RadioGraphics

MR Imaging Evaluation of Perianal Fistulas: Spectrum of Imaging Features[1]

Jaime de Miguel Criado, MD • Laura García del Salto, MD • Patricia Fraga Rivas, MD • Luis Felipe Aguilera del Hoyo, MD • Leticia Gutiérrez Velasco, MD • M. Isabel Díez Pérez de las Vacas, MD • Ana G. Marco Sanz, MD Marcos Manzano Paradela, MD • Eduardo Fraile Moreno, MD, PhD

CME FEATURE

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LEARNING OBJECTIVES FOR TEST 6

After completing this journal-based CME activity, participants will be able to:

■ Describe the main MR imaging features and classification of perianal fistulas.

■ Discuss the role of MR imaging in evaluation and management of perianal fistulas.

■ List the MR imaging sequences and protocol used in evaluation of perianal fistulas.

INVITED COMMENTARY

See discussion on this article by Heise and Pickhardt (pp 194–197).

TEACHING POINTS
See last page

Perianal fistulization is an inflammatory condition that affects the region around the anal canal, causing significant morbidity and often requiring repeated surgical treatments due to its high tendency to recur. To adopt the best surgical strategy and avoid recurrences, it is necessary to obtain precise radiologic information about the location of the fistulous track and the affected pelvic structures. Until recently, imaging techniques played a limited role in evaluation of perianal fistulas. However, magnetic resonance (MR) imaging now provides more precise information on the anatomy of the anal canal, the anal sphincter complex, and the relationships of the fistula to the pelvic floor structures and the plane of the levator ani muscle. MR imaging allows precise definition of the fistulous track and identification of secondary fistulas or abscesses. It provides accurate information for appropriate surgical treatment, decreasing the incidence of recurrence and allowing side effects such as fecal incontinence to be avoided. Radiologists should be familiar with the anatomic and pathologic findings of perianal fistulas and classify them using the St James's University Hospital MR imaging–based grading system.

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Introduction

A fistula is defined as an abnormal connection between two structures or organs or between an organ and the surface of the body. In the case of perianal fistula, it is a connection between the anal canal and the skin of the perineum. Perianal fistulization is an uncommon process, with a prevalence of 0.01%, although it causes significant morbidity. It predominantly affects young males, with a male-to-female ratio of 2:1. The most common presenting symptom is discharge (65% of cases), but local pain due to inflammation is also common (1).

The treatment of fistulas requires surgery. While this is successful in most cases, it is associated with a significant prevalence of recurrence (2). Successful surgical management of anal fistulas requires accurate preoperative assessment of the course of the primary fistulous track and the site of any secondary extension or abscesses (3).

Although imaging techniques played a limited role in evaluation of perianal fistulas in the past, it is now increasingly recognized that imaging techniques, especially magnetic resonance (MR) imaging, may play a crucial role. MR imaging allows identification of infected tracks and abscesses that would otherwise remain undetected. Furthermore, radiologists can provide detailed anatomic descriptions of the relationship between the fistula and the anal sphincter complex, thereby allowing surgeons to choose the best surgical treatment, significantly reducing recurrence of the disease or possible secondary effects of surgery, such as fecal incontinence (4,5).

In this article, we review the anatomy of the perianal region and the etiology and prevalence of perianal fistulas. We also discuss the role of imaging techniques in evaluation of perianal fistulas, the protocol applied at our institution to assess perianal fistulas, and recent advances in MR imaging evaluation of perianal fistulas. We then describe location of anal fistulas and the two main classification systems for perianal fistula: the Parks and the St James's University Hospital classifications. Finally, we show the MR imaging findings of perianal fistulas, present our experience over the past 2 years in 188 patients with 199 perianal fistulas, and discuss the usefulness of MR imaging in management
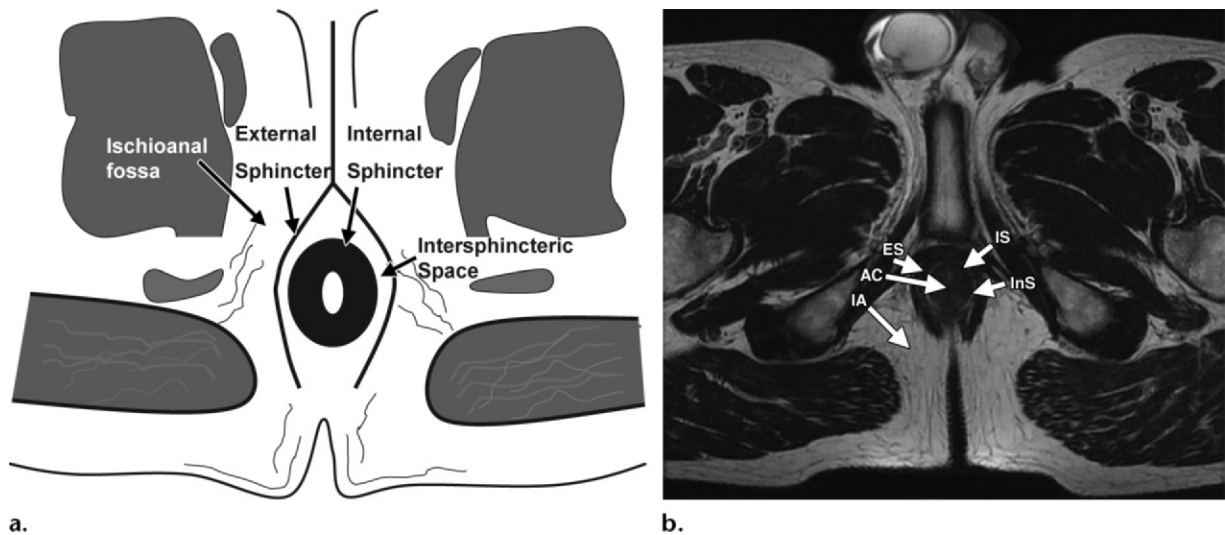
of perianal fistulas. We also highlight key details that radiologists should provide to surgeons to ensure effective treatment and improve therapeutic outcome.
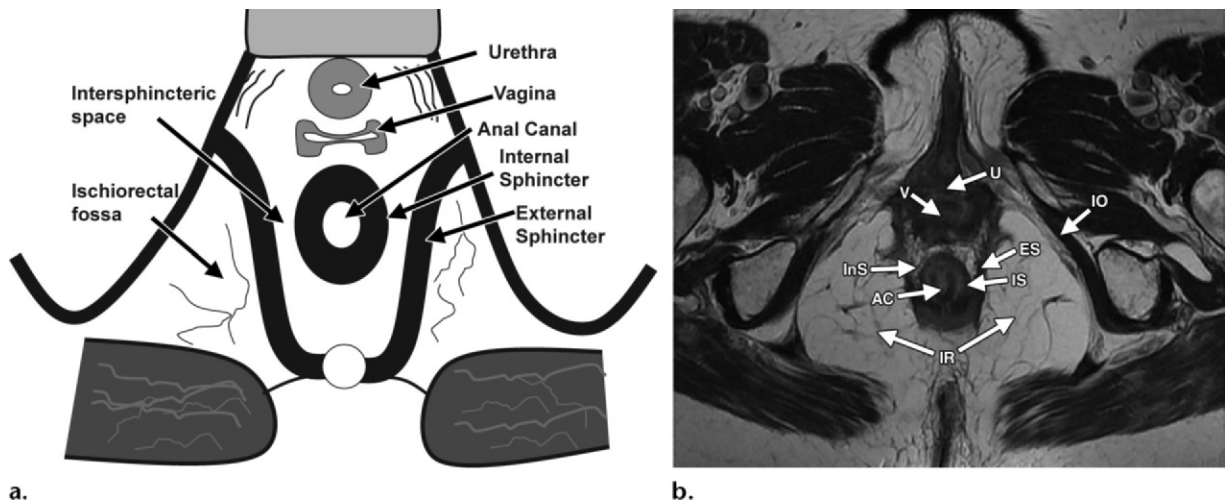
Anatomy

