



## **Preoperative MR imaging of anal fistula**

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## 1. Learning Objectives

To describe the pathogenesis, classification, and MR imaging of anal fistula.

## 2. Background

To fully understand the role of imaging with regard to anal fistula, an appreciation of its etiology and how the various fistula types are defined by anatomic boundaries is mandatory.

### ANATOMY

The **anal canal** is essentially a cylinder surrounded by two muscular sphincters, the internal and external anal sphincters (Figure1).

The **internal sphincter** is involuntary and is composed of smooth muscle continuous with the circular smooth muscle of the rectum. In most individuals, it can be divided without causing a loss of continence.

The **external sphincter** is composed of striated muscle and is continuous superiorly with the puborectalis and levator ani muscles. A division of the external sphincter can lead to incontinence.

The **intersphincteric space** is the surgical plane of dissection between the internal and external sphincters. It consists of a sheet of fat containing loose areolar tissue.

The fat-filled **ischioanal fossa** lies lateral to the sphincter complex and is traversed by a network of fibroelastic connective tissue fibers.

With regard to the lining of the anal canal, the proximal half is characterized by longitudinal mucosal folds, the anal columns of Morgagni. The distal aspect of each column is linked to its neighbor by a small semilunar fold (the anal valves), which in turn forms small pockets (the anal sinuses, or crypts of Morgagni). The distal undulating limit of these valves is the **dentate (pectinate) line**, which lies approximately 2 cm proximal to the anal verge. The dentate line marks the most distal aspect of the anal transitional zone, a histologic junction between anal squamous epithelium and rectal columnar epithelium.

### ETIOLOGY

The dentate line is a crucial landmark in anal fistula because the anal glands empty into the crypts that lie proximal to the valves. Most authorities believe that it is the infection of these intersphincteric glands that is the initiating event in anal fistula, in a process known as the **“cryptoglandular hypothesis”**. It is believed that gland infection results in an intersphincteric abscess if the draining duct becomes blocked by infected debris. This abscess may resolve by means of spontaneous drainage into the anal canal or may progress to an acute anorectal abscess. Anal fistula develops when an intersphincteric infection is allowed to continue unabated. Acute anorectal abscess and anal fistula are, therefore, generally believed to be acute and chronic manifestations, respectively, of the same disease.

### CLASSIFICATION

By definition, a fistula is an abnormal tract that connects two epithelial surfaces. There will usually be an internal enteric opening in the anal canal at the level of the dentate line—that is, at the original site

of the duct draining the infected gland. The fistula can reach the perianal skin by a variety of routes, some more tortuous than others, and by penetrating and involving the muscles of the anal sphincter and surrounding tissues to a variable degree.

Ø Fistulas may thus be classified according to the route taken by this **primary tract** that links the internal and external openings into intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric (Figure2).

While most fistulas probably start as a simple single primary tract, unabated infection may result in ramifications that branch away from this. These secondary tracts are generally known as known as extensions.

Ø **Extensions** may be intersphincteric, ischioanal, or supralelevator (pararectal), and their morphology may suggest tracts or abscesses (Figure3).

**THE ANATOMIC DESCRIPTION OF THE PATH TAKEN BY THE PRIMARY FISTULA TRACT AND THE LOCATION OF ANY ASSOCIATED EXTENSION FORMS ITS CLASSIFICATION.**

## **TREATMENT**

The primary objectives are to eradicate the tract and drain all associated sites of infection while simultaneously preserving anal continence.

To achieve this, two surgical questions need to be answered preoperatively:

- ü What is the relationship between the fistula and the anal sphincter?
- ü Are there any extensions from the primary tract that need to be treated to prevent recurrence, and, if so, where are they?

For many years radiologists have attempted to help answer the surgical questions posed above, with varying degrees of success.

## **MR IMAGING**

In recent years, MR imaging has emerged as the leading contender for preoperative classification of fistula in ano. The success of MR imaging for preoperative classification of fistula in ano is a direct result of the sensitivity of MR for tracts and abscesses combined with high anatomic precision and the ability to image in surgically relevant planes. The ability of MR imaging to help not only accurately classify tracts but also identify disease that otherwise would have been missed has had a palpable effect on surgical treatment and, ultimately, patient outcome.

### **Technique**

#### **1.COILS**

The best spatial resolution is achieved by using a dedicated **endoluminal anal coil**, which may be combined with a **surface coil** to increase the field of view.

However, it should be borne in mind that accuracy with a body or external coil alone remains high. Indeed, examination with a body or phased-array coil has become standard practice, not least because endoluminal coils specifically designed for anal imaging remain relatively unavailable.

#### **2.SEQUENCES**

**Unenhanced T1-weighted images** provide an excellent anatomic overview of the sphincter complex, levator plate, and the ischiorectal fossae. Fistulous tracks, inflammation, and abscesses, however, appear as areas of low to intermediate signal intensity and may not be distinguished from normal structures such as the sphincters and levator ani muscles. T1-weighted sequences can be combined with intravenous contrast material for the fistula to be highlighted (Figure15.C).

On **T2-weighted and STIR images**, pathologic processes including fistulas, secondary fistulous tracks, and fluid collections are clearly depicted. They appear as areas of high signal intensity in contrast with the lower signal intensity of the sphincters, muscles, and fat (especially on STIR images) (Figure15.B).

Fat-suppression techniques are widely used with both gadolinium-enhanced T1-weighted and T2-weighted sequences.

### 3.IMAGING PLANES

It is important that the imaged volume extend several centimeters above the levators and include the whole presacral space, both of which are common sites for extensions. The entire perineum should also be included. On occasion, tracts may extend for several centimeters, even leaving the pelvis or reaching the legs, and any tract visible must be followed to its termination if this has not been included on the standard image volume.

It is central to success that imaging planes are correctly aligned with respect to the organ of interest, namely the anal canal. Because the anal canal is tilted forward from the vertical by approximately 45°, straight transverse and coronal images will fail to achieve this alignment because of marked partial volume effect. Oblique transverse and coronal planes oriented orthogonal and parallel, respectively, to the anal sphincter are therefore necessary and are most easily planned by using a midline sagittal image.

v The precise location of the primary tract (eg, ischioanal or intersphincteric) is usually most easily appreciated by using transverse images; the radial site of the internal opening is also well seen on images in this plane (Figure7, Figure8; Figure9).

v Coronal images best depict the levator plate, which helps distinguish supra- from infralevator infection (Figure4; Figure11.A; Figure12). The height of the internal opening may also be best appreciated on coronal images (Figure10.B), with the caveat that the anal canal must be imaged along its entire craniocaudal extent.

### 3. Imaging Findings/Procedure Details

#### 1. PRIMARY TRACT (Figure2)

##### **INTERSPHINCTERIC FISTULA (Figure 4)**

The enhancing track is seen in the plane between the sphincters and is entirely confined by the external sphincter. The fistulous track extends from the skin of the perineum or natal cleft to the anal canal, and the ischiorectal and ischioanal fossae are clear.

##### **TRANSSPHINCTERIC FISTULA (Figure5)**

Instead of tracking down the intersphincteric plane to the skin, the trans-sphincteric fistula pierces through both layers of the sphincter complex and then arcs down to the skin through the ischiorectal and ischioanal fossae.

## **SUPRASPHINCTERIC FISTULA**

The suprasphincteric fistula extends upward in the intersphincteric space and arch over the puborectalis muscle, where they must cross the levator plate to reach the perianal skin.

