MR imaging of fistula-in-ano

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Learning objectives

The purpose of this article is to describe the normal anatomy of the perianal region as seen on MR, the classification of fistula-in-ano and to illustrate its main MR imaging features.

Background

- Epidemiology

Fistula-in-ano are abnormal tracts that connect a primary opening inside the anal canal to a secondary opening in the perianal skin, being responsible for inflammatory changes of the region around the anal canal.

Perianal fistulas are an increasingly common condition, with a prevalence of approximately 0.01%, predominantly affecting young adults. Due to the higher abundance of anal glands in men, males are affected two to four-times more commonly than women.

Patients usually present with discharge (65% of cases). Local pain is also a common symptom, although some perianal fistulas may be completely asymptomatic.

- Anatomy

In order to clearly understand the etiology and classification of fistulous disease, one must be familiar with the pelvic floor and anal canal anatomy (Fig. 1).

The anal canal is a 2.5 to 4 cm long cylinder, extending from the levator ani muscle cranially to the anal verge caudally and is divided into three parts, separated by two lines (the dentate or pectinate line and the Hiton's white line).

The dentate line lies approximately 2 cm proximal to the anal verge and is a landmark for a histologic junction between rectal columnar epithelium (cranially) and anal squamous epithelium (caudally). It corresponds to the distal undulating limit of the anal valves, small semilunar folds between longitudinal mucosal folds (the anal columns of Morgagni) that are present in the proximal half of the anal canal. The anal valves form small pockets (the anal sinuses or crypts of Morgagni), where the anal glands secrete mucus that help lubricate the anus.

The Hilton's white line (lying below the pectinate line) divides the non-keratinized stratified squamous epithelium of the anal canal from the keratinized stratified squamous epithelium of the anus and perianal skin.

The anal canal is surrounded by two muscular sphincters: the internal sphincter (composed of smooth muscle and primarily responsible for resting involuntary anal continence) and the external sphincter (composed of striated muscle and primarily responsible for voluntary continence).

The internal sphincter corresponds to the inferior extension of the inner circular smooth muscle of the rectum and, in most individuals, can be divided without causing loss of fecal continence.

The external anal sphincter is composed of three parts (subcutaneous, superficial and deep), the latter continuous superiorly with the puborectalis and iliococcygeus muscle (parts of the levator ani muscle). Division of the external sphincter (often necessary for the surgical treatment of the fistulous tract) can lead to fecal incontinence.

Separating the internal and external sphincters is the intersphincteric space, composed of loose fat-containing areolar tissue and the rectal longitudinal smooth muscle (without obvious sphincteric effect). This space is a natural plane of lower resistance in which fistulas and pus can readily spread.

Two fat-filled contiguous spaces (the ischiorectal space cranially and the ischioanal space caudally) surround the anal canal, superficial to the sphincter complex and inferior to the levator ani muscle.

- Etiology

Most perianal fistulas are called idiopathic and its origin can be explained by the "cryptoglandular hypothesis". Although the anal glands are usually present in the subepithelium, one to two-thirds of these glands are deeply sited within the intersphincteric space. An abscess (secondary to acute infection and anal gland drainage obstruction) that develops in a superficial gland is most likely to discharge spontaneously into the anal canal. However, if it occurs at the intersphincteric plane (deep to the internal sphincter), the sphincter can act as a barrier, leading the pus along the path of the least resistance: the intersphincteric space. In fact, formation of an abscess is thought to be the initiating event in the natural history of fistula-in-ano, since around 87% of these patients eventually develop an anal fistula. For this reason, perianal abscesses and fistulas are thought to be the acute and chronic (respectively) manifestations of the same disease.

The only fistulas-in-ano that cannot be explained by the "cryptoglandular hypothesis" are the extrasphincteric fistulas, usually secondary to inflammatory processes such as Crohn's disease and diverticulitis. Other conditions that can result in fistula-in-ano

include tuberculosis, trauma during childbirth, radiation therapy and pelvic infection or malignancy (Fig. 2).

Images for this section:

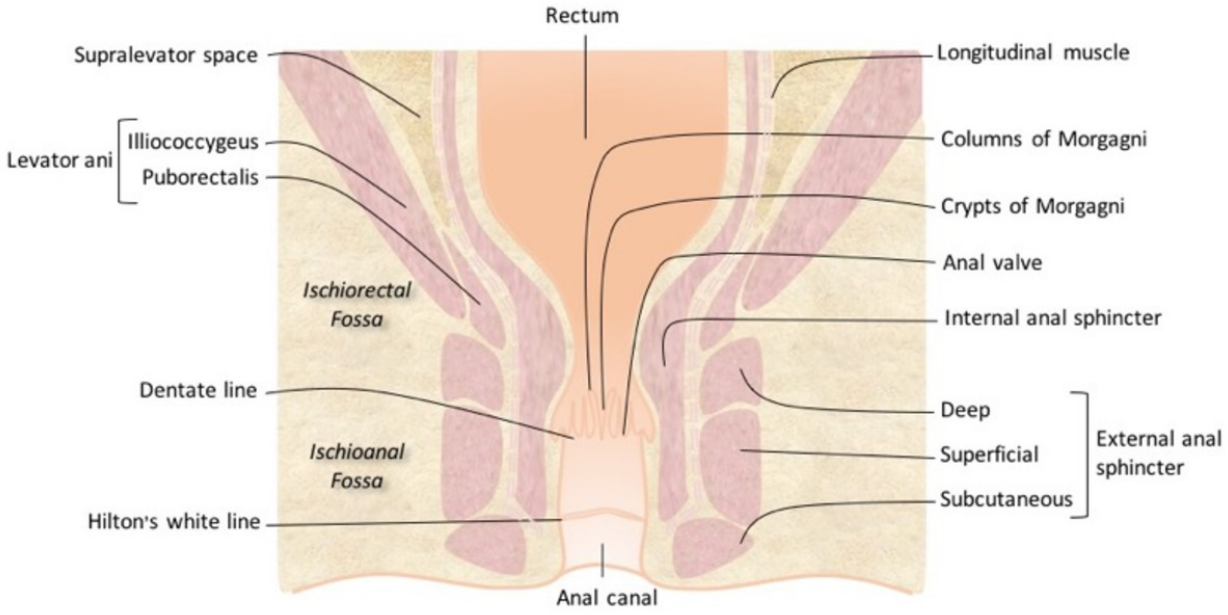

Fig. 1: Drawing of the normal anatomy of the perianal region in the coronal plane.