The anal canal is a cylindrical structure surrounded by two muscular layers, the internal and external sphincters. The internal sphincter is composed of smooth muscle, the fibers of which are continuous with the circular smooth muscle of the rectum (6). This sphincter contracts involuntarily and is responsible for 85% of the resting tone of the anal canal. The external sphincter is composed of striated muscle and has posterior attachments to the anococcygeal ligament and anterior attachments to the perineal body and urogenital diaphragm. It merges proximally with the puborectalis muscle, which then merges with the levator plate of the pelvic floor (7). The external sphincter contributes only 15% of the resting anal tone, although its strong voluntary contractions prevent defecation.

The internal sphincter can be divided without causing loss of continence, but excessive division of the external sphincter can lead to fecal incontinence. The two sphincters are separated by the intersphincteric space, which contains fat, areolar tissue, and the longitudinal muscle (Figs 1, 2). This space forms a natural plane of lower resistance in which fistulas and pus can readily spread (8). The longitudinal muscle is formed by distal termination of rectal longitudinal smooth muscle and does not clearly contribute to the function of the anal sphincter (9).

In terms of the lining of the anal canal, somatic skin should theoretically reach the anal margin, but in fact it advances up to a point approximately halfway along the anal canal. Here, squamous epithelium gives way to columnar epithelium, often through a transition zone (10). The proximal half of the anal canal is characterized by longitudinal mucosal folds, the anal columns of Morgagni. The distal part of each column is linked to its neighbors by small semilunar folds, the anal valves, which in turn form small pockets, the crypts of Morgagni. The undulating distal limit of these valves is known as the dentate line (pectinate line), which marks the most distal region of the anal transition zone, approximately 2 cm proximal to the anal verge (Fig 3).

Figure 1.   Normal male anatomy. Drawing **(a)** and T2-weighted MR image **(b)** show the normal male anatomy of the perineum at the level of the mid anal canal (*AC* in **b**) in the axial plane. In **b**, *ES* = external sphincter, *IA* = ischioanal fossa, *InS* = intersphincteric space, *IS* = internal sphincter.

Figure 2.   Normal female anatomy. Drawing **(a)** and T2-weighted MR image **(b)** show the normal female anatomy of the perineum at the level of the proximal half of the anal canal (*AC* in **b**) in the axial plane. In **b**, *ES* = external sphincter, *InS* = intersphincteric space, *IO* = internal obturator muscle, *IR* = ischiorectal fossa, *IS* = internal sphincter, *U* = urethra, *V* = vagina.

Figure 3.   Drawing shows the normal anatomy of the anal canal in the coronal plane.

The anal glands, which were described by Chiari (11) in 1878, are six to 10 branched glandular structures with a stratified columnar epithelium lining. These glands are evenly distributed around the circumference of the anal canal, with ducts opening into the base of the crypts of Morgagni, located above the anal valves at the level of the dentate line. In most of the population, these glands are subepithelial, but some branches may pass through the internal sphincter to end in the areolar tissue of the intersphincteric space (11). Branches of any gland may extend over an area of about 1 cm^2, but as a general rule the anal glands do not extend out into the external sphincter. Anal glands provide a free channel facilitating the spread of infection from the anal lumen deep into the sphincter muscles, from where it may spread secondarily in almost any direction (10,12).

Etiology and Pathogenesis

Perianal fistulas may be caused by several inflammatory conditions and events, including Crohn disease, pelvic infection, tuberculosis, diverticulitis, trauma during childbirth, pelvic malignancy, and radiation therapy. However, most are idiopathic and are generally thought to represent the chronic phase of intramuscular anal gland sepsis. Perhaps the most widespread theory about the cause of perianal fistula is the cryptoglandular hypothesis (8), whereby intersphincteric gland infection represents the initial event, which leads to formation of an intersphincteric fistula track or abscess if the draining duct becomes obstructed. Chronic infection in the primary site in the intersphincteric plane produces a persistently discharging fistula or recurrent abscess.

Most of the glands are subepithelial, with some lying in the longitudinal layer deep in the internal sphincter, although others may terminate in the intersphincteric space, close to the external sphincter. If an abscess develops in a superficial gland, it is most likely to discharge spontaneously into the anal canal. However, if the abscess is located deep to the internal sphincter, the sphincter can act as a barrier. In such cases, rupture of the abscess results in pus traveling along the path of least resistance, the intersphincteric space, and an intersphincteric fistula will form when it reaches the skin (8). Alternatively, infection may pass through both layers of the external sphincter, forming a transsphincteric fistula, and enter the ischiorectal fossa, causing inflammatory changes and abscesses (10).