## **EXTRASPHINCTERIC FISTULA**

Extrasphincteric fistula is characterized by the surprising absence of intersphincteric infection. Instead, the fistula entered the rectum or anorectal junction directly. Clearly, infection of the anal glands cannot explain this type of fistula, thus primary rectal or pelvic disease (eg, diverticular disease, rectal Crohn disease, carcinoma) should be sought when this type was encountered.

The external anal sphincter is clearly visualized by using MR imaging. It is relatively hypointense, and its lateral border contrasts against the fat in the ischioanal fossa, both on STIR and especially on fast T2-weighted MR studies. Thus, it is relatively easy to determine whether a fistula is contained by the external sphincter or has extended beyond it. If a fistula remains contained by the external sphincter throughout its course, then it is highly likely to be intersphincteric. In contrast, any evidence of a tract in the ischioanal fossa effectively excludes an intersphincteric fistula. Transsphincteric, suprasphincteric, and extrasphincteric fistulas all share the common feature of a tract that lies beyond the confines of the external sphincter. Any tract that penetrates the pelvic floor above the level of the puborectalis muscle is potentially a suprasphincteric or extrasphincteric fistula. The level of the internal opening distinguishes between these types of fistula; specifically, the internal opening is anal in suprasphincteric fistulas and rectal in extrasphincteric fistulas.

## **2. INTERNAL OPENING**

The exact location of the internal opening can be difficult to define, whatever the imaging modality used. Two questions need to be answered. What is the radial site of the internal opening, and what is its level? The vast majority of anal fistulas open into the anal canal at the level of the dentate line, commensurate with the cryptoglandular hypothesis of fistula pathogenesis. Furthermore, most fistulas also enter posteriorly, at the 6-o'clock position, because anal glands are more abundant posteriorly (radial positions around the anus are referenced with respect to a clock face, with 12 o'clock being directly anterior) (Figure6).

Unfortunately, the dentate line cannot be identified as a discrete anatomic entity, even when endoanal receiver coils are used, but its general position can be estimated with sufficient precision for the imaging assessment to be worthwhile. The dentate line lies at approximately the mid–anal canal level. This is generally midway between the superior border of the puborectalis muscle and the most caudal extent of the subcutaneous external sphincter. The dentate level is probably best appreciated on coronal views, which allow the craniocaudal extent of the puborectalis muscle and external sphincter to be appreciated; with experience, however, its location can be estimated with reasonable precision by using transverse views.

The radial site of the internal opening is easy to identify if the fistula tract can be traced right to the anal mucosa (Figure7; Figure8). However, it is frequently impossible to trace a tract right up to the anal mucosa, especially if an endoanal coil has not been used. In such cases, an intelligent deduction must be made as to where the internal opening is likely to be. This is best accomplished by looking for the area of maximal intersphincteric sepsis, since the internal opening is likely to lie very close to this (Figure9).

## **3. EXTENSIONS (Figure3)**

The major advantage of MR imaging is the facility with which it can demonstrate extensions

associated with a primary tract. Morphologically, extensions frequently take the form of complex tract systems, regions of which have often become dilated to create an abscess (although a precise radiologic distinction between abscess and a large tract remains elusive) (Figure11.B). Extensions appear as hyperintense regions on T2-weighted and STIR images and enhance if intravenous contrast material is used.

The commonest type of extension is one that arises from the apex of a transsphincteric tract and extends into the roof of the ischioanal fossa (Figure10.A). Extensions may be several centimeters from the primary tract, which makes them difficult to detect during clinical examination. This is especially the case when extensions are contralateral to the primary tract (Figure14). It is also important to search for supralelevator extensions, since these are not only difficult to detect but pose specific problems with regard to treatment (Figure4; Figure11.A; Figure12). Horseshoe extensions spread across both sides of the internal opening and are recognized on MR images by their unique configuration (Figure13).

Complex extensions are especially common in patients with recurrent fistula in ano or in those who have Crohn disease (Figure15.A).

#### **4. Conclusion**

Over the past few years, imaging, notably MR, has revolutionized the treatment of patients with fistula in ano. This is because MR can be used to classify fistulas preoperatively with high accuracy while also alerting the surgeon to disease that would otherwise have been missed.

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## 7. Mediafiles

**Figure1**

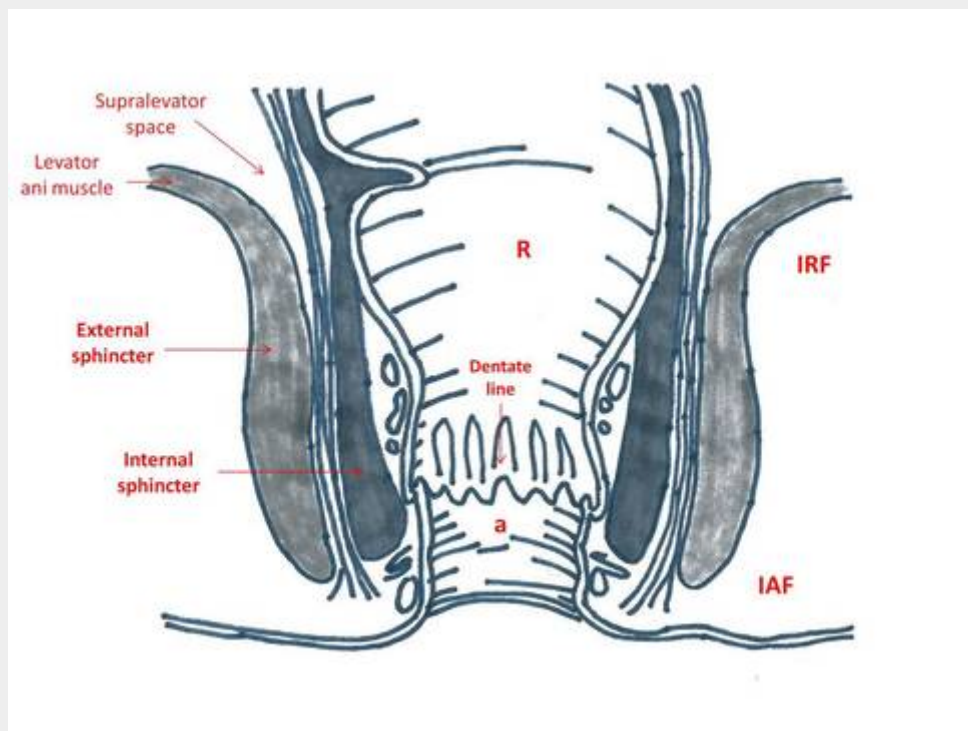


Figure1. Line diagram shows the normal anatomy of the perianal region in the coronal plane. a = anal canal, IAF = ischioanal fossa, IRF = ischiorectal fossa, R = rectum.