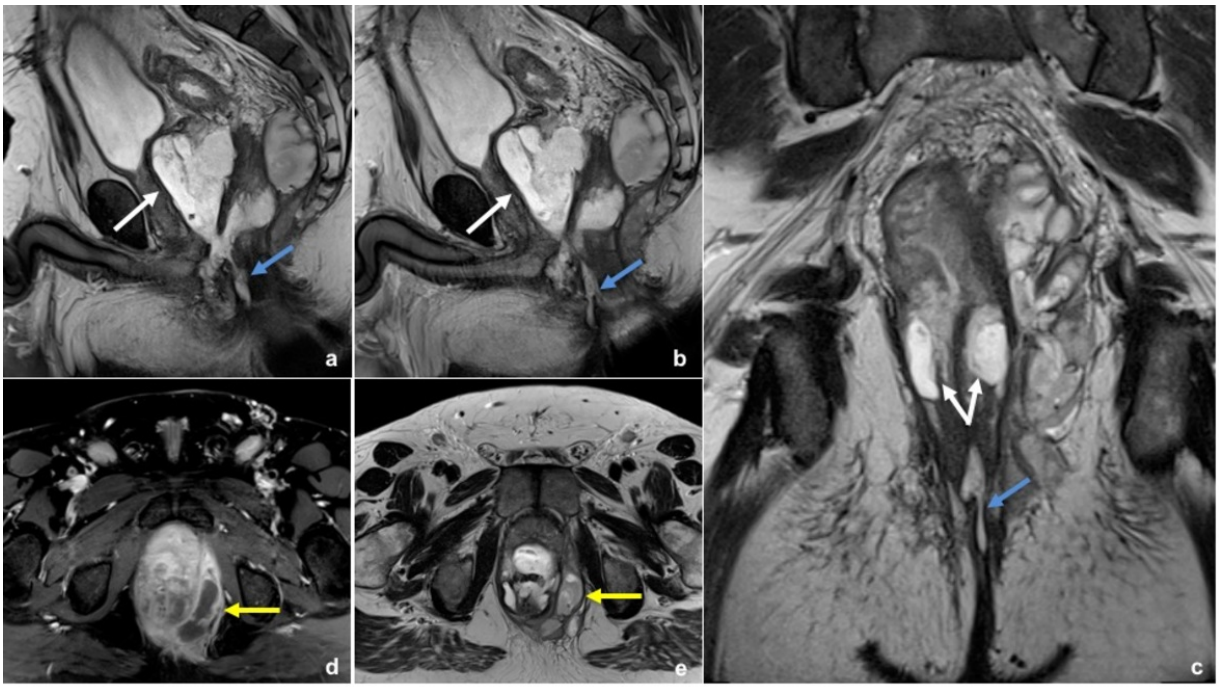

Fig. 2: Mucinous rectal carcinoma as a predisposing factor for the development of a perianal fistula. Sagital (a, b) and coronal (c) T2-weighted MR images show a voluminous rectal mass filled with mucin, which has high signal intensity on T2-weighted images (white arrows). A complex fistulous path (blue arrows) extending to the sphincters can be found contiguous to the antero-inferior margin of the tumour. Axial contrast-enhanced T1-weighted image with fat suppression (d) shows a hypointense lesion with rim enhancement (yellow arrow). On the axial T2-weighted image (e), the same lesion is moderately hyperintense, consistent with an abscess.

Findings and procedure details

In the past, several imaging techniques were used to evaluate patients with fistula-in-ano.

Contrast material-enhanced fistulography was the first modality used, but only a small percentage (16%) of patients were correctly diagnosed by this technique because of the limited accuracy in the characterization of the primary tract (particularly the evaluation of the exact level of the internal opening) and the inability to assess secondary extensions and the relationship between any tract and the sphincter complex.

Computed tomography (CT), especially with rectal and intravenous contrast material, can be used to evaluate perirectal inflammatory disease and suspected perirectal abscesses. However, previous studies found that, because of the poor resolution of soft tissue in CT imaging, only about a quarter of the patients with fistula-in-ano were correctly classified.

Anal endosonography has also been used for the preoperative classification of perianal fistulas. Since the endoprobe is very close to the structures in the anal canal, this technique provides images of high spatial resolution with excellent imaging of the rectal wall and anal sphincter. Endosonography allows a correct diagnosis of the primary tract in more than 80% of the patients, being particularly useful in the evaluation of the site of the internal opening. However, a major drawback of this approach is the limited field of view, decreasing the ability to assess primary superficial, suprasphincteric, and extrasphincteric tracts or secondary extensions.

- MR Imaging of fistula-in-ano

MR imaging, as a result of its intrinsic ability to accurately define the anatomy of the anal canal (Fig. 3) and of its high sensitivity in identifying tracts and abscesses in surgical relevant planes, has emerged as the "gold standard" for non-invasive assessment of fistula-in-ano.

In fact, previous studies showed that MR imaging of perianal fistulas allows the diagnosis in the vast majority of the patients, with accurate classification of both the primary tract (sensitivity, 100%; specificity, 86%) and abscesses (sensitivity, 96%; specificity, 97%). MR imaging is also capable of identifying disease that would be otherwise missed (namely secondary tracts or abscesses), with consequent reduction of fistula recurrence.

Lastly, the ability to define the anatomic relationships of the fistula with the external sphincter has the potential to predict and reduce postoperative fecal incontinence.

<u>Technique</u>

In order to evaluate fistula-in-ano it is mandatory that imaging planes are correctly aligned with respect to the anal canal.

Since the anal canal is tilted forward from the vertical by approximately 45° in the sagittal plane, a sagittal fast spin-echo (FSE) T2-weighted sequence must be performed initially and truly axial and coronal images along the long axis of the canal can be obtained from this sequence (Fig. 4).

Since some tracts may extend for several centimeters, it is important that the imaged volume extends several centimeters above the levator ani muscle and include the whole presacral space as well as the entire perineum.

Following the sagittal T2-weighted sequence, the pelvic MRI protocol for perianal fistula evaluation at our institution includes oblique axial and oblique coronal T2-weighted FSE, fat-suppressed oblique axial and oblique coronal T2-weighted FSE and fat-suppressed T1-weighted sequences (before and after iv administration of gadolinium-based contrast material).

Interpretation

The precise location of the internal opening and classification of the primary tract is easily obtained in the axial plane. On the other hand, the levator plate is better evaluated in the coronal plane, allowing the distinction between supra and infralevator disease. The height of the internal opening is also well seen on images in this plane.

Active and inactive fistulous tracts, as well as abscesses, are hypointese on unenhanced T1-weighted images, appearing with similar intensity to normal structures such as the sphincteric and levator ani muscles.

However, inflammatory active fistulas (due to the presence of granulation tissue with increased vascularity) and fluid collections like abscesses (due to the presence of pus) are clearly depicted on T2-weighted images, appearing as areas of high signal intensity in contrast with the lower signal intensity of the anal sphincter, muscles, and fat. Tissues surrounding the fistulous tract may also be hyperintense on fat-suppressed T2-weighted images due to edema or inflammation.

On contrast-enhanced fat-suppressed T1-weighted images, active inflammation within the fistulous tract will enhance, while fluid in the tract remains hypointense. In such sequences, perianal abscesses will typically have a central hypointensity (corresponding to pus) with peripheral rim enhancement of the fibrous wall and surrounding inflammation.

Secondary tracts have imaging features similar to those of the primary tract.

Fistula classification

Accurate classification of fistula-in-ano includes the evaluation of the path taken by the primary tract, description of the internal opening and location of any associated extension or abscess.

Primary tract

The first classification of the primary tract of fistulas-in-ano was the Parks classification, based on surgical findings from 400 patients with perianal fistulas referred to the St Mark's Hospital (London, England). This classification described four groups of fistulas in the coronal plane (Fig. 5), using the external sphincter as the keystone:

- Intersphincteric fistulas (45% of cases in the study) were the most common fistulas of the four categories. These fistulas are seen in the plane between the sphincters and are entirely confined by the external sphincter, which acts as a barrier to the spread of infection. The fistulous tract extends from the skin of the perineum or natal cleft to the anal canal, and the ischiorectal and ischioanal fossae are clear.

- Transsphincteric fistulas (30% of cases in the study), in which the tract penetrates both the internal and external anal sphincters, and then arcs down to the skin through the ischiorectal and ischioanal fossae.

- Suprasphincteric fistulas (20% of cases in the study), when the tract progresses upward into the intersphincteric space and arches over the top of the puborectalis muscle, then crossing the levator plate to the ischioanal fossa to reach the perianal skin.

- Extrasphincteric fistulas (5% of cases in the study), characterized by the absence of intersphincteric infection or anal canal involvement. Instead, the tract enters the rectum or anorectal junction directly after crossing the ischiorectal fossa and levator muscles. As stated before, infection of the anal glands cannot explain these fistulas, and primary rectal pelvic diseases must be excluded when this type of fistula is encountered.

Internal opening

The internal opening can be described according to the "anal clock": with the patient in the supine position, the anal clock is a transversal view of the canal, with 12 o'clock being directly anterior (Fig. 6).

Because anal glands are more common posteriorly, most fistulas enter at this level (6 o'clock position). However, it is sometimes impossible to trace a tract right up to the anal mucosa, making it difficult to depict the internal opening. In such cases, one must consider that the probable internal opening is close to the area of maximal intersphincteric sepsis.

The height of the internal opening relative to the canal anal and sphincters can be assessed in the coronal plane. Although most fistulas open into the anal canal at the level of the dentate line, some open at a higher position with consequent implications in patient outcome: the higher the opening the more sphincter will be divided, increasing the probability of post-operative fecal incontinence.

Extensions/secondary tracts

A major advantage of MR imaging is the possibility to evaluate the presence of extensions associated with a primary tract, representing focus of infection that would have otherwise gone unidentified. Missed extensions are the main cause of recurrence (reaching 25% in some studies).