However, the cryptoglandular hypothesis cannot explain formation of fistulas in inflammatory processes such as Crohn disease and diverticulitis, which result in development of extrasphincteric fistulas, with a direct communication between the perineum and rectum or other visceral structures such as the vagina, with no involvement of the anal canal.

Prevalence

Perianal fistulas have a prevalence of approximately 0.01% and predominantly affect young adults (1), with a male-to-female ratio of approximately 2:1. The most common presenting symptom is discharge (65% of cases), although local pain is also frequent. However, fistulas may be completely asymptomatic (13).

Role of Imaging Techniques in Evaluation of Perianal Fistulas

The role of imaging techniques in evaluation of perianal fistulas has been addressed by many authors. In particular, MR imaging has emerged as the technique of choice for preoperative evaluation of perianal fistulas to improve patient outcome. The importance of MR imaging in this context lies in its ability to demonstrate hidden areas of sepsis and secondary extensions, both of which contribute to the high rate of recurrence after surgery (3). Furthermore, MR imaging can be used to define the anatomic relationships of the fistula to predict the likelihood of postoperative fecal incontinence.

Before the introduction of MR imaging for these purposes, several other imaging techniques were used, with disappointing results. In a retrospective review of fistulography images from 25 patients to ascertain the utility of contrast material–enhanced fistulography, correct diagnoses were achieved in only 16% of the patients, demonstrating that this approach was inaccurate and unreliable (14). Fistulography has two major drawbacks: *(a)* the difficulty of assessing secondary extensions owing to lack of proper filling with contrast material and *(b)* inability to visualize the anal sphincters and hence determine their relationship to the fistula (15).

Computed tomography (CT) with rectal and intravenous contrast material can be used to analyze anal fistulas, particularly those in the rectal area. While useful for evaluation of perirectal inflammatory disease and suspected perirectal abscesses, CT usually fails to define subtle fistulas and abscesses owing to poor resolution of soft tissue (16,17).

Teaching Point

Anal endosonography was the first imaging technique used to describe the anatomy of the anal canal and anal sphincters in detail (18). This technique provides excellent imaging of the rectal wall and anal sphincter and of intersphincteric fistulas and their relationship to the anal sphincters (19,20). However, the limited field of view is a considerable inconvenience with this approach, precluding use of endosonography to assess primary superficial, suprasphincteric, and extrasphincteric tracks or secondary extensions.

When anal endosonography was compared with digital rectal evaluation and MR imaging in 108 primary fistula tracks, the proportion of fistula tracks correctly classified with each modality was as follows: 61% with digital examination, 81% with anal endosonography, and 91% with MR imaging (21). In addition, endosonography allowed correct identification of the internal opening in 91% of the patients versus 97% with MR imaging. Thus, it was concluded that endosonography with a high-frequency transducer is superior to digital examination for preoperative classification of perianal fistula. However, while MR imaging is superior in all respects, endosonography remains a viable alternative for identification of the internal opening.

Accordingly, it is becoming increasingly recognized that MR imaging plays a crucial role in preoperative evaluation of perianal fistula and the patient outcome. The true potential of MR imaging in assessment of anal fistulas became evident in a study of 16 patients with cryptoglandular fistulas, when MR imaging findings were compared with the subsequent findings from examination under anesthesia (22). The authors concluded that MR imaging is the most accurate method for determining the presence and course of anal fistulas and that it may help reduce recurrence due to inaccurate surgical assessment. These conclusions were confirmed in a follow-up study of 35 patients that reported correct MR imaging assessments in 33 of the patients (94%), including two cases in which examination under anesthesia failed to identify distant sepsis (23).

In a prospective study of 42 patients with suspected anal fistulas (4), the results of digital rectal examination, dynamic contrast-enhanced MR imaging, and surgical exploration were compared. MR imaging had a sensitivity of 97% and specificity of 100% for detection of fistulas. In addition, it allowed identification of more secondary tracks and was more accurate in identification of complex fistulas than either digital rectal examination alone or surgical exploration.

A more recent study of 56 patients with anal fistulas who underwent high-spatial-resolution MR imaging demonstrated that MR imaging provides important additional information about secondary extensions and recurrent fistulas, particularly in patients with Crohn disease. The authors recommended MR imaging for the preoperative work-up (24).

In a larger study of 71 patients with recurrent anal fistula in which MR imaging findings were revealed after initial fistula surgery, the postoperative recurrence rate was as low as 16% when surgeons always acted on the MR imaging findings, suggesting that areas of infection had been missed. By contrast, the rate of recurrence was 30% when surgeons only sometimes acted on MR imaging results and 57% when MR imaging results were ignored. Furthermore, in the 16 patients who required further unplanned surgery, MR images had initially correctly indicated the site of disease in all cases, confirming that surgery guided by MR imaging reduces further recurrence of anal fistula by 75% and should be performed in all patients with recurrent fistula (5).

Finally, results of MR imaging, anal endosonography, and clinical examination with use of evidence-based medicine methods were compared to determine the optimal technique for classifying perianal fistulas. It was concluded that MR imaging is the optimal technique for distinguishing complex from simple perianal fistulas, although anal endosonography is superior to clinical examination and may be used if the availability of MR imaging is limited (25).

Taken together, the results of these studies confirm that MR imaging is currently the technique of choice for evaluation of perianal fistulas and associated complications.

MR Imaging Technique

The advantages of MR imaging include multiplanar imaging and a high degree of soft-tissue differentiation, which show the fistulous track in relation to the underlying anatomy in a projection relevant to surgical exploration (26). MR imaging examinations performed with body or phased-array coils require no special patient preparation, are well tolerated, and provide excellent anatomic detail of the anal sphincters and the anatomic boundaries of the pelvis. Use of endoanal coils was initially proposed to improve MR imaging evaluation of perianal fistulas, but such coils are poorly tolerated in symptomatic patients. Endoanal coils
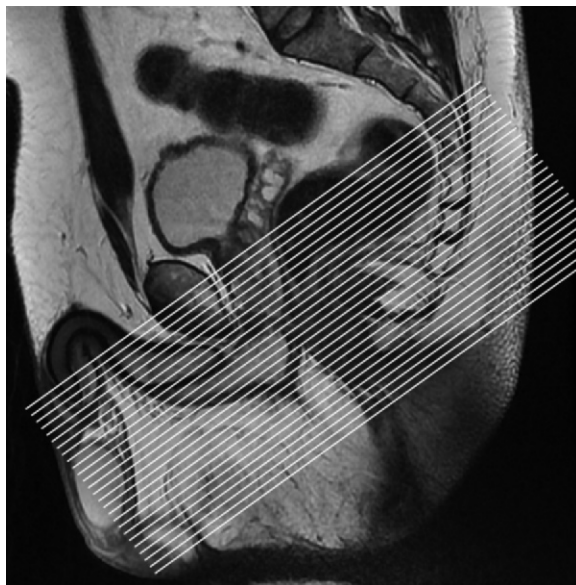
provide superior anatomic resolution of fistulous disease within the sphincter (27) but have a limited field of view, which can result in undetected sepsis (28) or supralevator and subcutaneous extension (29).