**Figure2**

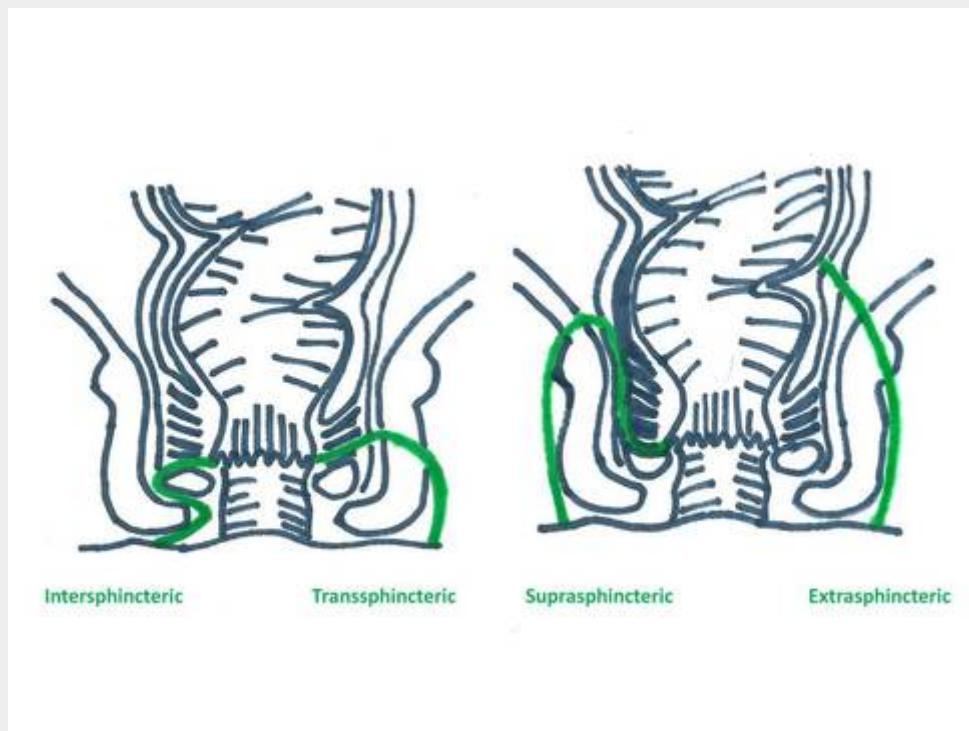


Figure2. Line diagram shows classification of fistula in ano in coronal plane: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric.

**Figure3**

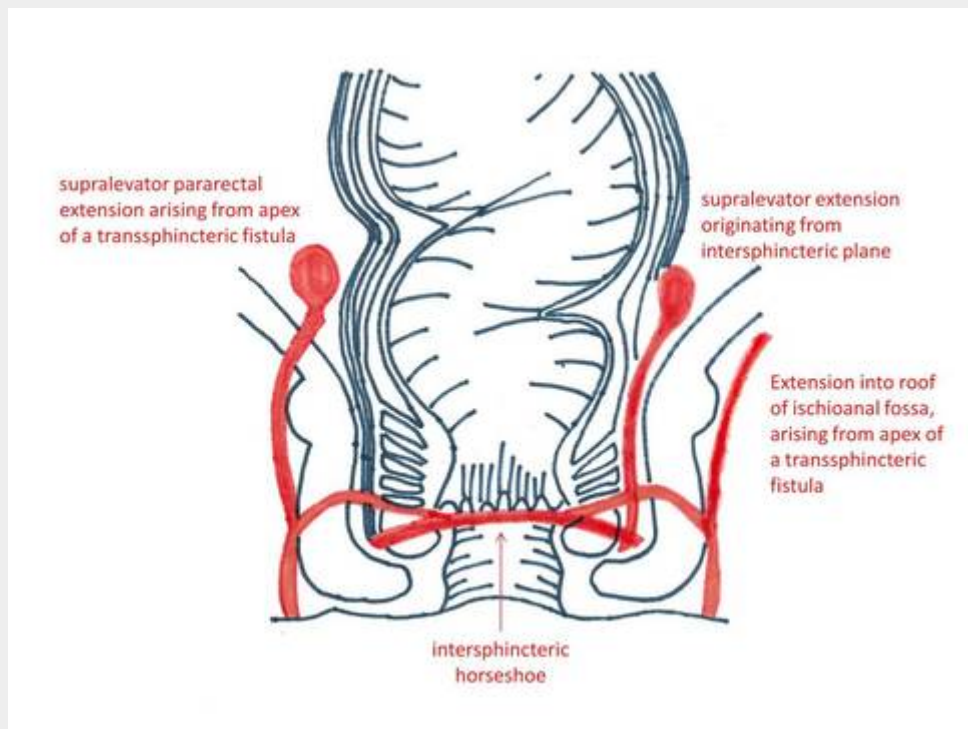


Figure3. Line diagram shows fistula extensions in coronal plane.

**Figure4**

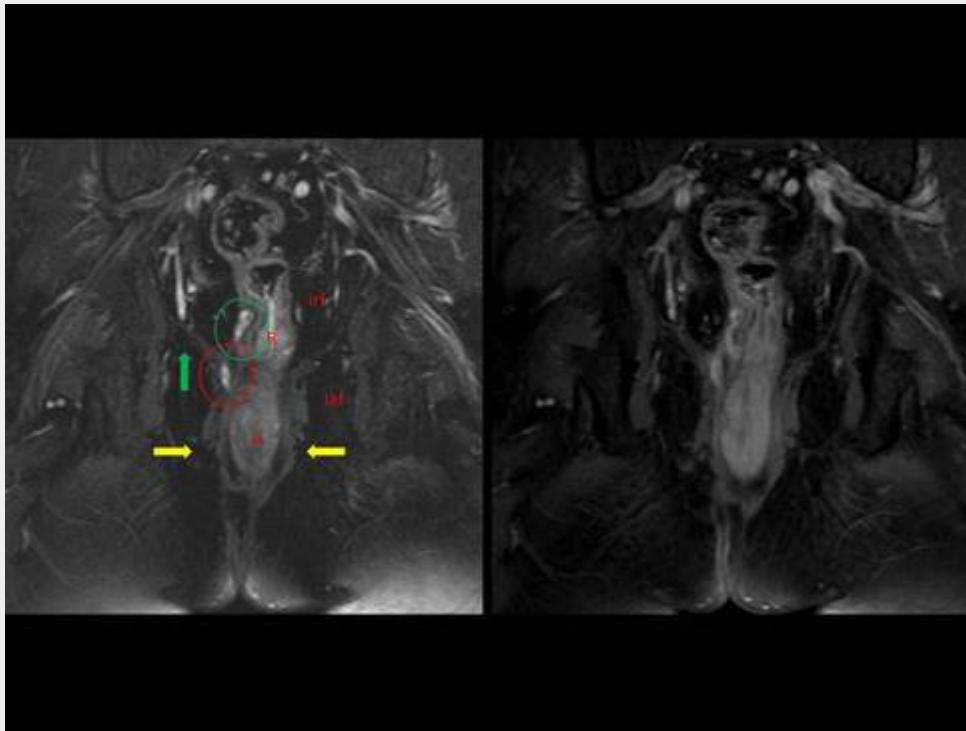


Figure 4. Coronal T2-w with fat suppression (A) and coronal contrast-enhanced T1-w image with fat suppression (B) show a intersphincteric fistula (red circle) with a supralelevator extension (green circle). The anatomy of the perianal region is well demonstrated on coronal MR images. The sphincter complex, ischioanal (irf) and ischioanal (iaf) fossae, and levator ani sling are clearly seen. a = anal canal, R = rectum. This fistula does not penetrate the adjacent external sphincter (yellow arrow), which is clearly visualized, and there is no tract in the ischioanal fossa. Coronal images also clearly show levator plates (green arrow) bilaterally, so that it is easy for the radiologist to be confident that infection extends above them.