The commonest type of extension is found in the ischioanal fossa, rising from the apex of a transsphincteric tract (Fig. 11). Extensions can also occur in the horizontal plane, known as "horseshoes" (Fig. 9, 16). Lastly, there may be also supralevator extensions.

Extensions frequently take the form of complex tract systems, becoming dilated enough to create an abscess. Complex extensions are more common in patients with recurrent fistula in ano or in those who have Crohn's disease (Fig. 15, 16).

Due to the growing application of MRI for the pre-operative evaluation of perianal fistulas, the Parks classification of perianal fistulas was latter modified to a MR imaging-based classification that included relevant MR imaging findings in the axial and coronal planes. This classification (known as the St. James University Hospital Classification) took into consideration the primary fistulous tract, but also the secondary extensions and abscesses, dividing perianal fistulas into five groups:

- Grade I (simple linear intersphincteric fistulas) (Fig. 7): the tract extends from the anal canal through the intersphincteric space, clearly contained by the relatively hypointense external sphincter. No extensions or abscesses are found in the intersphincteric space or ischiorectal and ischioanal fossae.

- Grade II (intersphincteric fistula with an abscess or secondary tract) (Fig. 8, 9): extensions and abscesses may be of the horseshoe type (spreading across both sides of the internal opening), or may branch in the ipsilateral intersphincteric plane but, as in grade I fistulas, the pathologic process is always confined by the external sphincter,

which is never crossed. In fact, any evidence of a tract in the ischioanal or ischiorectal fossae excludes an intersphincteric fistula (either grade I or II).

- Grade III (transsphincteric fistula) (Fig. 10): the fistula pierces both layers of the sphincter complex, reaching the perineal skin through the ischiorectal and ischioanal fossae without being complicated by secondary tracts or abscesses in these areas.

- Grade IV (transsphincteric fistula with an abscess or secondary tract in the ischiorectal or ischioanal fossa) (Fig. 11, 12): the tract crosses the external sphincter to reach the ischiorectal and ischioanal fossae, where it is complicated by an abscess or extension.

- Grade V (supralevator and translevator disease) (Fig. 13, 14, 15, 16): any tract that penetrates the pelvic floor above the insertion point of the levator ani muscle is potentially a suprasphincteric or extrasphincteric fistula. The level of the internal opening distinguishes between these types of fistula: in suprasphincteric fistulas the internal opening is anal, while in extrasphincteric fistulas the internal opening is rectal, from where the fistulous tract extends directly to the perineal skin through the ischiorectal and ischioanal fossae, with no involvement of the anal canal.

This MR imaging-based classification has been shown to have prognostic value: while grades I and II are associated with favorable outcome, higher grades are associated with worse outcome, with higher rates of recurrence needing reoperation. In fact, this classification appears to be a more powerful predictor of postoperative outcome than the information obtained from surgical exploration.

Besides, this classification also has influence in the type of treatment chosen, as will be further explained.

Submucosal fistulas and sinus tracts are not included in the Parks or St. James classification. These fistulas are superficial and can be distinguished by the fact that submucosal fistulas are located inferiorly to the anal canal, while sinus tracts are superficial tracts without any communication with the anal canal (Fig. 17).

Treatment

Treatment of idiopathic perianal fistulas is usually surgical, and different surgical procedures are used according to its MR imaging-based classification.

Treatment of superficial fistulas (grades I and II) can be achieved by placement of a seton through the fistulous tract for long time, until complete drainage. While this is the safest

option, it does not definitively eradicate the fistula. Fistulotomy (laying the fistula open by means of surgical incision, followed by daily frequent packing for a short period of time) can be used in such fistulas without a significant effect on continence.

In cases of higher grade fistulas (grades III-V), retention of post-operative continence is often a problem. For this reason, these fistulas are ideally managed on stages.

In the first stage, the part of the fistulous tract distal to the external sphincter can still be laid open. A seton is placed from the skin opening, along the line of the fistula, through the internal opening and out through the anus, forming a loop. This seton promotes drainage of any infected material and allows the fistula tract to heal gradually around the seton.

The second stage can be concluded with different types of procedures, the choice depending mostly on the type of fistula, the underlying cause and patient/surgeon preferences. Some options include removal of the seton with no further intervention (aiming for spontaneous closure) or the use of fibrin plugs and glue to achieve tract closure.

Treatment of perianal fistulas secondary to Crohn's disease is particular. Initial treatment involves antibiotics, but high rates of recurrence have been described after discontinuation. Purine analogs such as azathioprine and anti-tumor necrosis factor antibodies (infliximab) have been recently introduced, with good clinical results.

Treatment of perianal abscesses (independently of the underlying cause) consists of incision and drainage.

Images for this section:

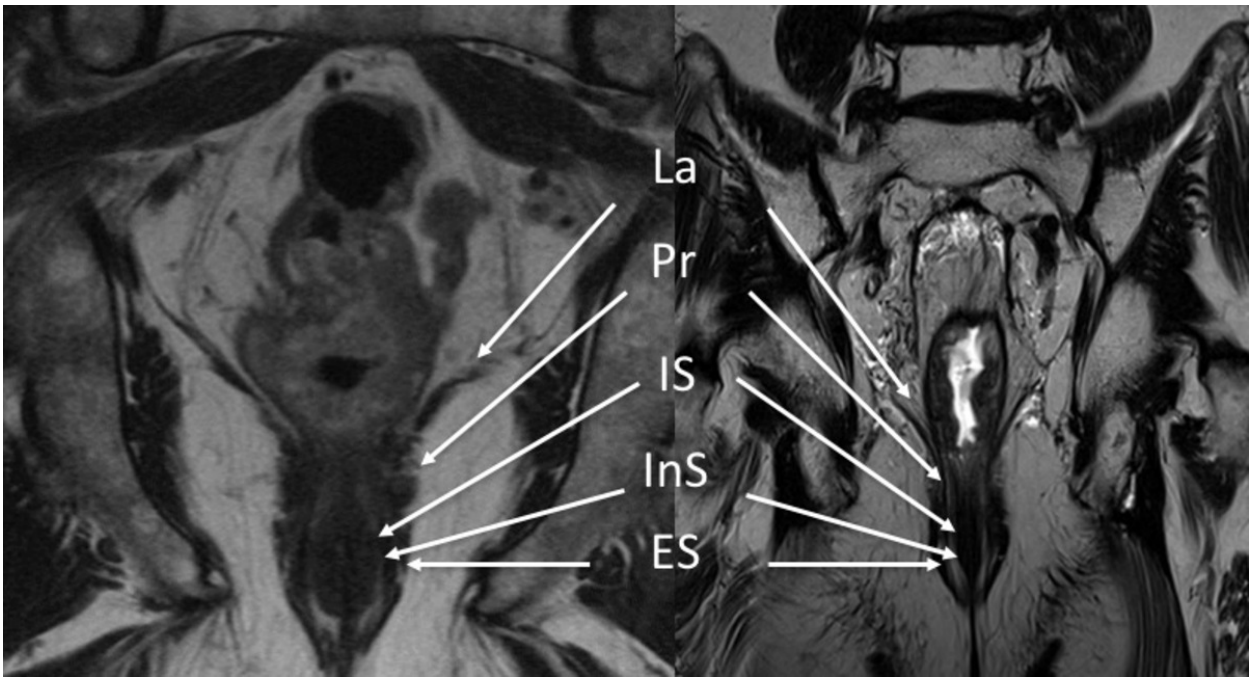

Fig. 3: Normal perianal anatomy on coronal T2-weighted images. La = levator ani, Pr = puborectalis, IS = internal sphincter, InS = intersphincteric space, ES = external sphincter.