An important advantage of MR imaging in fistula evaluation is the ability to study the anal sphincter complex in any surgically relevant plane. For this reason, it is critical that imaging planes are correctly aligned with respect to the anal canal. The anal canal is tilted forward from the vertical by approximately 45° in the sagittal plane; thus, straight axial and coronal images will not allow correct evaluation of the source and the fistulous track. Therefore, it is necessary to obtain oblique axial and coronal images oriented orthogonal and parallel to the anal canal, respectively.
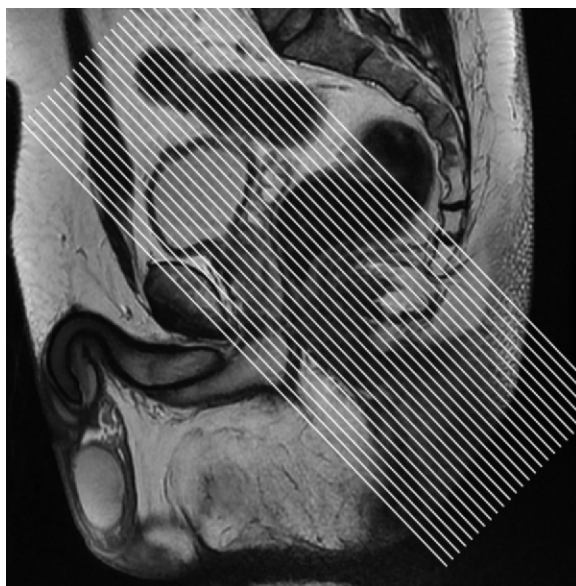
To achieve the correct orientation, a sagittal fast spin-echo (FSE) T2-weighted sequence should be performed initially, providing an overview of the pelvis and showing the extent and axis of the anal canal. The correct orientation of the anal canal for MR imaging can be derived from this sequence, providing truly axial (Fig 4) and coronal (Fig 5) images along the long axis of the anal canal and enabling correct assessment of perianal fistulas. The levator plate and the entire perineum should be included to identify areas of sepsis and infected tracks that may lead to recurrence.

The most appropriate protocol used at our institution for evaluation of perianal fistulas consists of the following sequences: oblique axial T1-weighted FSE, oblique axial T2-weighted FSE, and oblique axial and oblique coronal fat-suppressed T1-weighted FSE with gadolinium-based contrast material, oriented perpendicular or parallel (in the case of the latter) to the long axis of the anal canal. The planes used are obliquely axial and obliquely coronal relative to the pelvis, but these planes are truly orthogonal and parallel relative to the anal canal and thus suitable for correct evaluation of perianal fistulas. It is not appropriate to use the terms *axial* and *coronal* to refer to these planes; their use is not correct in terms of the orientation of the planes relative to the pelvis (4,15,24,30–32). Full details of the MR imaging parameters are given in the Table.

Fat-suppressed T2-weighted sequences such as short inversion time inversion-recovery (STIR) or frequency-selective fat-satured T2-weighted FSE may be used to increase the conspicuity of fluid-containing tracks or abscesses (28). Frequency-selective fat suppression should be used with the

Figure 4.   Suggested orientation for axial MR imaging of the anal canal. Sagittal T2-weighted image through the midline is used to obtain images that are truly axial relative to the anal canal.

Figure 5.   Suggested orientation for coronal MR imaging of the anal canal. Coronal MR imaging is performed at 90° relative to the axial plane to obtain images parallel to the long axis of the anal canal.

T2-weighted FSE sequence because the high signal intensity of fat can hide active fistulous tracks or abscesses, which also have high signal intensity. On fat-suppressed T2-weighted images, fluid, pus, and granulation tissue are seen as areas of high signal intensity on a background of low-signal-intensity fat (5,15,26,33).

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Suggested Protocol for MR Imaging of Anal Fistulas

Parameters	T2W FSE	T1W FSE	T2W FSE	FS T1W FSE	FS T1W FSE
Imaging plane	Sagittal	Oblique axial	Oblique axial	Oblique axial	Oblique coronal
TR/TE (msec)	4500/110	450/12	4500/110	450/12	450/12
FOV (cm)	29 × 29	26 × 26	26 × 26	26 × 26	24 × 24
Section thickness (mm)	2.5	4.0	4.0	4.0	4.0
Intersection gap (mm)	0	0.8	0.8	0.8	0.8
Matrix	320 × 256	384 × 224	320 × 256	384 × 224	512 × 224
NSA	2	2	4	2	2

Note.—Parameters were established with the Signa Excite 1.5-T system (GE Healthcare, Milwaukee, Wis). FOV = field of view, FS = fat-suppressed, NSA = number of signals acquired, TE = echo time, T1W = T1-weighted, TR = repetition time, T2W = T2-weighted.

The STIR sequence provides good suppression of fat signal, but the images tend to be of poorer spatial resolution than frequency-selective fat-satured T2-weighted FSE images, which provide better visualization of anatomic details (34). On frequency-selective fat-saturated T2-weighted FSE images, the efficiency of fat suppression may not be uniform; therefore, care must be taken to place the patient close to the center of the magnet to maximize the homogeneity of fat suppression (35). In a prospective study of 42 patients, STIR imaging failed to demonstrate secondary tracks and did not reveal small residual perianal abscesses from perianal inflammation, making it less suitable for demonstration of fluid collections or extensions than are T1-weighted sequences with intravenous contrast material (36).