**Figure5**

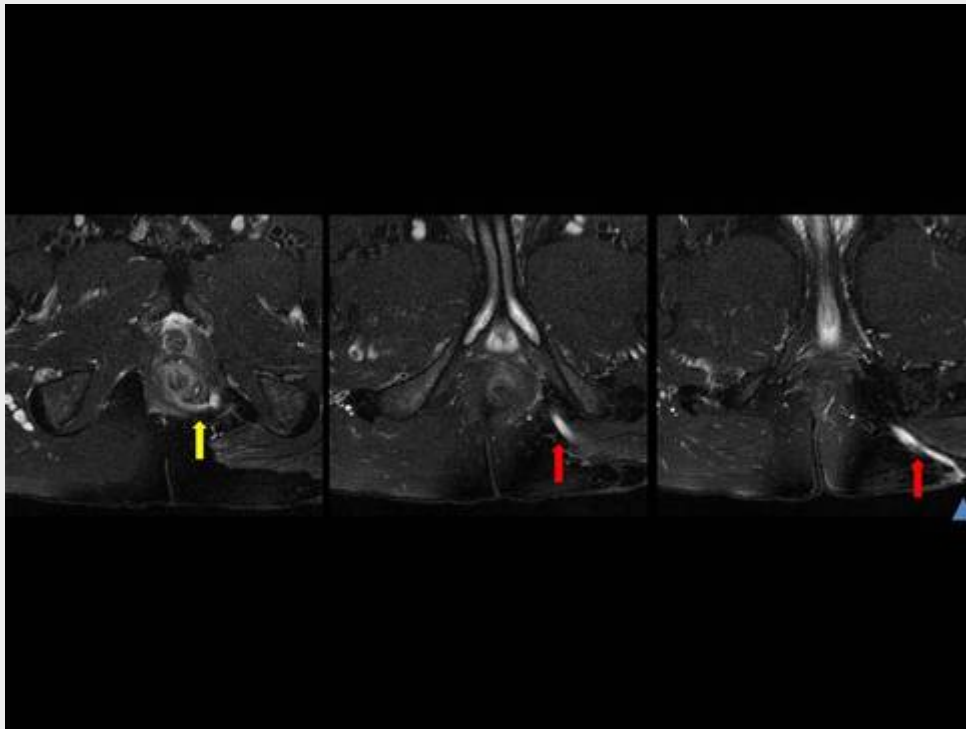


Figure5. Axial T2-w images with fat suppression show a transsphincteric fistula with tract in left ischioanal fossa (red arrow) where it can be clearly seen to penetrate external sphincter (yellow arrow) to reach the intersphincteric space. Internal opening is posterior at 6 o'clock. Blue arrowhead = external opening.

**Figure6**

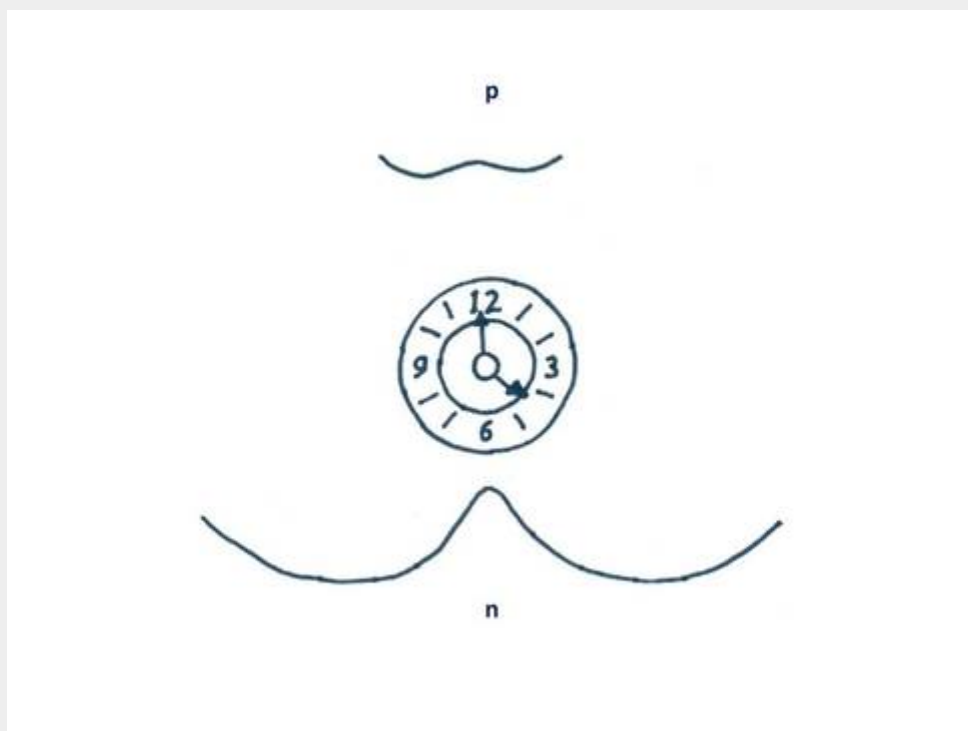


Figure6. Drawing illustrates the anal clock, which is the surgeon's view of the perianal region when the patient is in the lithotomy position. The anterior perineum (p) is at the 12 o'clock position, and the natal cleft (n) is at the 6 o'clock position; 3 o'clock refers to the left lateral aspect, and 9 o'clock, the right lateral aspect of the anal canal. This schema exactly corresponds to the orientation of axial MR images of the perianal region.

**Figure7**

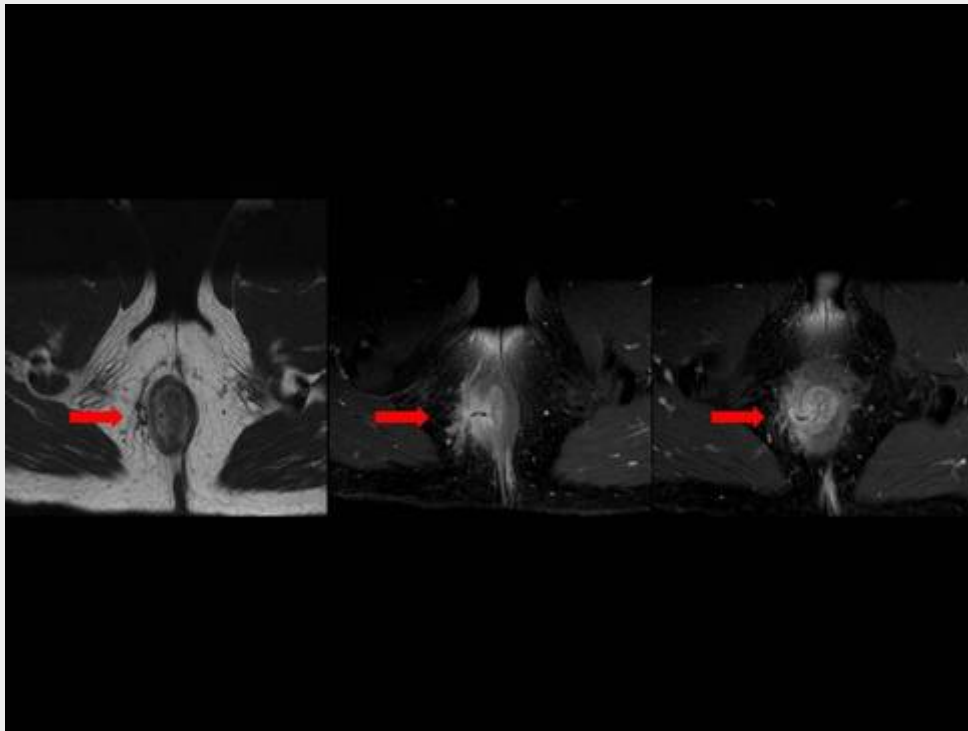


Figure7. Axial T2-w image (A) and axial contrast-enhanced T1-w images with fat suppression (B and C) show internal opening of a transsphincteric fistula at 9 o'clock (red arrow).