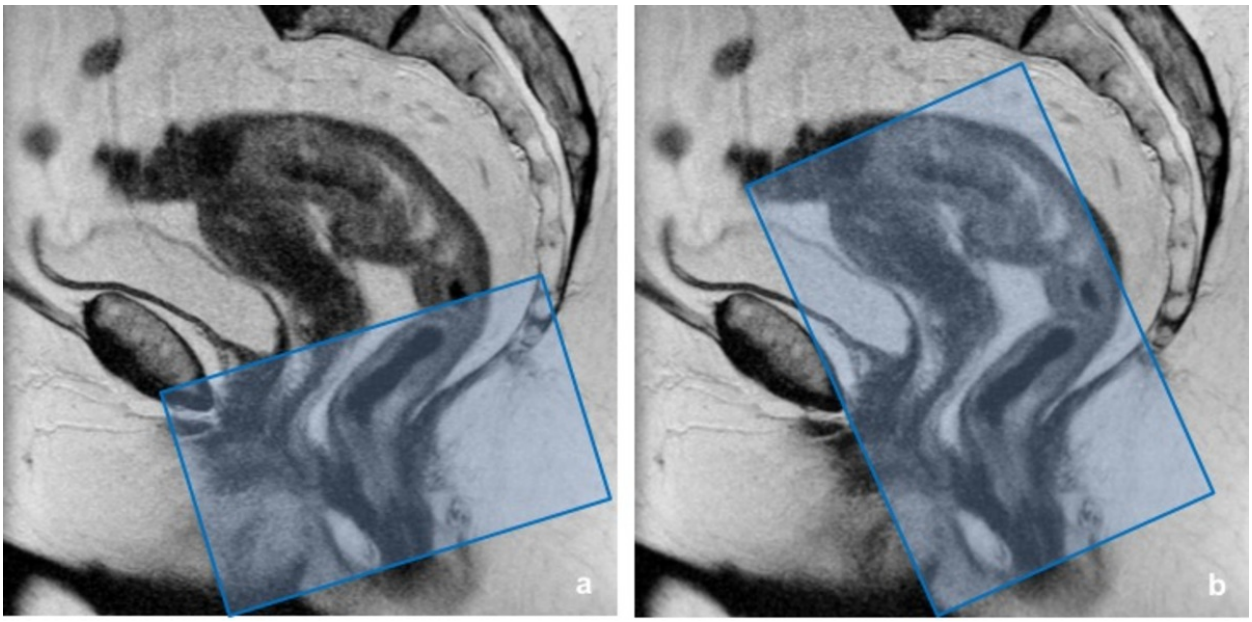

Fig. 4: Suggested orientation for axial (a) and coronal (b) MR imaging of the anal canal. Sagittal T2-weighted images through the midline are used to obtain images that are truly axial and coronal relative to the anal canal.

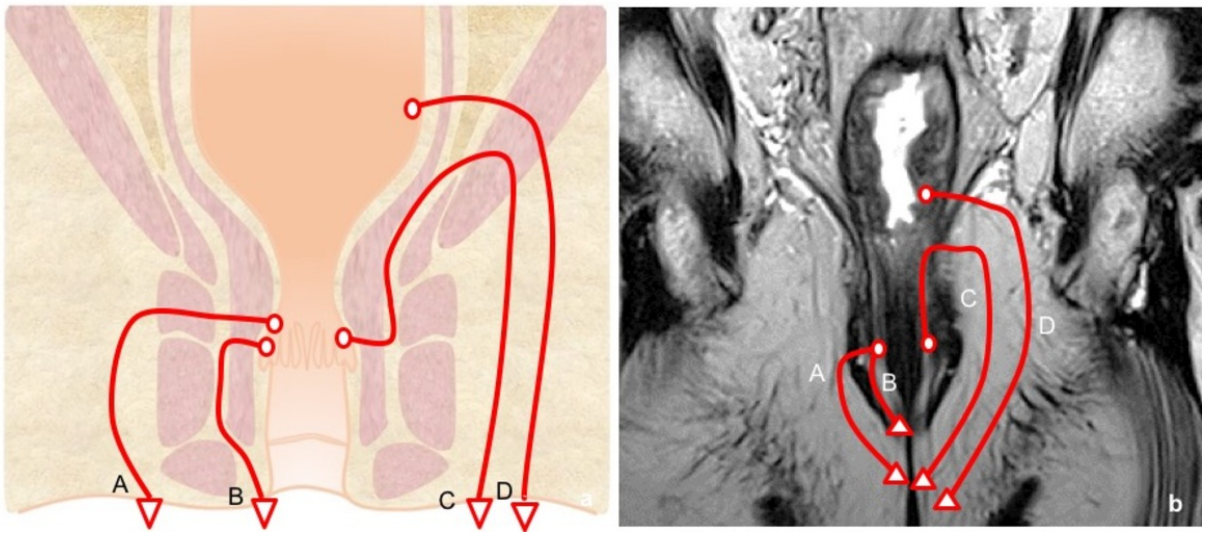

Fig. 5: Parks classification. Line diagram (a) of the anal canal in the coronal plane and coronal T2-weighted MR image (b) show the Parks classification of perianal fistulas. A = transsphincteric, B = intersphincteric, C = suprasphincteric, D = extrasphincteric.

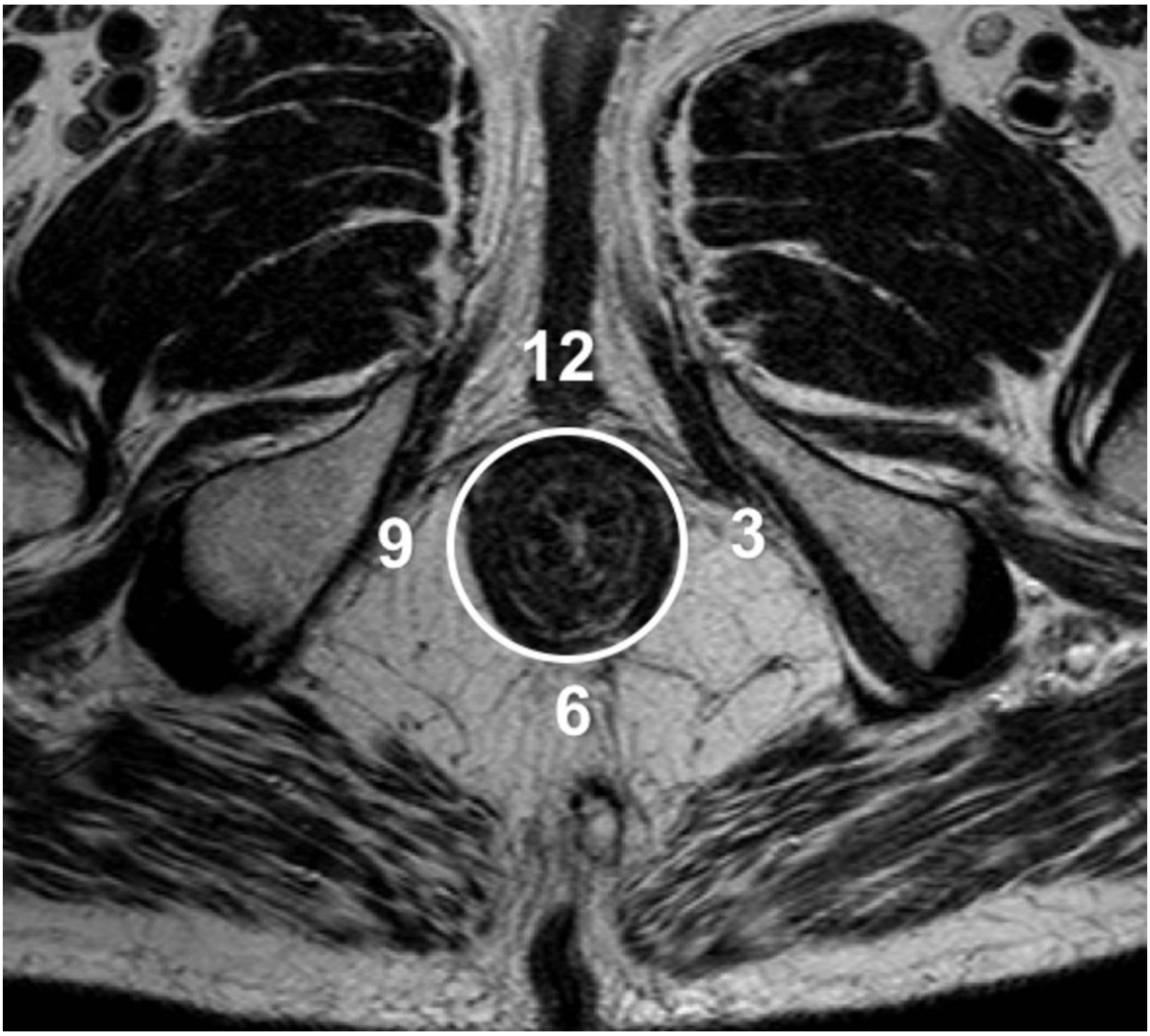

Fig. 6: Axial T2-weighted MR images shows the "anal clock". The anterior perineum is located at 12 o'clock and the posterior midline or intergluteal cleft is at 6 o'clock, while the left lateral aspect of the anal canal is at 3 o'clock and the right lateral aspect is at 9 o'clock.