Selection of the MR imaging protocol is particularly important in postoperative patients. Local alteration of the magnetic field by a foreign body could induce susceptibility artifact. The term *susceptibility* refers to the ability of a substance to distort the static magnetic field. The artifact occurs at the interface of substances with differing magnetic susceptibilities. MR imaging artifacts in the postoperative patient may be due to suture artifact, like a seton, placed through the fistula track. Silk is one of the most commonly used sutures, and the susceptibility artifact induced by silk is the most prominent relative to those from all the other types of sutures (37).

Refocused pulses, usually 180°, correct many sources of dephasing, making FSE imaging effective for minimizing susceptibility artifact. However, if frequency-selective fat saturation techniques are used, variations of the regional magnetic field surrounding the seton may create an inhomogeneous magnetic field, with resultant areas of suboptimal fat saturation. Susceptibility-induced field inhomogeneity makes frequency-selective fat saturation difficult, and frequency-selective fat saturation exacerbates susceptibility artifact (38). One should consider not using frequency-selective fat saturation when severe susceptibility artifact is expected.

The STIR sequence is an effective alternative method of suppressing fat signal and is less dependent on the homogeneity of the main magnetic field. STIR relies on T1 relaxation differences instead of precessional frequency differences to cancel the signal from fat, thereby minimizing susceptibility effects during fat-suppressed imaging (39). This sequence is less sensitive to magnetic field inhomogeneities and can be used with low-field-strength magnets (34).

Recent Advances in MR Imaging Evaluation of Perianal Fistulas

T2-weighted sequences are essential in evaluation of the pelvic region because they provide excellent soft-tissue contrast of the pelvic organs. The two-dimensional (2D) spin-echo–based T2-weighted sequence, performed in multiple planes, plays a crucial role in basic standardized protocols for pelvic MR imaging.
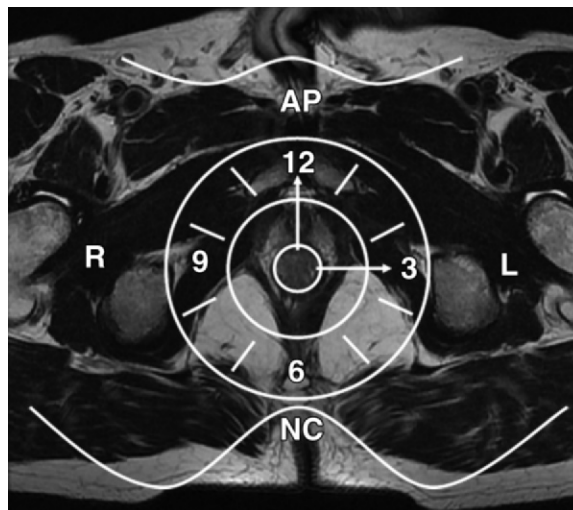
New sequences will offer opportunities to improve efficiency and diagnostic capability. Three-dimensional (3D) T2-weighted turbo spin-echo (TSE) sequences can provide source data for postprocessing reformation of images into any desired plane. Therefore, a single 3D T2-weighted sequence with postprocessing reformation of images in the axial, coronal, and sagittal planes can potentially replace 2D sequences in those three planes, decreasing the number of sequences performed from three to one (40–42).

The 3D imaging technique has several advantages over 2D imaging: There is no operator dependence in acquiring images in any obliquity, a larger volume can be covered, thinner sections without intersection gaps can be obtained, a higher signal-to-noise ratio can be achieved, and imaging time can be reduced. The 3D T2-weighted TSE sequence has been studied for its usefulness in evaluation of rectal cancer (40), the body trunk (41), and the female pelvis (42). However, to our knowledge, use of the 3D T2-weighted TSE sequence for imaging of perianal fistulas has not been reported.

Another new diagnostic tool for detection of perianal fistulas is digital subtraction MR fistulography. Subtraction MR fistulography is based on abnormal enhancement of the inflamed fibrous walls of fistulas or abscesses on T1-weighted images after intravenous administration of contrast material. In a prospective study of 36 patients, results of subtraction MR fistulography were compared with surgical findings in patients with anal fistulas or abscesses (43).

The examination protocol was defined as subtraction MR fistulography because image subtraction resulted in visualization of fistulas as high-signal-intensity tubular structures containing varying degrees of low-signal-intensity fluid; the surrounding fat appeared dark. The authors demonstrated that high-resolution subtraction MR fistulography, which consisted of a high-resolution 3D T1-weighted gradient-echo sequence and the image subtraction technique, was useful in diagnosis of anal fistulas.

Use of diffusion-weighted sequences for evaluation of perianal fistulas has been reported (44). Diffusion-weighted imaging reflects changes in water mobility caused by interactions with cell membranes, macromolecules, and alterations of the tissue environment. Because inflammatory tissues usually have high signal intensity at diffusion-weighted imaging, it may be a promising sequence for diagnosis of anal fistulas, particularly as an adjunct to T2-weighted imaging in patients with risk factors having to do with adverse effects of contrast material: previous allergic reactions or impaired
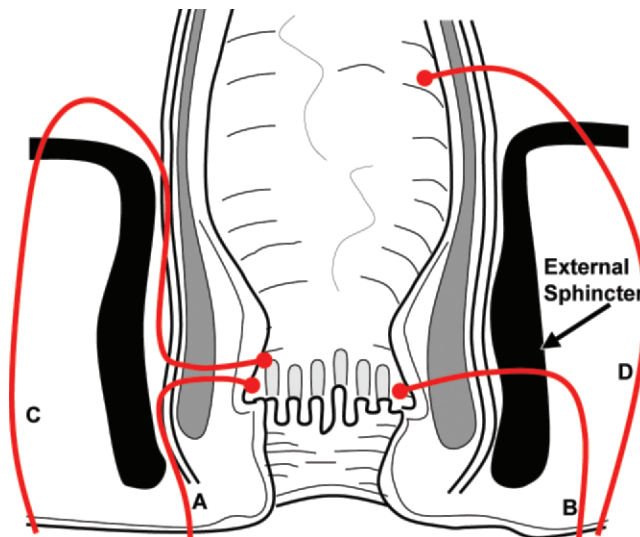

Figure 6.   Anal clock. Axial T2-weighted MR image of the male perineum shows the anal clock diagram used to correctly locate anal fistulas with respect to the anal canal. *AP* = anterior perineum, *L* = left aspect of the anal canal, *NC* = natal cleft, *R* = right aspect of the anal canal.

renal function with concern about development of nephrogenic systemic fibrosis.