**Figure8**

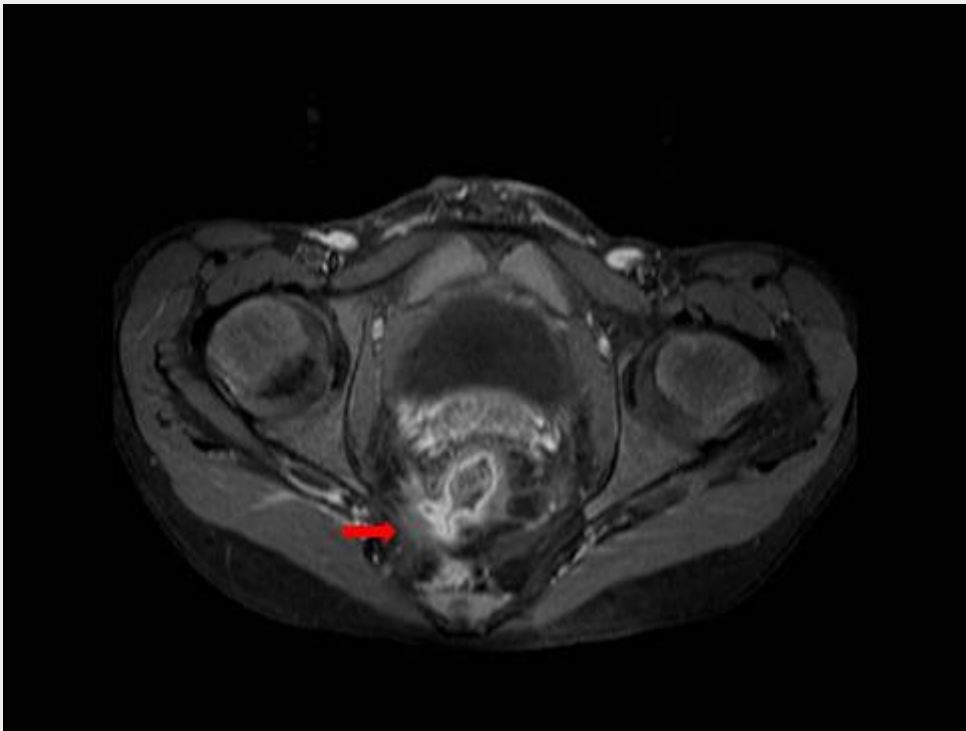


Figure8. Axial contrast-enhanced T1-w image with fat suppression shows internal opening at 7 o'clock (red arrow). The radial site of the internal opening is easy to identify because the fistula tract can be traced right to the anal mucosa.



**Figure9**

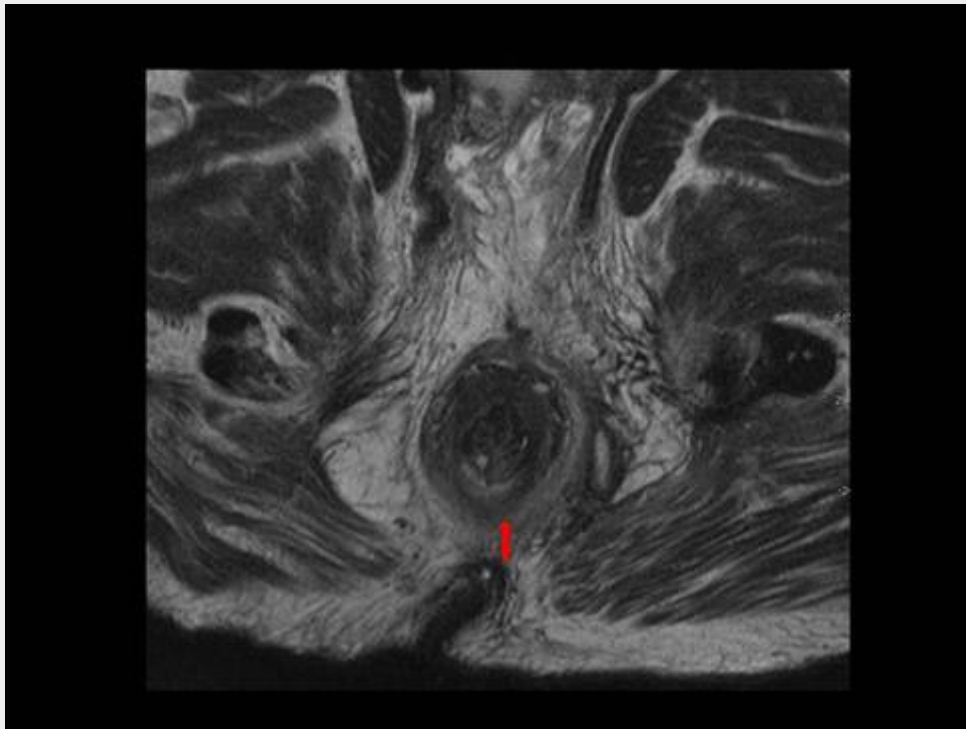


Figure9. Axial T2-w image at level of internal opening shows primary tract (red arrow) at 6 o'clock. Unlike figure 4, the tract cannot be traced right to the anal mucosa. However, an internal opening at 6 o'clock was reported because this position indicated site of maximal infection in the intersphincteric plane. The internal opening was confirmed at this site during subsequent EUA.

**Figure10.A**

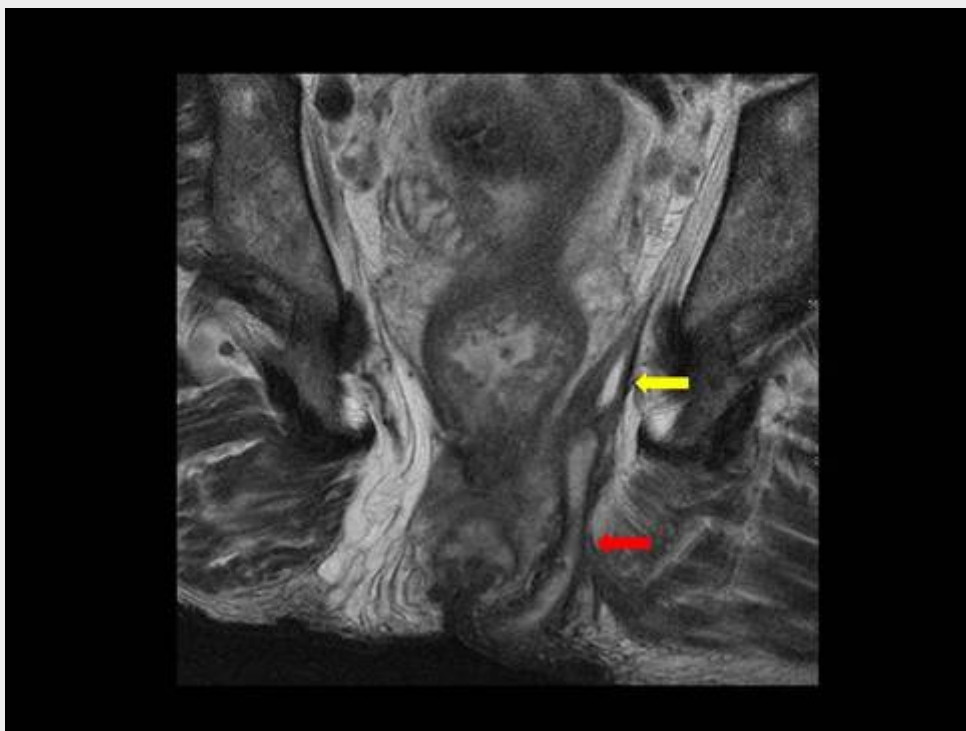


Figure10.A. Coronal T2-w image shows left-sided transsphincteric tract (red arrow) with extension (yellow arrow) from apex of tract into roof of ipsilateral ischioanal fossa.

