal pelvic fat also appears hyperintense. Associated fibrosis generally appears as hypointense on both T1 and T2-weighted images. Both fistulas and abscess cavities tend to enhance peripherally. Intense enhancement of the fistula wall as well as the surrounding inflamed soft tissues are the typical imaging findings. Unenhanced T1-weighted images are very helpful for detecting hemorrhage in early postoperative phase. Diffusion-weighted imaging (DWI) may also be helpful by demonstrating the fistulous tract in the background of suppressed signal from the surrounding tissues. Though low spatial resolution is a significant limitation of its use as the sole diagnostic sequence (11), DWI may be helpful for detecting small abscesses that would otherwise be missed.

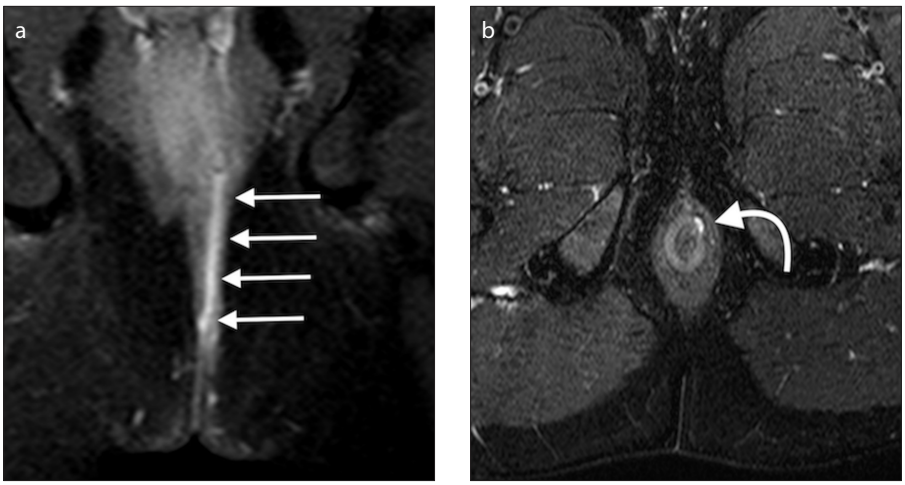

Figure 1. a, b. Grade 1 perianal fistula. Coronal contrast-enhanced fat-suppressed T1-weighted **(a)** and axial fat-suppressed T2-weighted **(b)** images show grade 1 simple intersphincteric fistula (*straight* and *curved white arrows,* respectively) at 1 o'clock position. There is no secondary extension or associated abscess cavity.

Main points

- MRI is the imaging modality of choice for evaluating anal and perianal diseases owing to its superior soft tissue resolution and multiplanar imaging capability.
- According to St James classification, perianal fistulas are graded as follows: Grade 1, simple intersphincteric fistula; grade 2, intersphincteric fistula with abscess; grade 3, transsphincteric fistula; grade 4, transsphincteric fistula with abscess; grade 5, supralevator fistulas. Increasing grades correlate with worse clinical and surgical outcomes.
- Lack of intersphincteric extension is a key feature for differentiating various anal and perianal inflammatory conditions such as hidradenitis suppurativa and pilonidal sinus from perianal fistulas.

Parks et al. (12) classified perianal fistulas as intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric fistula. In accordance with cryptoglandular hypothesis, intersphincteric fistulas comprise the most commonly encountered subgroup. Transsphincteric fistulas were defined as the ones that pierce and penetrate both the external and internal sphincters, whereas suprasphincteric fistulas as the ones crossing and violating the levator plate. In contrast to other fistula subtypes, extrasphincteric fistulas do not readily involve the intersphincteric space. Therefore, evaluation for underlying or accompanying pelvic diseases is recommended in these cases.

Internal opening of fistulas is described in accordance with the anal clock system: 12 o'clock denotes anterior, while 6 o'clock points posterior. Internal opening of fistulas are usually located at the level of the dentate line (5) except for the extrasphincteric fistulas.