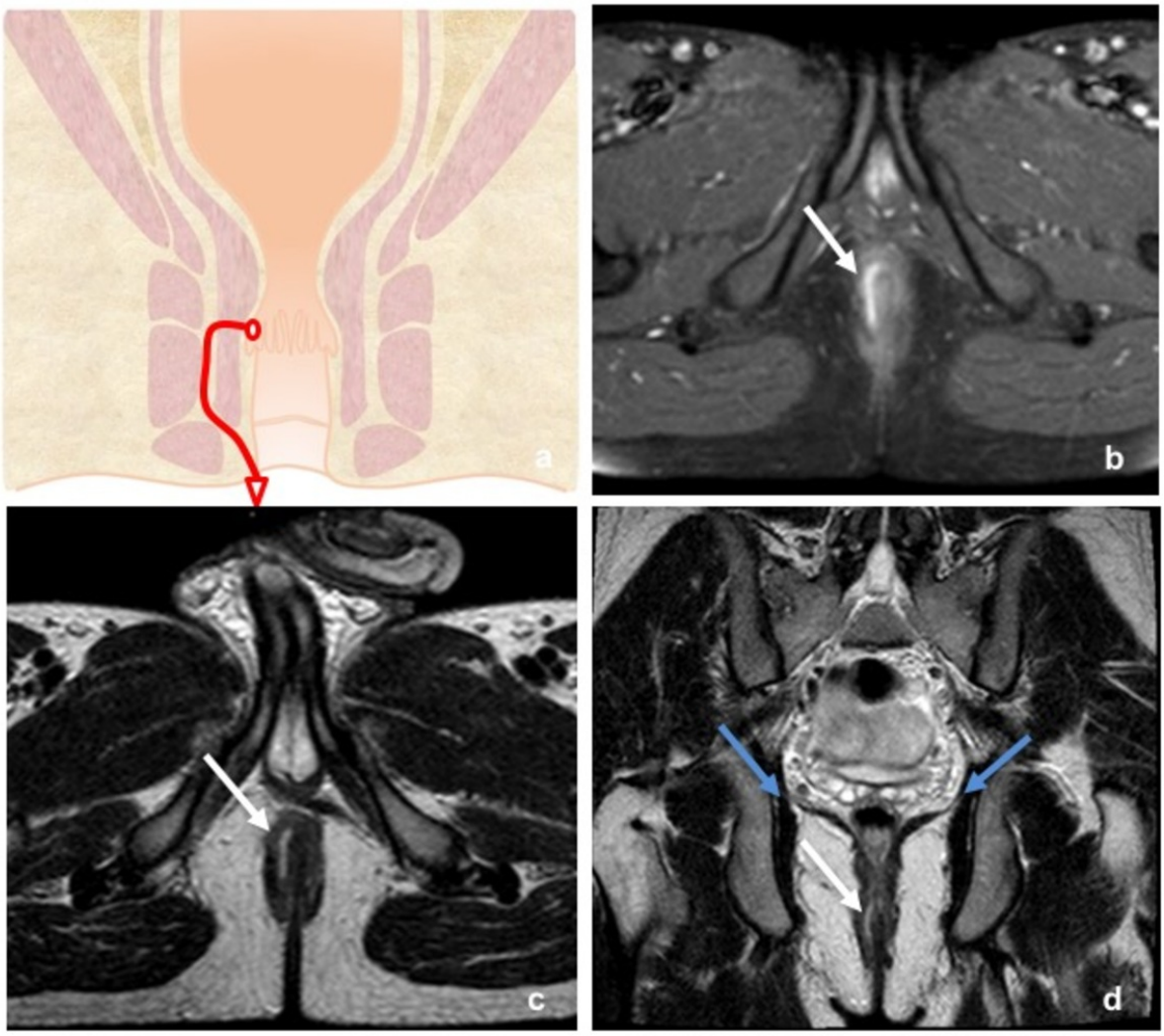

Fig. 7: Grade I. (a) Illustration in coronal plane of the anal canal shows a right intersphincteric fistula. Axial contrast-enhanced T1-weighted image with fat suppression (b) image show a intersphincteric fistula (white arrow). Axial (c) and coronal (d) T2-weighted MR images show the intersphincteric fistula (white arrows), contained by the external sphincter without extensions or abscesses in the intersphincteric space or ischioanal fossa. Coronal image clearly depicts levator plates (blue arrows) bilaterally, showing no infection above them.

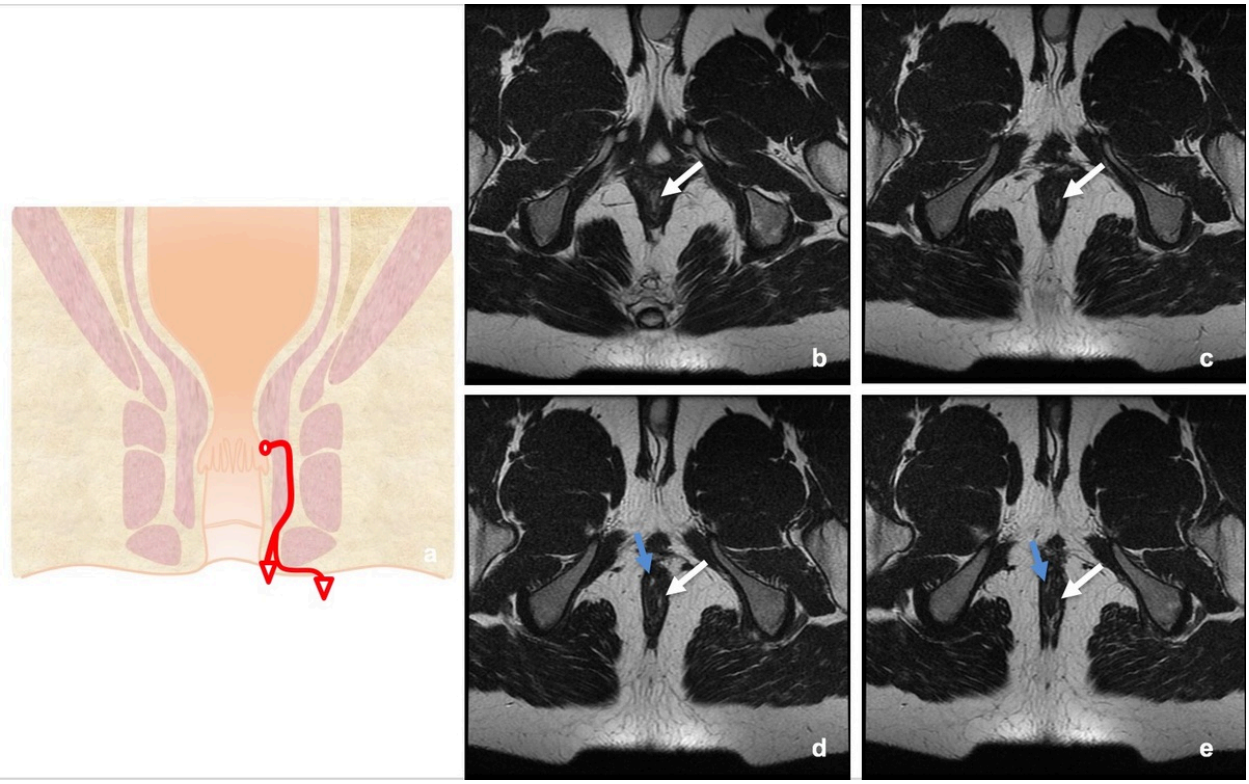

Fig. 8: Grade II. (a) Coronal drawing of the anal canal shows a left intersphincteric fistula with a secondary tract. (b-e) Axial T2-weighted MR images show a intersphincteric fistula with a primary tract at 3 o'clock (white arrows) and a secondary tract at 11 o'clock (blue arrows).