**Figure10.B**

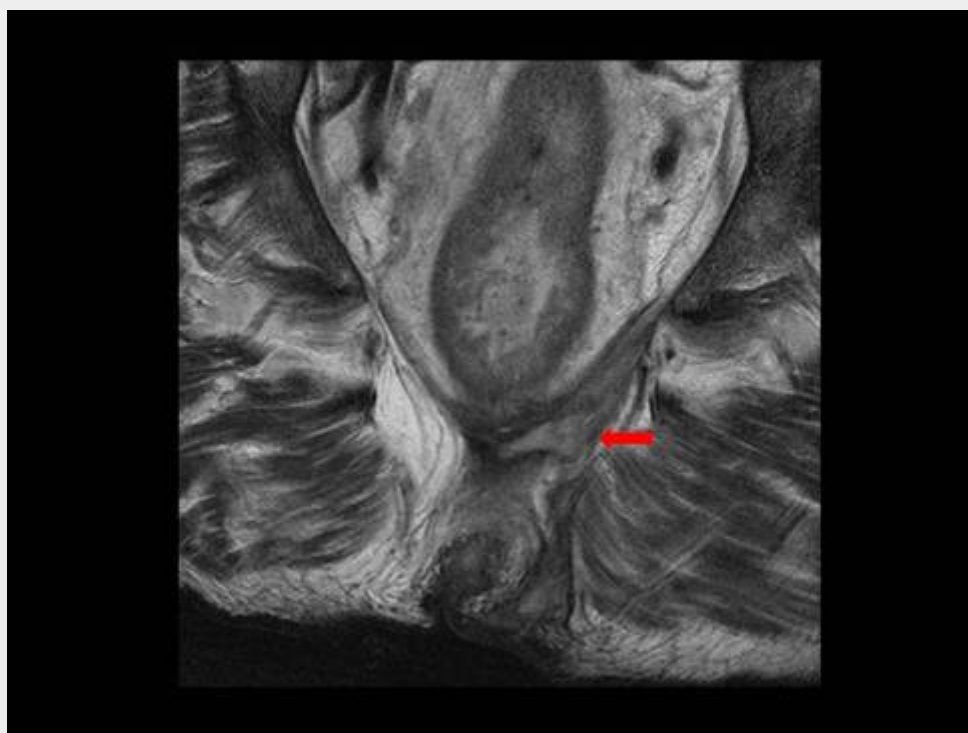


Figure10.B. The height of the internal opening may be appreciated on coronal images. The enteric entry point is suggested by a medial track (red arrow).

**Figure11.A**

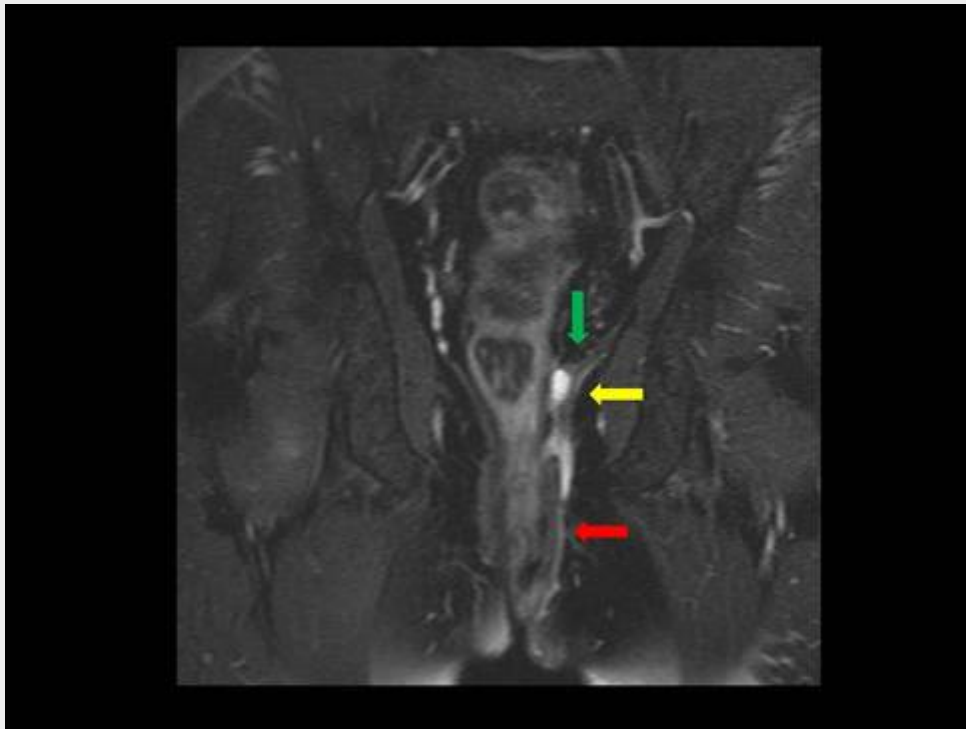


Figure11.A. Coronal T2-w image with fat suppression shows a transsphincteric fistula (red arrow) with tract in left ischioanal fossa with a supralelevator extension (yellow arrow) that is seen above the levator plate (green arrow). Coronal images best depict the levator plate, which helps distinguish supra- from infralevator infection.

**Figure11.B**

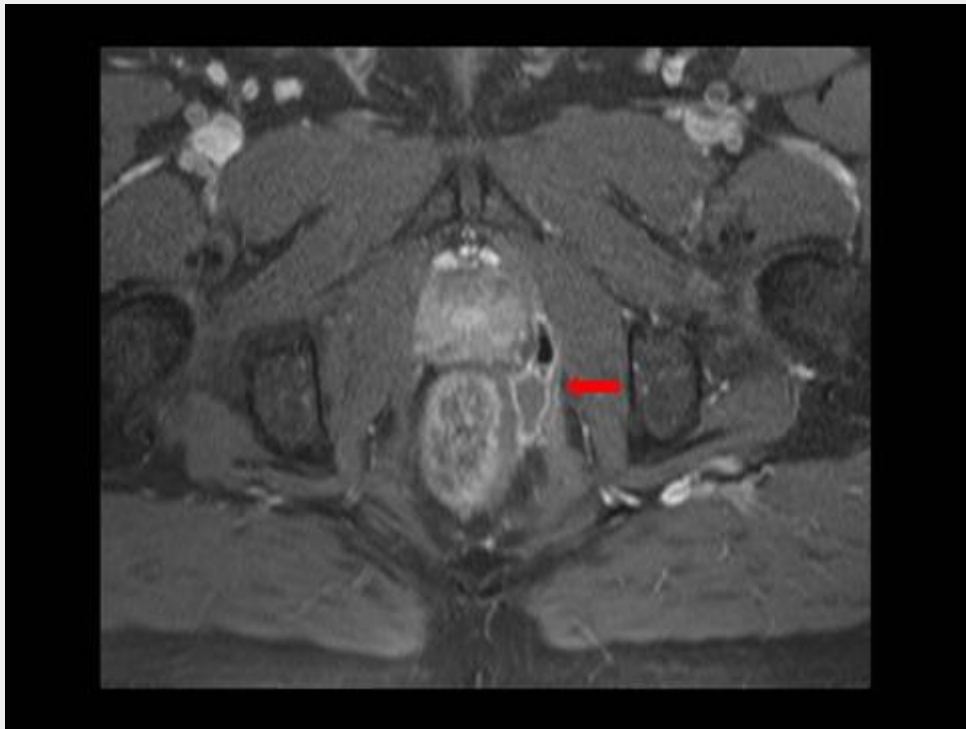


Figure11.B. Axial contrast-enhanced T1-w image shows the supralelevator extension whose morphology suggests an abscess with some gas inside (red arrow). Exactly when a tract becomes an abscess is not precisely defined, but both terms describe regions of infection. The walls brilliantly enhance and retained pus remains unenhanced, with resulting ring enhancement, an appearance that is typical of abscess formation elsewhere in the body.