Parks classification was revised with respect to imaging findings by St. James classification into five distinct grades with increasing grades correlating to worse surgical outcome (13): in grade 1 intersphincteric fistulas, tract extends from skin to anal canal traversing through intersphincteric plane, without any associated abscess or secondary extensions (Fig. 1). In case of grade 1 fistulas having associated abscesses or secondary extensions within the intersphincteric plane, they are upgraded to grade 2 (Fig. 2). Grade 3 transsphincteric fistulas extend through both the internal and external sphincters (Fig. 3). When additional ischioanal fossa abscess or secondary tract is present, they are accepted as grade 4 fistula (Fig. 4). Grade 5 supralevator fistulas pose a different pathogenetic mechanism as they are not related to intersphincteric plane and dentate line. They breach the levator muscle through their courses and are related with pelvic infections (Fig. 5). Grade 5 fistulas are analogous to Parks classification's suprasphincteric and extrasphincteric fistulas.

Patients with perianal Crohn disease constitute a specific subset of patients as anal involvement in Crohn disease tends to occur with recurrent and complex perianal fistulas (2, 3). Presence of perianal Crohn disease

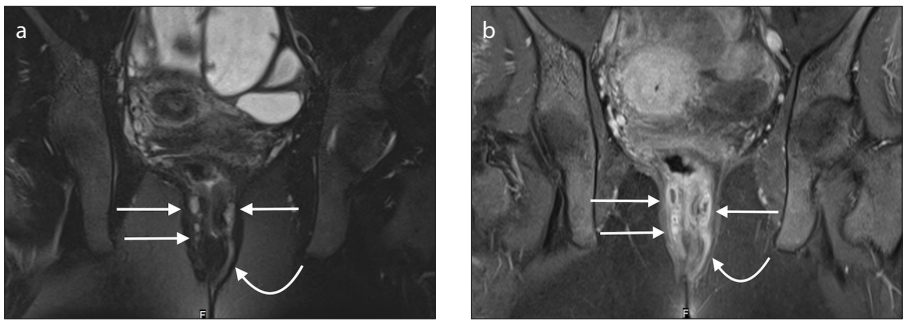

Figure 2. a, b. Grade 2 perianal fistula. Coronal fat-suppressed T2-weighted **(a)** and contrast-enhanced fat-suppressed T1-weighted **(b)** images reveal intersphincteric fistula *(curved white arrows)* and related abscess cavities *(white arrows)* of varying sizes. Abscess cavities exhibit hyperintensity on T2-weighted image and peripheral rim type enhancement on contrast-enhanced T1-weighted image. Patient had a history of Crohn disease.

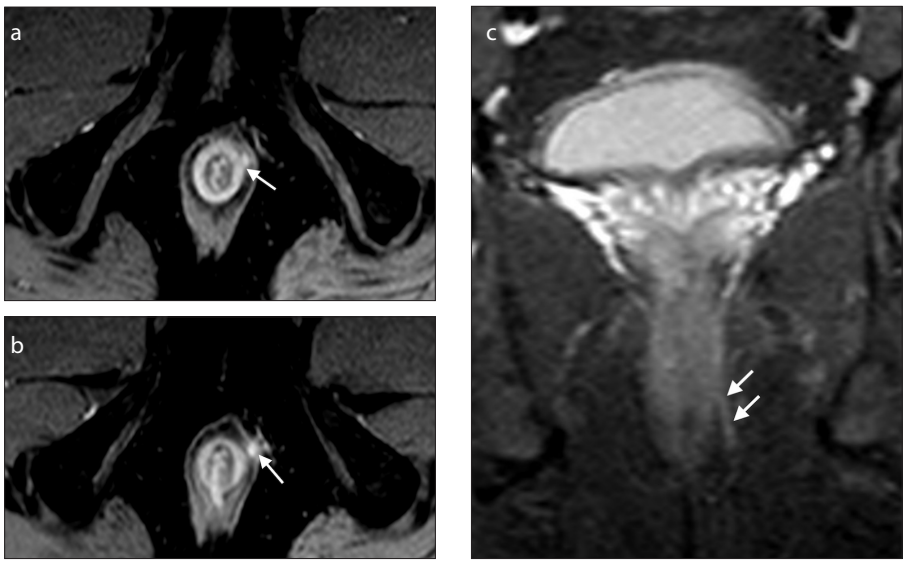

Figure 3. a–c. Grade 3 perianal fistula. Axial contrast-enhanced fat-suppressed T1-weighted images **(a, b)** demonstrate fistulous tract at 2 o'clock *(white arrows)*. Tract traverses through both internal **(a)** and external **(b)** sphincters. On coronal contrast-enhanced fat-suppressed T1-weighted image **(c)** note lack of ischioanal abscess or secondary tract with respect to fistulous tract *(white arrows)*. Findings are compatible with grade 3 transsphincteric fistula.