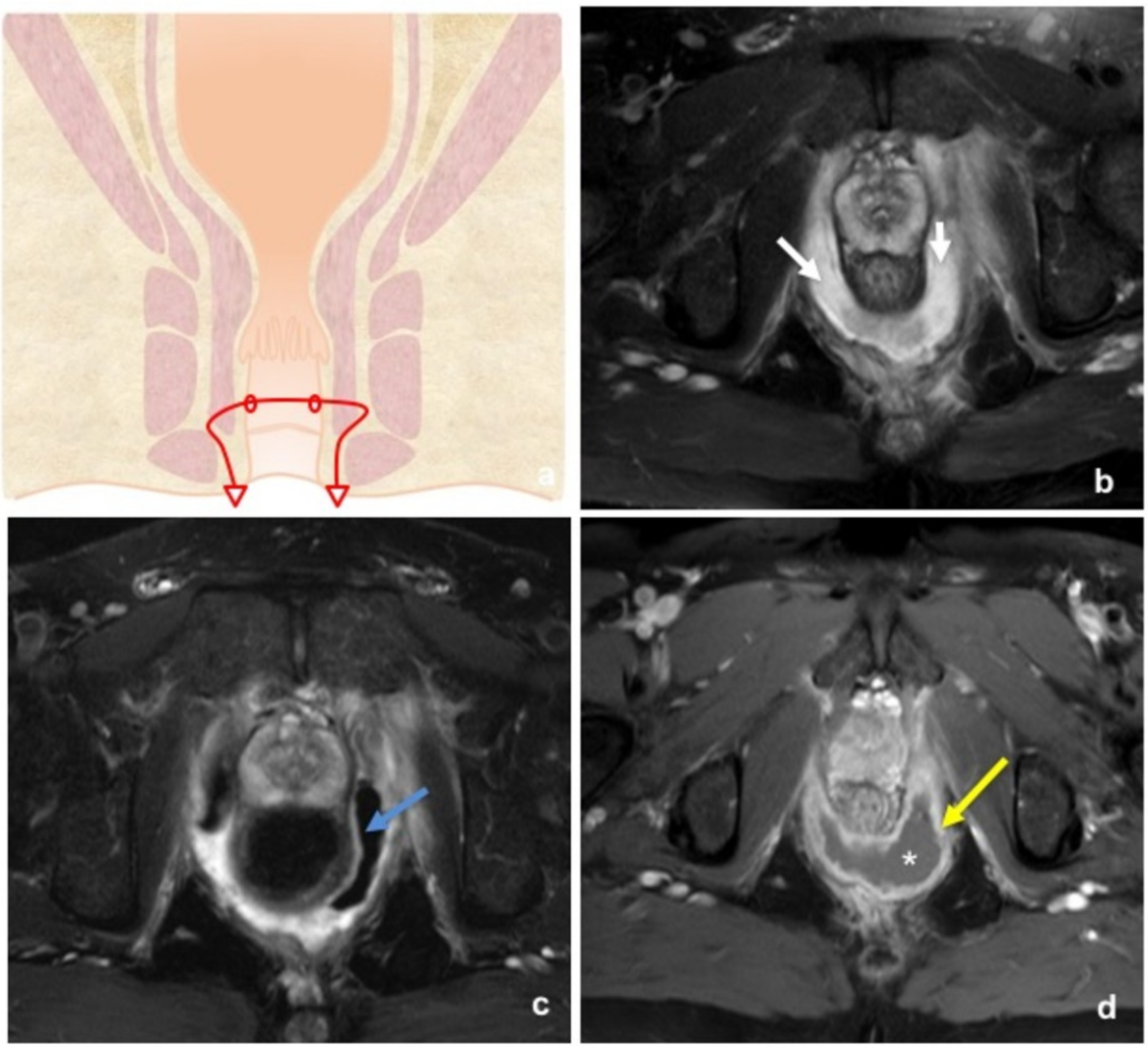

Fig. 9: Grade II. (a) Coronal drawing of the anal canal shows a horseshoe fistula encircling the anal canal. Axial T2-weighted images with fat suppression (b and c) show an intersphincteric abscess spreading across both sides of the internal opening (white arrows). Axial contrast-enhanced T1-weighted image (d) shows rim enhancement (yellow arrow) of the fibrous wall of the abscess, with central hypointensity (*) secondary to retained pus. Gas within abscess (blue arrow) has a low signal intensity, similar to that of the anorectal lumen.

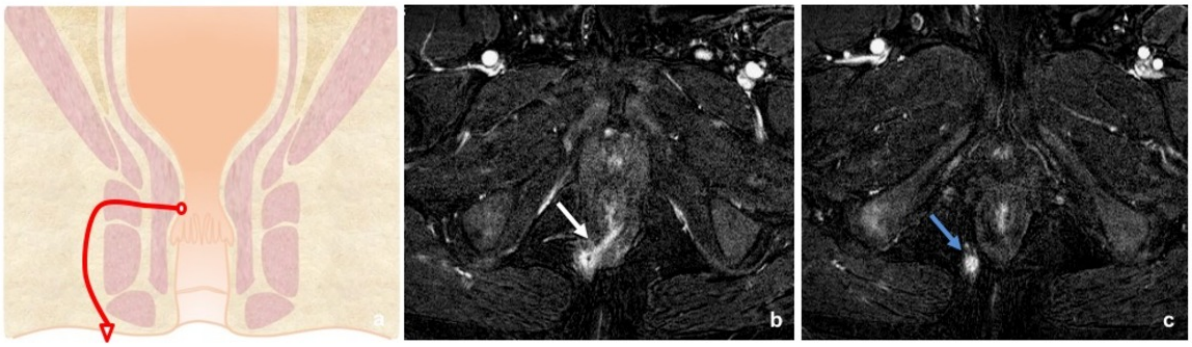

Fig. 10: Grade III. (a) Coronal drawing of the anal canal shows a transsphincteric fistula. Axial contrast-enhanced T1-weighted images with fat suppression (b and c) show a transsphincteric fistula (white arrow) clearly penetrating both sphincters. The fistula reaches the skin through the right ischioanal fossa (blue arrow). Internal opening is posterior, at 7 o'clock.

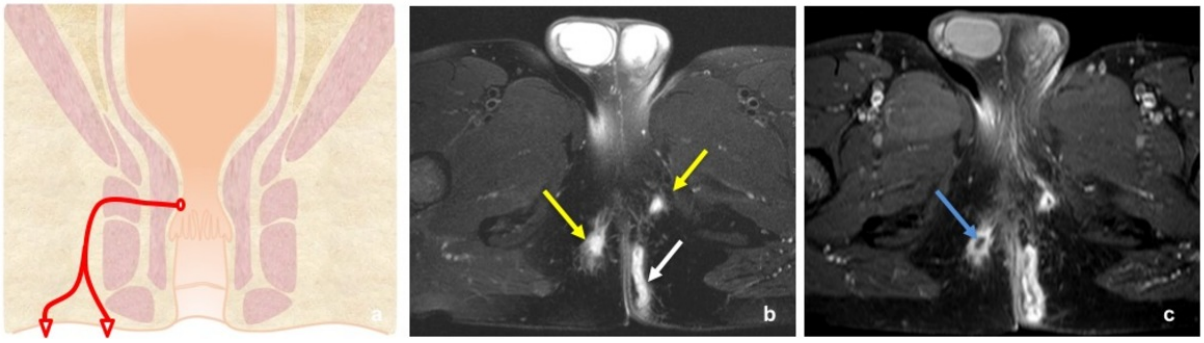

Fig. 11: Grade IV. (a) Illustration in coronal plane of the anal canal shows a transsphincteric fistula with secondary tracts. Axial T2-weighted image with fat suppression (b) and axial contrast-enhanced T1-weighted image with fat suppression (c) show a complex transsphincteric fistula (white arrow) with secondary tracts within both ischioanal fossae (yellow arrows). On the T2-weighted image, active tracts appear as hyperintense structures due to the granulation tissue within the tract. On contrast-enhanced fat-suppressed T1-weighted MR image the active granulation tissue enhances while fluid in the tract itself remains hypointense (blue arrow).