A recent development is use of dynamic contrast-enhanced MR imaging for determining the degree of activity in perianal Crohn disease. With this technique, 2D T1-weighted sequences are performed and time–signal intensity curves are obtained to determine whether a fistula is active by measuring the volume of enhancing pixels. It was concluded that dynamic contrast-enhanced MR imaging might be helpful in selecting a subpopulation of patients with perianal Crohn disease who should be monitored more closely for development of more extensive disease (45).

Finally, another development is the possibility of evaluating perianal fistulas by using 3.0-T imaging. In theory, higher-field-strength MR imaging provides a better signal-to-noise ratio, which can be used to achieve increased temporal resolution, decreased imaging time, and increased spatial resolution. The increased spatial resolution has the potential to improve lesion visibility. The finer detail of reformatted images can help in characterization of perianal fistulas.

Figure 7. Parks classification. Drawing of the anal canal in the coronal plane shows the Parks classification of perianal fistulas. *A* = intersphincteric, *B* = transsphincteric, *C* = suprasphincteric, *D* = extrasphincteric. The external sphincter is the keystone of the Parks classification.

In 3.0-T imaging, the intrinsic tissue relaxation kinetics defined by T1, T2, and T2* values vary slightly at higher field strengths, causing a decrease in intrinsic image contrast. Although the intrinsic image contrast is decreased, the T1-shortening effect of gadolinium relative to that in adjacent tissues is more pronounced (46,47). Therefore, a perianal fistula could be highlighted more markedly from adjacent tissues and the outlines of the fistula track could be more readily apparent at 3.0 T than at 1.5 T.

Location of Anal Fistulas: The Anal Clock

Anal fistulas are classified according to their progression relative to the anal sphincter and pelvic floor structures. To characterize a perianal fistula, it is essential to adequately describe the point of origin in the anal canal and the path of the fistula with respect to the pelvic anatomic boundaries. To locate the point of origin and describe the direction of the fistulous track, we use an "anal clock" scheme, which is the same as that used by surgeons to describe injuries around the anal region (Fig 6).

With the patient in the lithotomy position, the anterior perineum is located at 12 o'clock and the natal cleft is at 6 o'clock, with the left lateral aspect of the anal canal at 3 o'clock and the right lateral aspect at 9 o'clock (48). These descriptions correspond exactly with the view of the anal canal on axial MR images obtained with the patient in the decubitus supine position.

Classification of Perianal Fistulas

Fistulas may be classified according to the route taken by the main track running from the anal canal to the skin. Any anatomic system of classification of perianal fistulas must be based on the relationship between the primary track and the anal sphincter muscles, particularly since current treatment involves sectioning of these structures, the preservation of which is essential to maintain rectal continence, especially in reference to the external sphincter and puborectalis muscle.
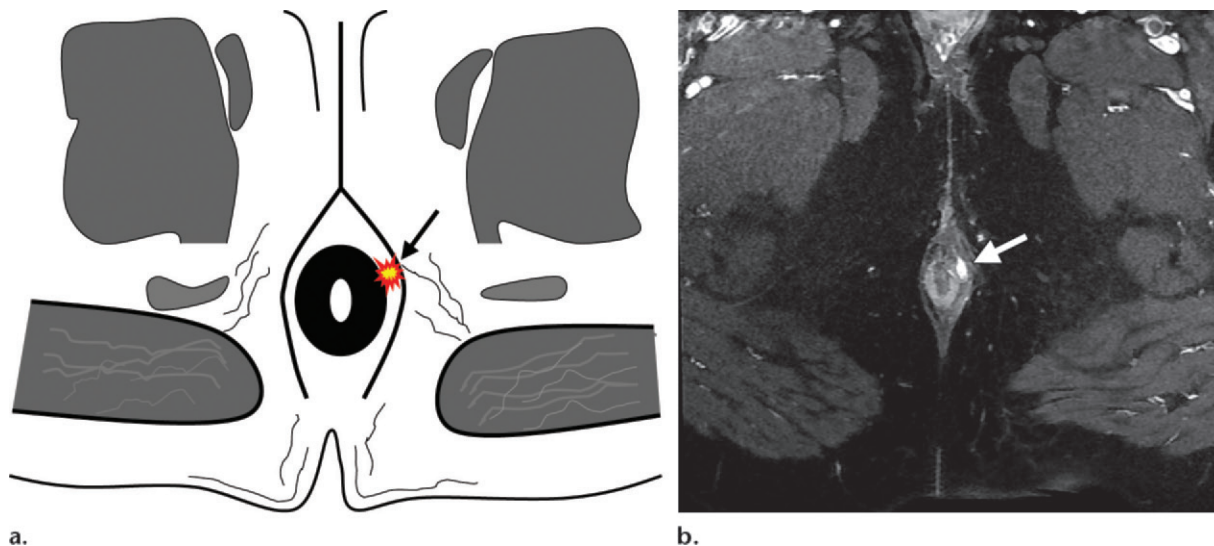
There are two main classification systems for perianal fistulas: the Parks classification and the St James's University Hospital classification.

Parks Classification

On the basis of surgical findings from 400 patients referred to the St Mark's Hospital surgery department in London, England, Parks et al (49) described perianal fistulas in the coronal plane according to the course of the fistula and its relationships to the internal and external sphincters. Fistulas were classified into four groups: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric. In the Parks classification, the external sphincter is used as the keystone (Fig 7).

Teaching Point

Teaching Point

Figure 8. Grade 1: simple linear intersphincteric fistula. **(a)** Drawing of the anal canal in the axial plane shows a simple intersphincteric fistula at the 2-o'clock position (arrow). **(b)** Axial contrast-enhanced fat-suppressed T1-weighted MR image shows the left intersphincteric fistula (arrow) bounded by the external sphincter without a secondary fistulous track or abscess.