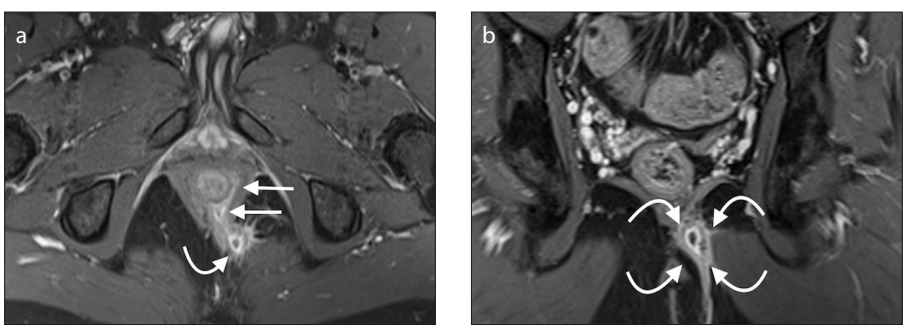

Figure 4. a, b. Grade 4 perianal fistula. Axial **(a)** and coronal **(b)** contrast-enhanced fat-suppressed T1-weighted images show grade 4 transsphincteric fistula *(straight white arrows)* with accompanying abscess cavity in the left ischioanal fossa *(curved white arrows)*.

pose a diagnostic challenge as MRI has certain limitations and low sensitivity when it comes to demonstrate Crohn disease related strictures and superficial ulcerations (10).

Defects of sphincter complex should be considered in the differential diagnosis of perianal fistulas as they can be encountered after surgical treatment. Postsurgical defects of the anal canal may mimic mostly transsphincteric fistula as they may traverse both internal and external sphincters. However, appearance of low signal intensity on T2-weighted images may be helpful to differentiate postsurgical wall defects since perianal fistulas usually present with high T2 signal intensity (Fig. 6).

Rectovaginal/anovaginal fistula

The leading cause of rectovaginal/anovaginal fistulas is trauma due to obstetric reasons, followed by Crohn disease and pelvic radiotherapy. Malignancies and other postsurgical complications constitute minority of the cases. These fistulas may be debilitating for the patients, with a great potential to decrease patients' quality of life (14).

MRI exams performed with phased array coils may not detect tiny fistulas due to their lower resolution. However, they have the advantage of covering a large field of view in a noninvasive way, enabling the readers to detect any possible associated findings. It has been reported that the use of rectal contrast may be helpful in detecting subtle fistula tracts, not otherwise detected (14). Rectovaginal/anovaginal fistulas are typically detected as tiny hyperintense tracts on T2-weighted images. Accompanying presence of air both in fistulous tract and in the rectovaginal septum is an important diagnostic clue for accurate diagnosis (15). It should be borne in mind that MRI is not very sensitive to detect the presence of tiny air bubbles in the fistulous tract. In advanced cases, accompanying dense inflammatory changes and small abscesses in the close vicinity, especially in rectovaginal septum, may be detected. These abscesses and inflammatory changes may obscure the underlying fistula tract (Fig. 7). Abscess cavities located in rectovaginal septum have typical hypointense signal on T1-weighted images and appear hyperintense on T2-weighted images. Peripheral mural enhancement is an important ancillary imaging feature for diagnosing abscesses.