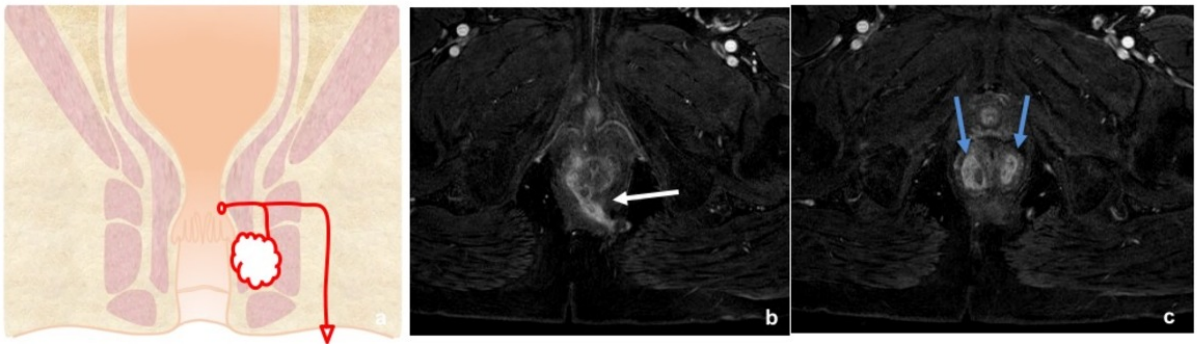

Fig. 12: Grade IV. (a) Drawing of the coronal view of the anal canal shows a transsphincteric fistula with an intersphincteric abscess. Axial contrast-enhanced T1-weighted with fat suppression MR images show a transsphincteric fistula with internal opening at 6 o'clock (white arrows) with intersphincteric abscesses (blue arrows) with nonenhancing pus in the cavity.

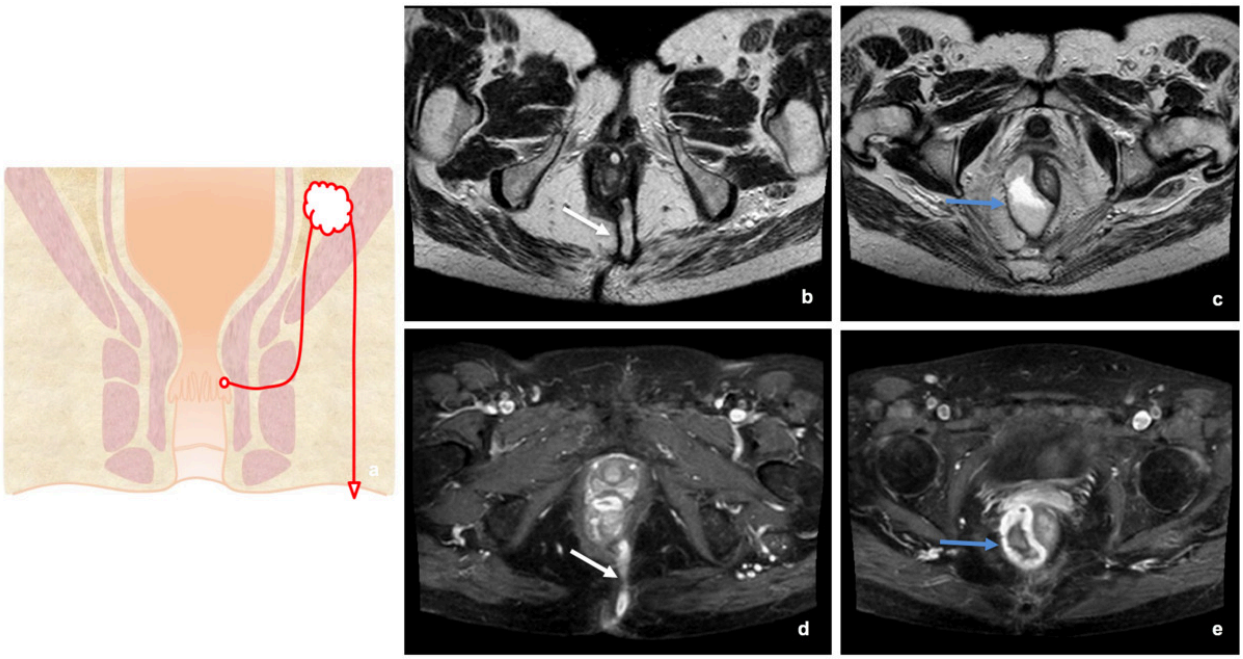

Fig. 13: Grade V. (a) Drawing of the coronal view of the anal canal shows a fistula that arises from anal canal, penetrates both the internal and external anal sphincter, and then ascends into supralevator space where it forms an abscess. Axial T2-weighted (b, c) and axial contrast-enhanced T1-weighted images with fat suppression (d, e) show a transsphincteric fistula (white arrows) with internal opening at 5 o'clock and a supralevator abscess (blue arrows).

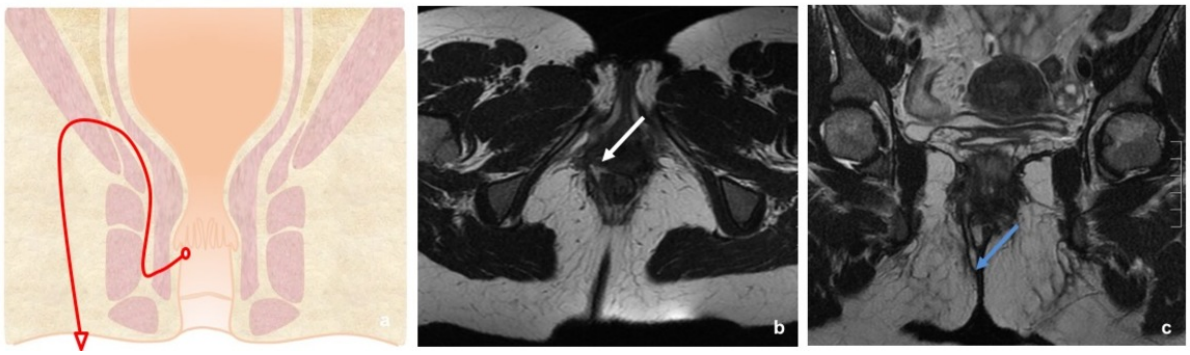

Fig. 14: Grade V. (a) Illustration in coronal plane shows a suprasphincteric fistula. Axial (b) and coronal (c) T2-weighted MR images show a fistula with internal opening at 11 o'clock (white arrow). The tract spreads upward in the intersphincteric space and arches over the puborectalis muscle, crossing the levator plate to reach the ischioanal fossa and then the perianal skin (blue arrow).