**Figure12**

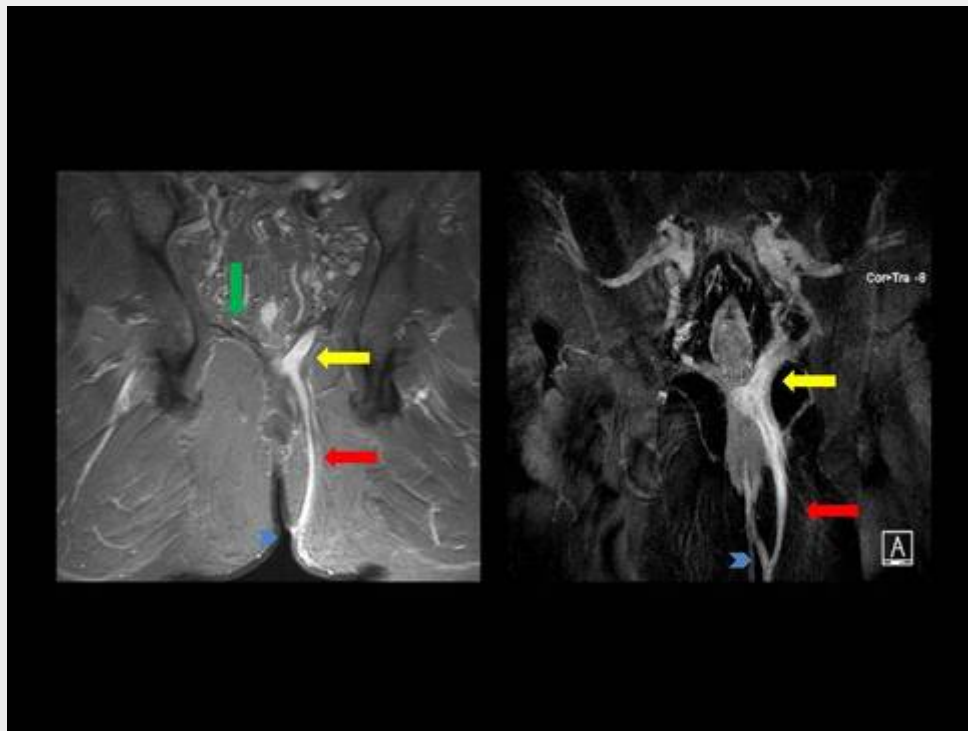


Figure12. Coronal STIR image (A) and coronal MIP (B) show a transsphincteric fistula (red arrow) with tract in left ischional fossa with a supralelevator extension (yellow arrow) seen above the levator plate (green arrow). Blue arrowhead = external opening.

**Figure13**

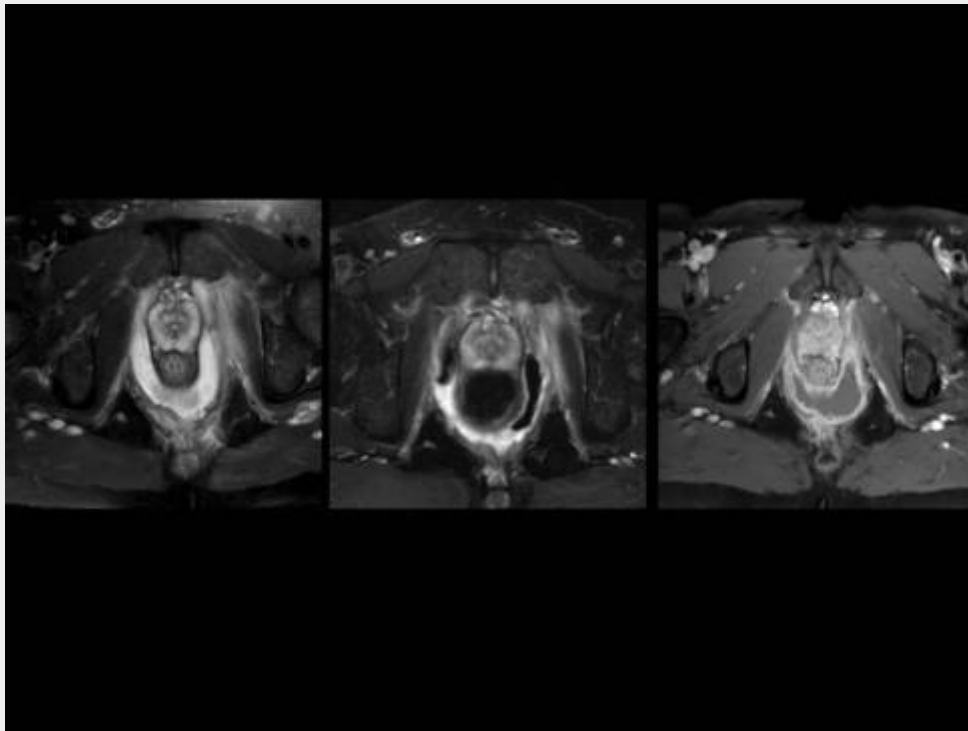


Figure13. Axial T2-w image with fat suppression (A and B) and axial contrast-enhanced T1-w image (C) show an intersphincteric horseshoe extension that practically encircles the anal canal. The walls brilliantly enhance and retained pus remains unenhanced, with resulting ring enhancement, an appearance that is typical of abscess formation. Gas within abscess (image B) has a low signal intensity similar to that of the anorectal lumen.