Anal fissure

Anal fissures arise from a split in the anal skin. On T2-weighted images they are usually encountered as tiny areas of increased signal intensity in their typical location, which is the midline posterior wall of anal canal (Fig. 8). Unusual locations may be

Figure 5. Grade 5 perianal fistula. Axial contrast-enhanced fat-suppressed T1-weighted image demonstrates grade 5 fistula extending into the supralevator area *(white arrows)*. Note the normal levator plate at the contralateral side *(dashed arrow)*.

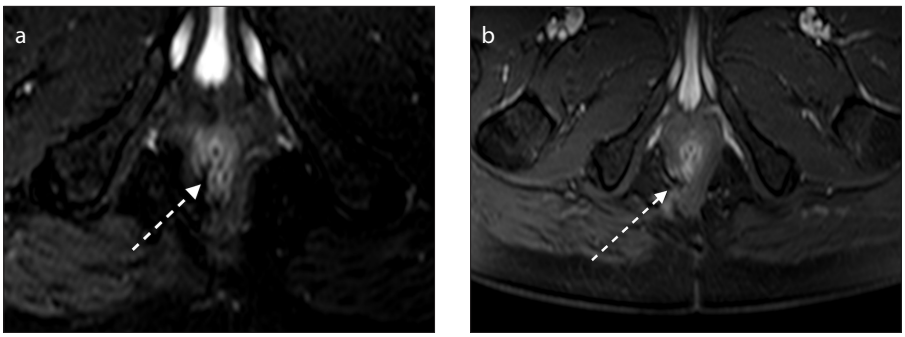

Figure 6. a, b. Postsurgical defect at anal sphincter. Axial fat-suppressed T2-weighted **(a)** and contrast-enhanced fat-suppressed T1-weighted **(b)** images demonstrate focal defect and thinning located in the external sphincter at 6-8 o'clock *(dashed white arrows)*. Patient had a history of recurrent perianal fistula despite multiple surgeries.

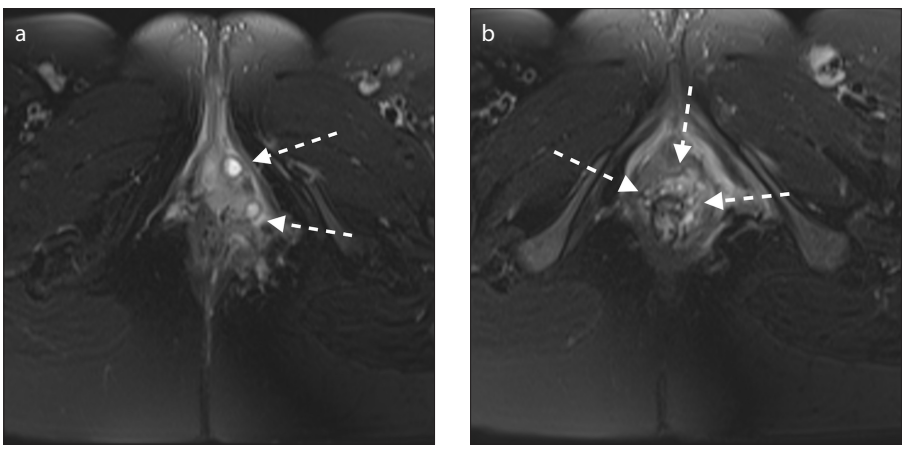

Figure 7. a, b. Rectovaginal fistula. Axial fat-suppressed T2-weighted images **(a, b)** (from cranial and caudal levels; respectively) show abscesses and thickening of the rectovaginal septum consistent with rectovaginal fistula *(dashed white arrows)*. There is ill-defined increased signal intensity in the neighboring structures due to inflammatory changes.

seen in patients with Crohn disease and tuberculosis.

The main clinically presenting symptoms are sharp, and sometimes excruciating, local pain most pronounced during defecation. Despite the fact that the exact pathogenesis is yet to be elucidated, increased tonus of internal sphincter with associating ischemia of the posterior anal canal was proposed as the main underlying mechanism (16). Early treatment of anal fissures is generally conservative. Patients resistant to pharmacotherapy and other conservative measures may be referred to surgery. It mainly consists of lateral internal sphincterotomy, most widely performed surgical approach with high healing rates (17).