The source of infection in most of these groups can be explained by the cryptoglandular hypothesis. Intersphincteric fistulas accounted for 45% of cases in the study of Parks et al (49) and represented the most common of the four categories. These fistulas ramify only in the intersphincteric space and do not traverse the external sphincter, which forms a relative barrier to the spread of infection. The track runs along the longitudinal muscle layer between the internal and external sphincters and may reach the perianal skin through or medial to the subcutaneous external sphincter.
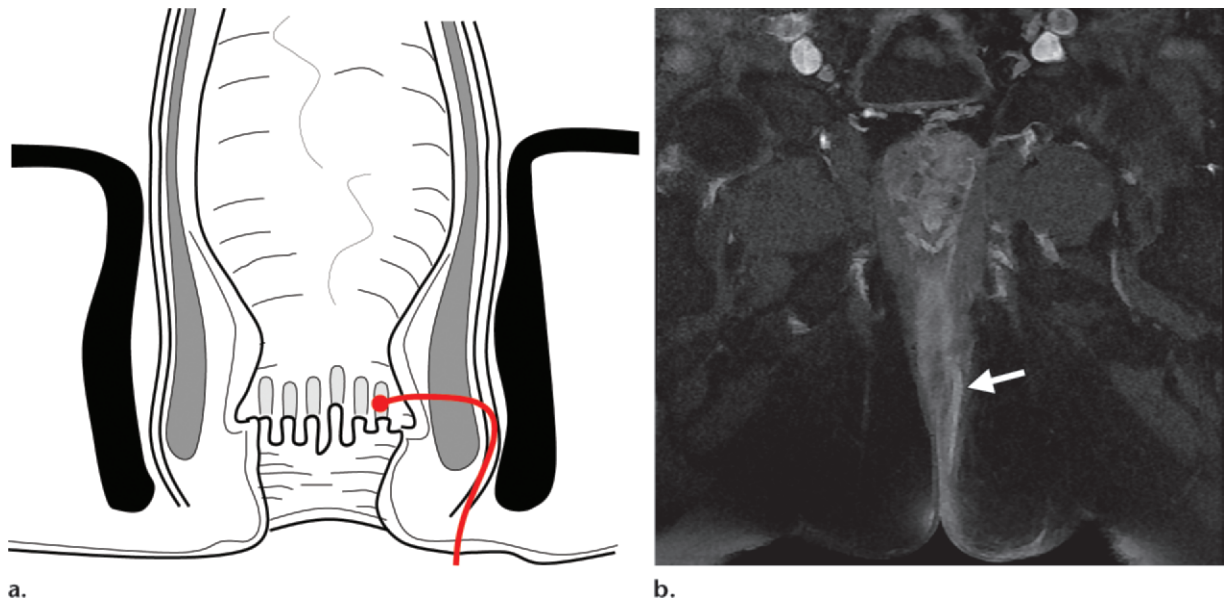
In transsphincteric fistulas (30% of cases in the study), the track passes from the intersphincteric space through the external sphincter into the ischiorectal fossa. In suprasphincteric fistulas (20% of cases in the study), the track progresses upward into the intersphincteric space, passes over the top of the puborectalis muscle, then descends through the levator plate to the ischiorectal fossa and finally to the skin.

The extrasphincteric fistula (5% of cases in the study) is the only type of fistula whose etiology cannot be explained by the cryptoglandular hypothesis. In extrasphincteric fistulas, the track passes from the perineal skin through the ischiorectal fossa and levator muscles then into the rectum. Thus, this fistula lies completely outside the external sphincter complex. No infection is found in the intersphincteric space, and the anal canal is not involved. When diagnosing this type of fistula, it is important to exclude primary rectal or pelvic diseases, such as Crohn disease, diverticular disease, or carcinoma (49).

All of these fistula types may be complicated by abscesses and by secondary tracks, also known as extensions. Extensions are branches from the primary track that may develop at any point, most commonly in the ischiorectal fossa. Extensions and abscesses may be intersphincteric, ischioanal, or supralevator (pararectal), therefore requiring specific treatment. Fistulas can also spread circumferentially in the intersphincteric space, ischioanal fossa, or supralevator space. Circumferential branches or abscesses that extend on both sides of the interior opening are known as horseshoe branches or abscesses and require careful surgery to ensure proper drainage.

Bear in mind that the perianal fistulas described by Parks et al (49) were evaluated at a specialized surgical institution, which may have led to a higher proportion of complex fistulas. This classification was based on a selected series of patients and may not be representative of the prevalence of disease in the general population.

a.   b.

Figure 9.   Grade 1: simple linear intersphincteric fistula (same patient as in Fig 8). **(a)** Drawing of the anal canal in the coronal plane shows the simple intersphincteric fistula to the left of the anal canal. **(b)** Coronal contrast-enhanced fat-suppressed T1-weighted MR image shows the highly enhancing intersphincteric fistula (arrow) confined by the external sphincter.

St James's University Hospital Classification

Because relevant MR imaging findings are not included in the Parks classification, an MR imaging–based classification was proposed that relates the Parks surgical classification to anatomic MR imaging findings in the axial and coronal planes. The St James's University Hospital classification was proposed by radiologists on the basis of imaging findings and does not represent an official surgical reference (48). In fact, the main role of radiologists in evaluation of perianal fistulas is to be descriptive and accurate in their reports, as details will be essential in future decisions about medical or surgical treatment.

This classification is simple to apply because it uses anatomic landmarks in the axial plane familiar to radiologists. Furthermore, the classification considers the primary fistulous track as well as secondary extensions and abscesses in evaluating and classifying fistulas. For these reasons and because it is easily understood by radiologists who can then provide accurate information to surgeons, we use this classification at our institution. The classification grades fistulas into five groups: grade 1, simple linear intersphincteric fistula; grade 2, intersphinc-