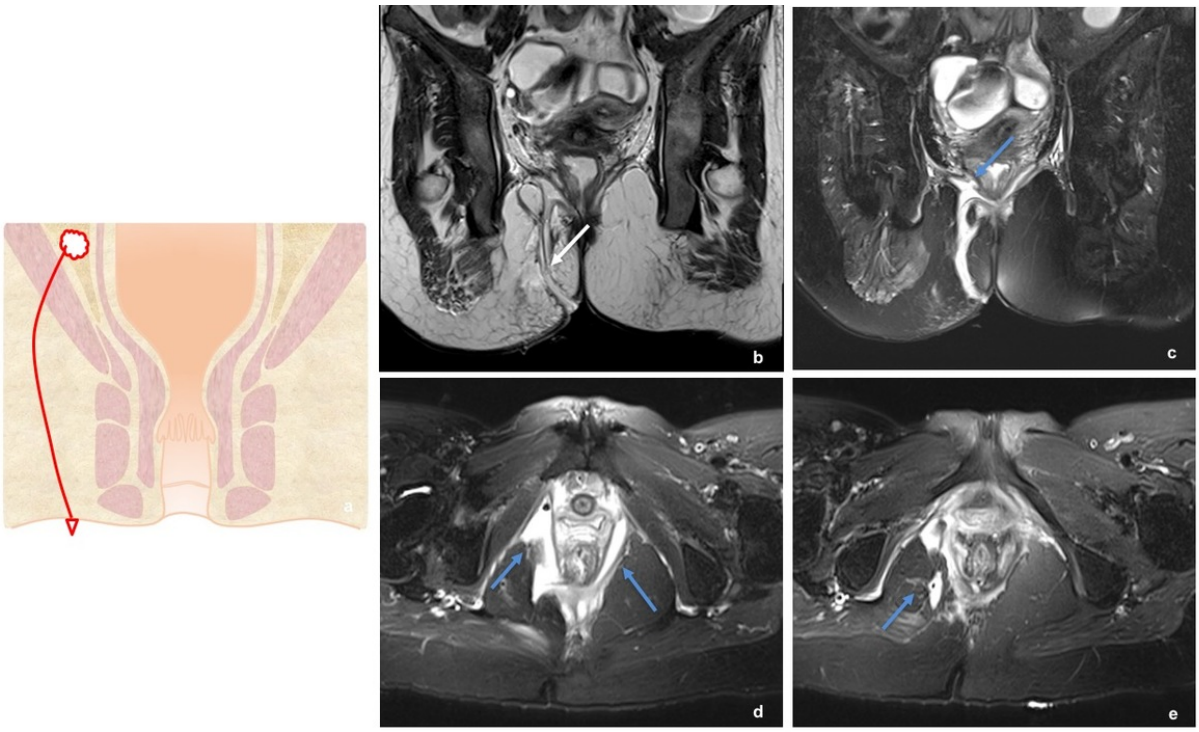

Fig. 15: Grade V. (a) Illustration in coronal plane shows a right extrasphincteric fistula with a supralevator abscess. Coronal T2-weighted MR image (b) in a patient with Crohn's disease shows a right extrasphincteric fistula (white arrow). Coronal (c) and axial (d, e) T2-weighted with fat suppression MR images depict the presence of supralevator abscesses (blue arrows).

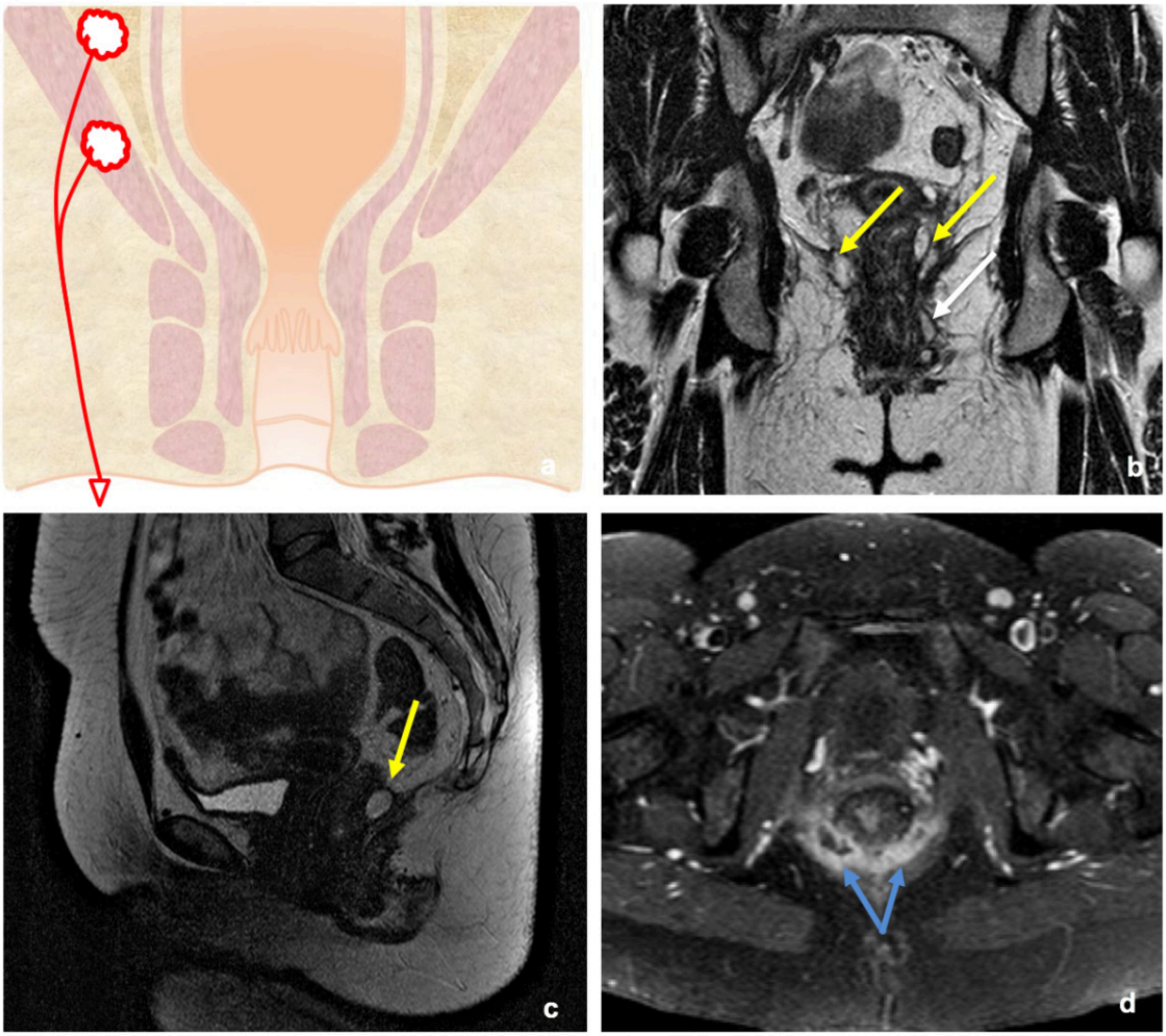

Fig. 16: Grade V. (a) Illustration in coronal plane shows a right extrasphincteric fistula with levator and supralevator abscess. Coronal (b) and sagital (c) T2-weighted MR images in a patient with Crohn's disease show a complex extrasphincteric fistula (white arrow) with abscesses at levator and supralevator level (yellow arrows). Axial contrast-enhanced T1-weighted image with fat suppression (d) shows a horseshoe supralevator abscess track (blue arrows).

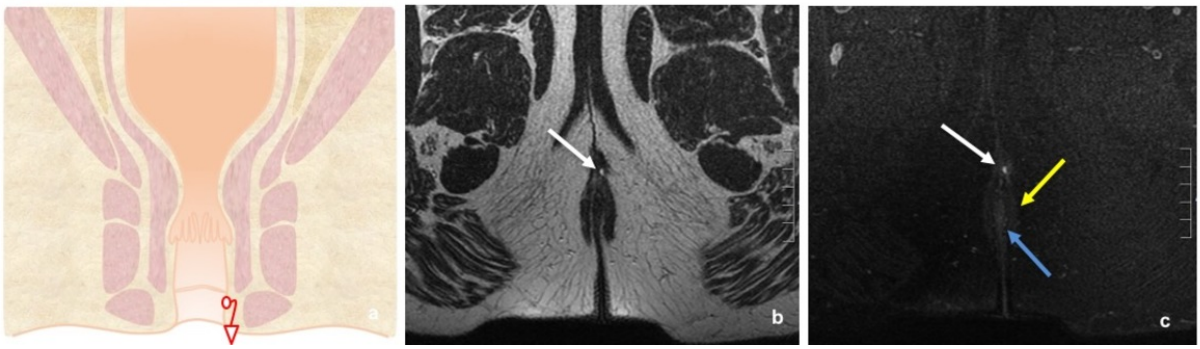

Fig. 17: Superficial tract. (a) Illustration in coronal plane shows a superficial tract that extends from perianal skin to end in ischional fossa. T2-weighted (b) with fat suppression (c) MR images show the superficial tract (white arrows). Both the internal (blue arrow) and external (yellow arrow) sphincters are normal.

Conclusion

MRI has had a major impact in the management of patients with fistula-in-ano by allowing a precise classification and assessment of disease extension. Radiologists should be familiar with the perianal anatomy and with the pathologic findings of fistula-in-ano in order to help choosing the most correct treatment approach so that the morbidity associated with this entity may be the lowest possible.

Personal information

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