Hypertrophic myopathy of internal anal sphincter

Hypertrophic myopathy of internal anal sphincter (HMAS) is characterized by diffuse thickening of anal sphincter. Most cases are sporadic; however, autosomal dominant mode of inheritance has also been reported (18). Anal pain is the most typical presenting symptom and it is considered to be due to spasmodic contraction of bulky anal sphincter. Increased anal pressure with manometric tests may provide helpful information for correct and definite diagnosis.

MRI is more suited to detect this abnormal thickening compared to CT. Absence of any anal fissure/fistula or associated inflammatory signal changes around anal sphincter muscles suggests HMAS in patients with relevant clinical signs and symptoms (Fig. 9).

Hidradenitis suppurativa

Hidradenitis suppurativa (HS) is a chronic disease with frequent recurrences. Follicular occlusion is considered to be the underlying pathogenetic mechanism, which results in chronic obstruction of the affected ducts. Subsequent rupture of these dilated ducts initiates chronic inflammation and fibrosis in the adjacent soft tissues. Hair follicles and apocrine glands are the most commonly affected anatomic structures.

MRI has an adjunctive role in demonstrating the extent of inflammatory changes, associated sinus tracts and abscesses (19). Cutaneous and subcutaneous changes are most prominent around the perineum and the medial aspect of the thigh. As inflammation is the underlying mechanism, involved areas appear as hypointense on T1-weighted images, hyperintense on T2-weighted and short tau inversion recovery (STIR) images (Fig. 10). In addition to diagnosis, MRI may also have a role in the posttreatment follow-up of these patients. With the quiescence of the ongoing inflammation after treatment, involved soft tissues and associated tracts typically lose their hyper-

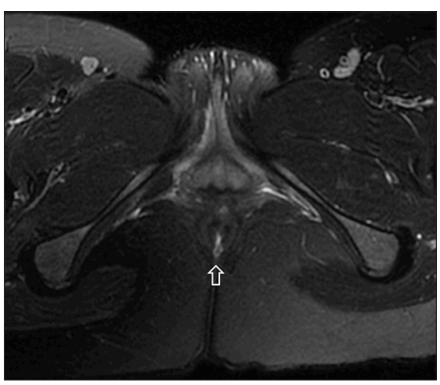

Figure 8. Anal fissure. Axial contrast-enhanced fat-suppressed T1-weighted image demonstrates an anal dermal split at the posterior midline location, consistent with anal fissure *(hollow arrow)*. Note that there is no communication with the perineal skin.