**Figure14**

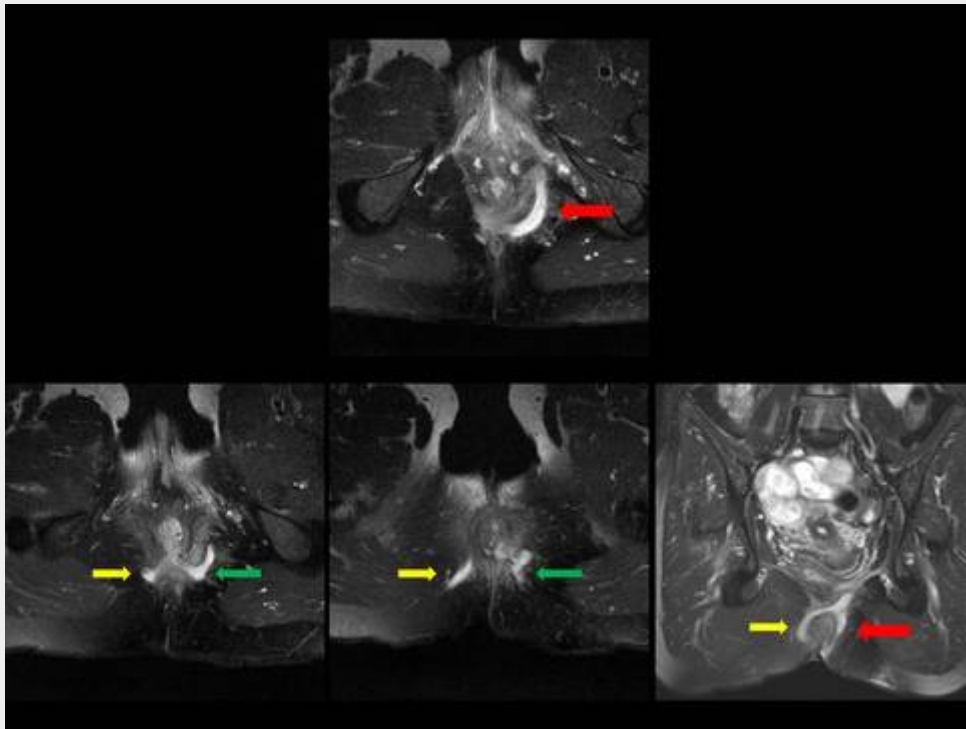


Figure14. Axial (A, B and C) and coronal (D) T2-w images with fat suppression show a transsphincteric primary tract in left ischioanal fossa (red arrow) with contralateral transsphincteric extension to the right ischioanal fossa (yellow arrow) that was undetected at clinical examination. The internal opening is seen at 5 o'clock (green arrow).



**Figure15.A**

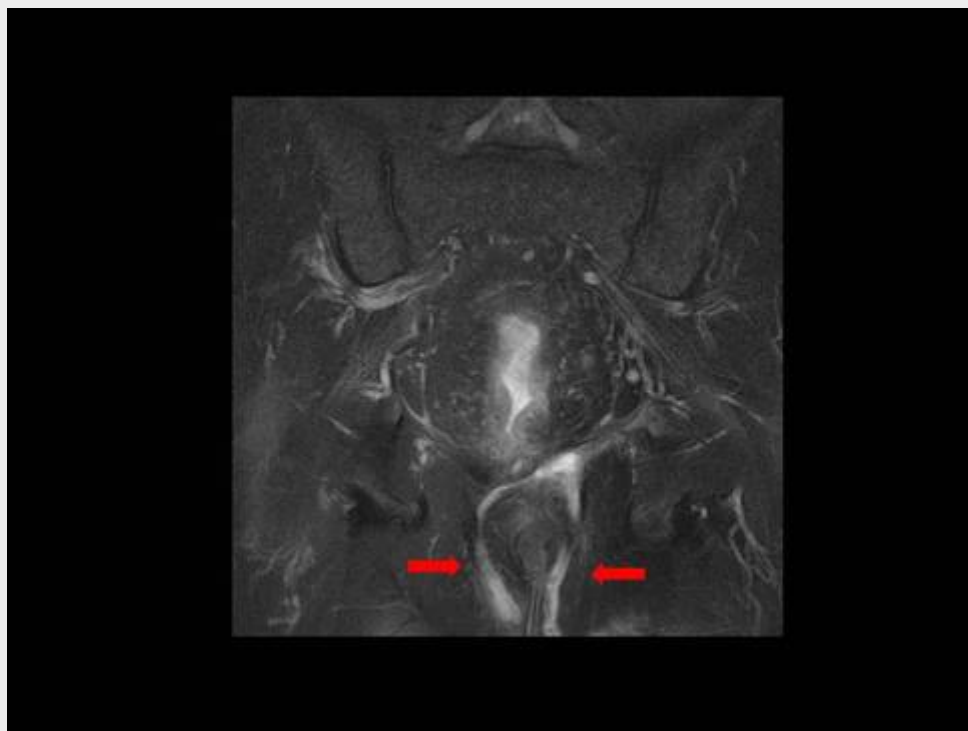


Figure15.A. Coronal T2-w image with fat suppression shows another complex fistula with two tracts in both ischioanal fossa (red arrows) in a patient with Crohn disease. The possibility of underlying Crohn disease should always be considered in patients who have a particularly complex fistula. Indeed, a perianal fistula is the presenting condition in 5% of patients, and 30%–40% of patients with Crohn disease will experience anal disease at some time.

**Figure15.B+C**

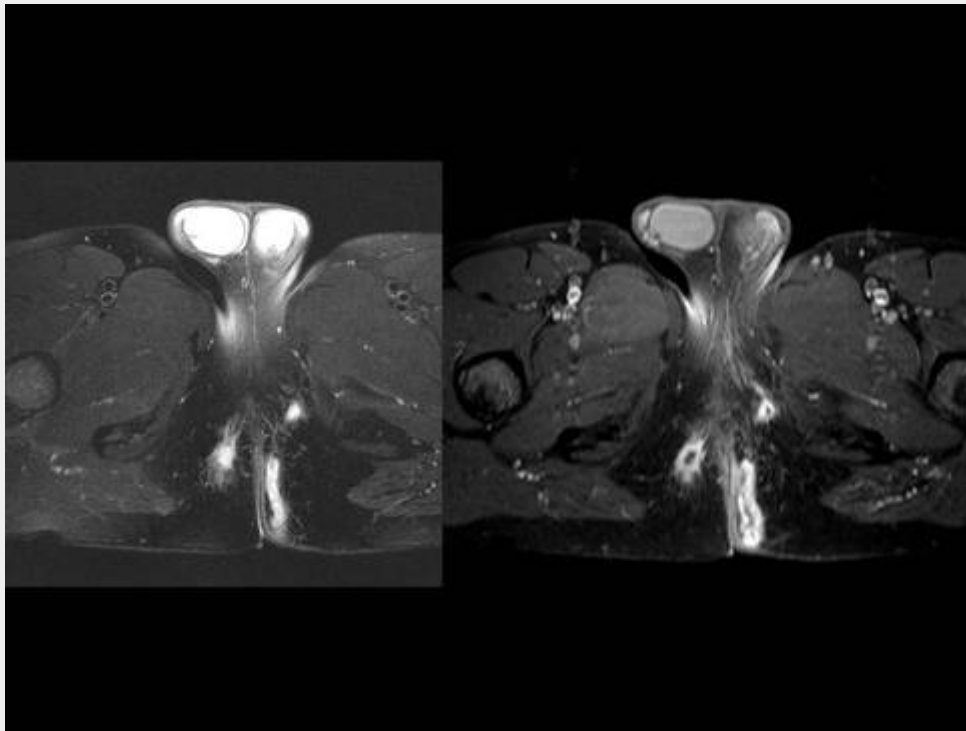


Figure15. Axial T2-w image with fat suppression (B) and axial contrast-enhanced T1-w image with fat suppression (C) show complex fistula with two tracts and inflammatory changes in both ischioanal fossa. Active tracts are filled with pus and granulation tissue and, thus, appear as hyperintense longitudinal structures on T2-w image in contrast with the lower signal intensity of the sphincters, muscles, and fat (especially on fat suppression and STIR images). On contrast-enhanced T1-w image, active granulation tissue enhances while fluid in the tract itself remains hypointense. Tracts are surrounded by hypointense fibrous walls that are characteristic thick in a patient with recurrent disease. Some hyperintensity is seen in these fibrous areas, probably reflecting edema. Hyperintensity also extends beyond the tracts and their fibrous sleeve, where it represents adjacent inflammation.