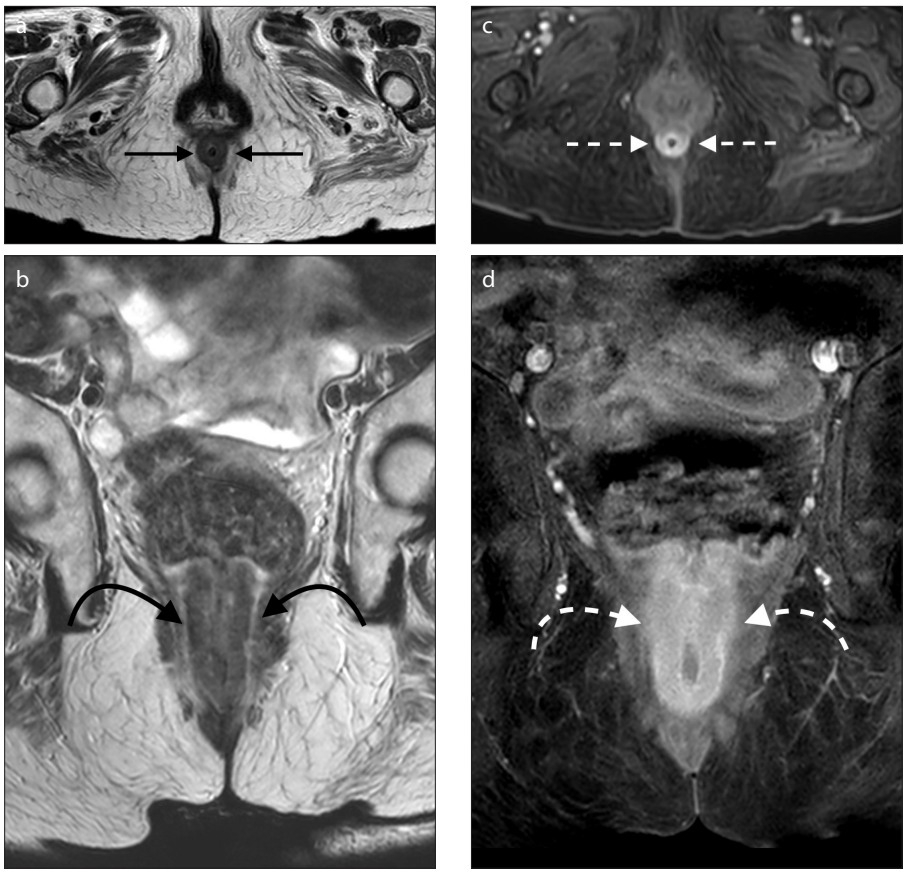

Figure 9. a–d. Hypertrophic myopathy of internal sphincter. Axial **(a)** and coronal **(b)** T2-weighted images show diffuse and marked thickening of the anal sphincter complex *(black arrows)*. Axial **(c)** and coronal **(d)** contrast-enhanced fat-suppressed T1-weighted images demonstrate avid enhancement of thickened internal sphincter muscle *(dashed white arrows)*. Note absence of focal nodular thickening, focal asymmetrical expansion and accompanying lymphadenopathy.

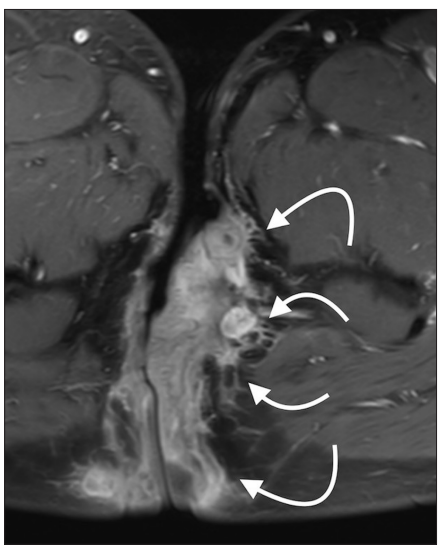

Figure 10. Hidradenitis suppurativa. Axial contrast-enhanced fat-suppressed T1-weighted image shows bilateral marked thickening of skin and subcutaneous tissues with accompanying contrast enhancement *(curved white arrows)* in a patient with known inguinoperineal hidradenitis suppurativa. Note lack of abnormal communication with the bowel segments.

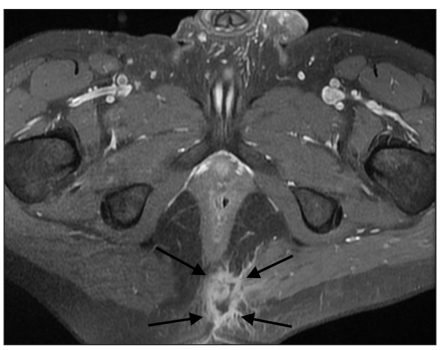

Figure 11. Pilonidal sinus. Axial contrast-enhanced fat-suppressed T1-weighted image reveals peripherally enhancing pilonidal sinus *(black arrows)*. Sinus tract has communication with the skin at the level of the natal cleft.

intense signal on T2-weighted and STIR images (20, 21).

Absence of abnormal communication between the affected soft tissue planes and bowel segments is a key feature for differentiating hidradenitis suppurativa from perianal fistulas (5, 8, 21).

Pilonidal sinus

Pilonidal sinus is caused by inflammation of the hair follicles with subsequent folliculitis, abscess and sinus tract at the location of the natal cleft. Location of pilonidal sinus far from and posterior to the anal canal, at the location of the natal cleft is clinically pathognomonic. Therefore, imaging is not mandatory for definite diagnosis. However, when performed, it is typically visualized as inflammatory changes in the superficial tissues around the coccyx and sacrum (Fig. 11). The absence of intersphincteric area involvement on imaging is a key feature to differentiate pilonidal sinus from perianal fistula (22).

Anal canal carcinoma

Anal canal carcinoma is a rare malignancy which comprises around 2.5% of all colorectal carcinomas. Local pain, pruritus, rectal bleeding, constipation, and frank mass are the most common presenting symptoms. Human papilloma virus, especially types 16 and 18 may coexist with squamous cell carcinoma (23). Tumors located below dentate line tend to drain into inguinal lymph nodes; while tumors located above the dentate line typically drain into internal iliac, perirectal, and mesorectal lymph nodes (24, 25).

MRI may enable accurate detection of the tumor extension into anal sphincter complex, anterior urogenital triangle and ischioanal fossa. T2-weighted images with plane orientations perpendicular and parallel to the long axis of anal canal are reported to be superior to STIR images for evaluating anal canal carcinomas and surrounding anatomical structures (26). Anal carcinomas are typically seen as lesions with intermediate increased signal intensity on T2-weighted images (1, 27). They are seen as asymmetric thickening with peritumoral stranding of neighboring soft tissues (Fig. 12). As lesions enlarge, they tend to exhibit heterogeneous signal intensity (26). On contrast-enhanced images, tumor is characteristically seen as an expansile soft tissue mass, as opposed to perianal fistulas, and demonstrate intense contrast enhancement. Metastasis should also be considered in differential diagnosis of expansile contrast enhancing masses in anal canal especially for patients with another primary malignancy (Fig. 13).

In addition to initial evaluation, MRI is also helpful for follow-up of anal canal tumors after neoadjuvant chemoradiotherapy. The typical signs of tumor regression are

mainly shrinking tumor size with associated decreased signal intensity on T2-weighted images (25–27).

DWI is also helpful in evaluating both the primary tumor and possible local recurrences. Restricted diffusion compared with adjacent wall on diffusion-weighted images and corresponding apparent diffusion coefficient (ADC) maps are typical findings. DWI may also be helpful in differentiating residual or recurrent tumor from treatment-related changes, which may mimic active malignancy from a morphologic standpoint. Response to chemoradiotherapy typically results in increased signal intensity on ADC maps, reflecting decreased intratumoral neoplastic cell population (28).

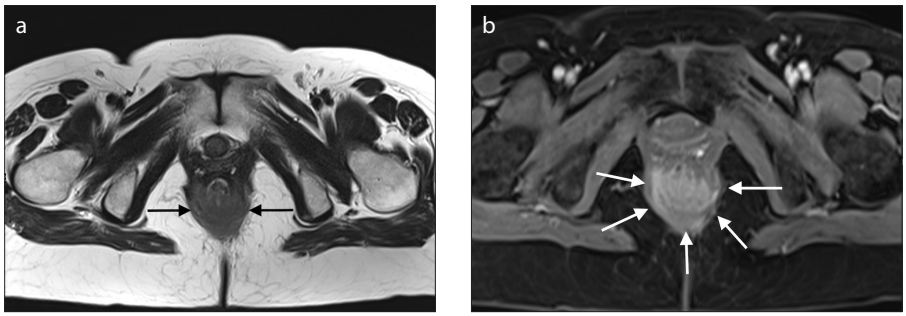

Figure 12. a, b. Anal canal carcinoma. Axial unenhanced T1-weighted image without fat suppression **(a)** and contrast-enhanced fat-suppressed T1-weighted image **(b)** demonstrate irregular mass lesion *(black and white arrows)* involving sphincter complex, mostly located in the posterior half of the anal canal. Tumoral tissue exhibits avid contrast enhancement.

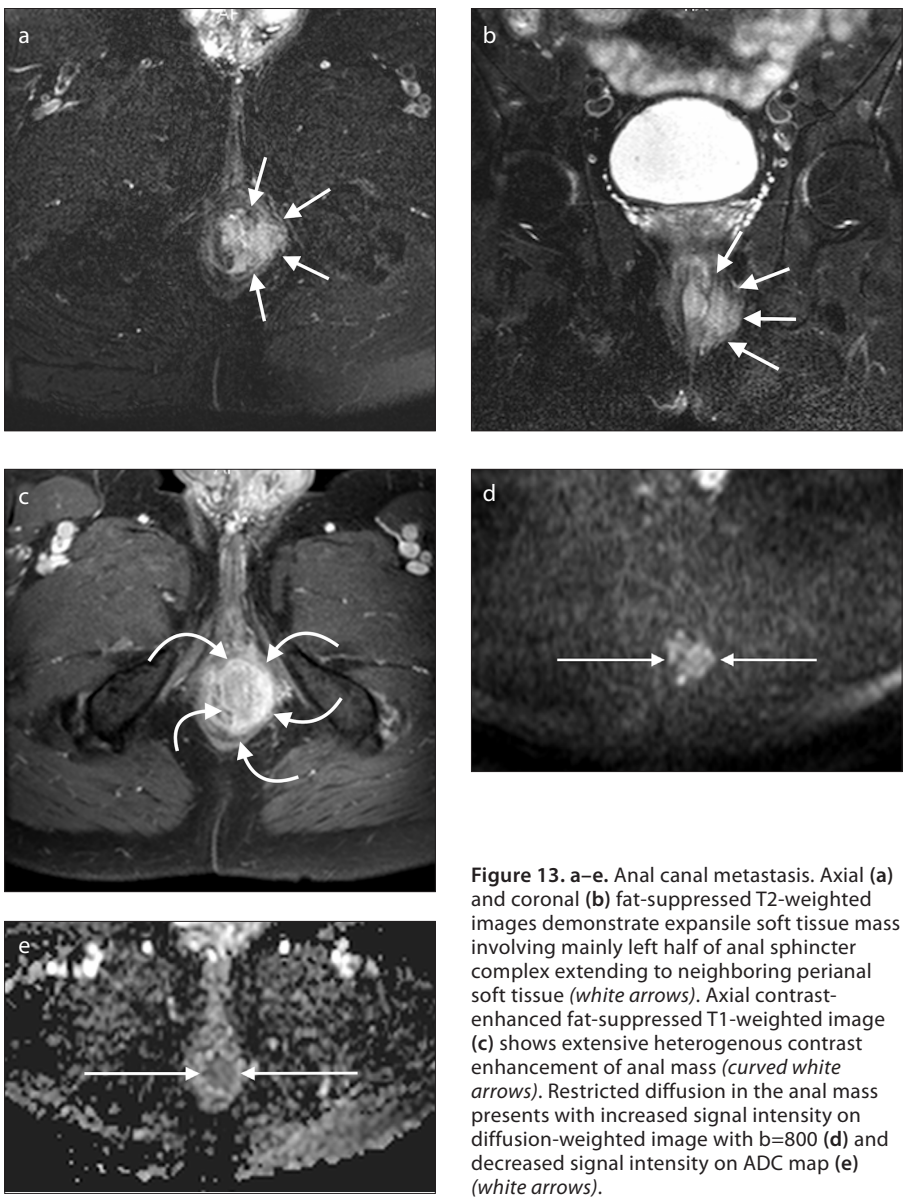

Figure 13. a–e. Anal canal metastasis. Axial **(a)** and coronal **(b)** fat-suppressed T2-weighted images demonstrate expansile soft tissue mass involving mainly left half of anal sphincter complex extending to neighboring perianal soft tissue *(white arrows)*. Axial contrast-enhanced fat-suppressed T1-weighted image **(c)** shows extensive heterogenous contrast enhancement of anal mass *(curved white arrows)*. Restricted diffusion in the anal mass presents with increased signal intensity on diffusion-weighted image with b=800 **(d)** and decreased signal intensity on ADC map **(e)** *(white arrows)*.

Conclusion

The anatomy of the anal and perianal region is complex and several different abnormalities may be seen in this confined anatomical space. Almost any imaging modality may be used for evaluating this area; however, MRI, with its superb and unmatched soft tissue resolution, emerges as the modality of choice. MRI, with high sensitivity and specificity, has a crucial role both for detection of perianal pathologies that has a wide differential diagnosis list and for detection of recurrences or residual pathologies during posttreatment follow-up.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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