teric with abscess or secondary track; grade 3, transsphincteric; grade 4, transsphincteric with abscess or secondary track in ischiorectal or ischioanal fossa; grade 5, supralevator and translevator.
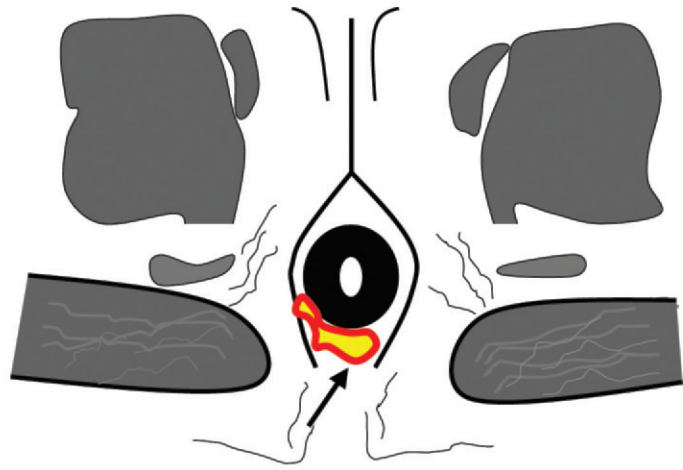
Grade 1: Simple Linear Intersphincteric Fistula.— In a grade 1 fistula, the track extends from the anal canal through the intersphincteric space to reach the skin of the perineum or natal cleft. No extensions or abscesses are found in the intersphincteric space or ischiorectal and ischioanal fossae. The fistulous track is always observed in the intersphincteric space and is entirely confined by the external sphincter (Figs 8, 9).
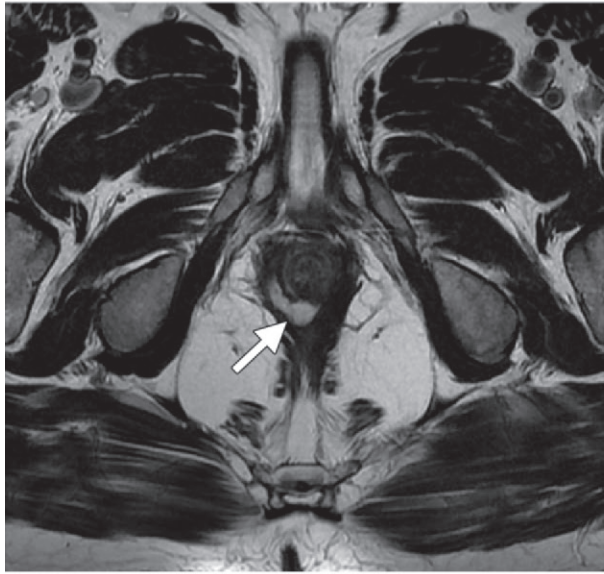
Grade 2: Intersphincteric Fistula with an Abscess or Secondary Track.— In a grade 2 fistula, the primary track and a secondary track or abscess occur in the intersphincteric space. They are always confined by the external sphincter, which is never crossed (Figs 10, 11). Extensions and abscesses may be of the horseshoe type, crossing the midline, or may branch in the ipsilateral intersphincteric plane.
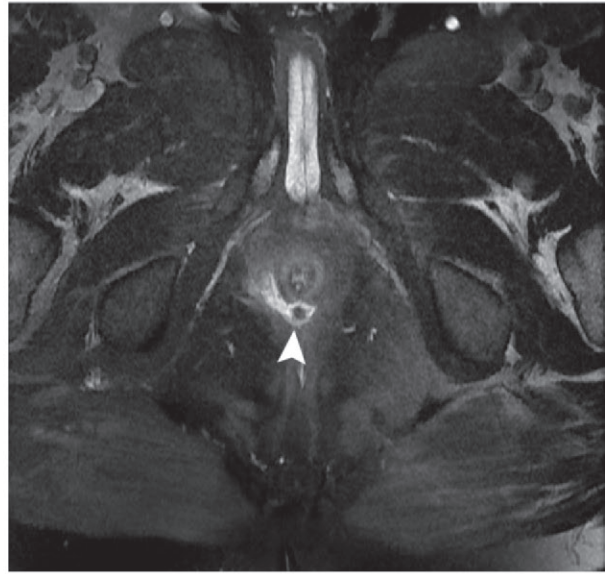
Figure 10. Grade 2: intersphincteric fistula with an abscess. **(a)** Axial drawing of the anal canal shows a right posterolateral abscess (arrow). **(b)** Axial T2-weighted MR image shows the high-signal-intensity fluid collection along the right postero-lateral aspect of the anal canal (arrow). **(c)** Axial contrast-enhanced fat-suppressed T1-weighted MR image shows the abscess in the right postero-lateral aspect of the intersphincteric space (arrow-head), bounded by the external sphincter.
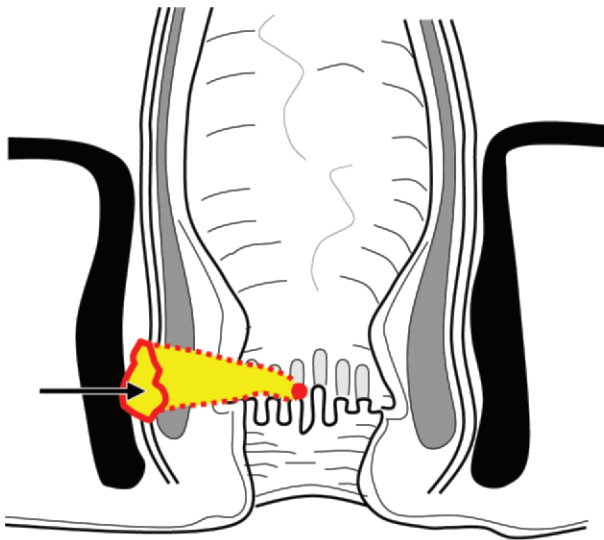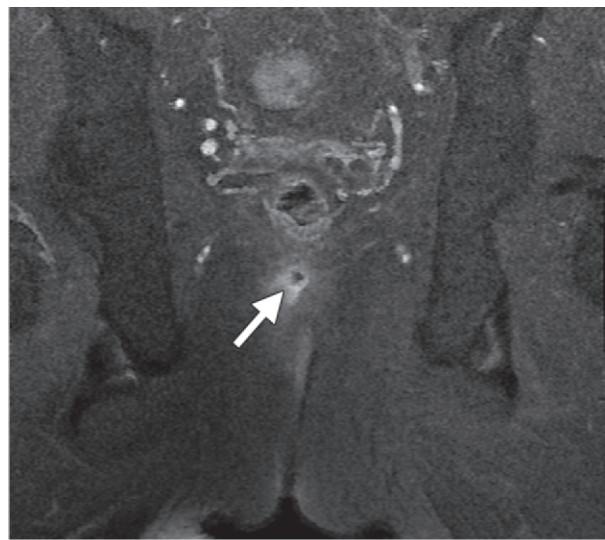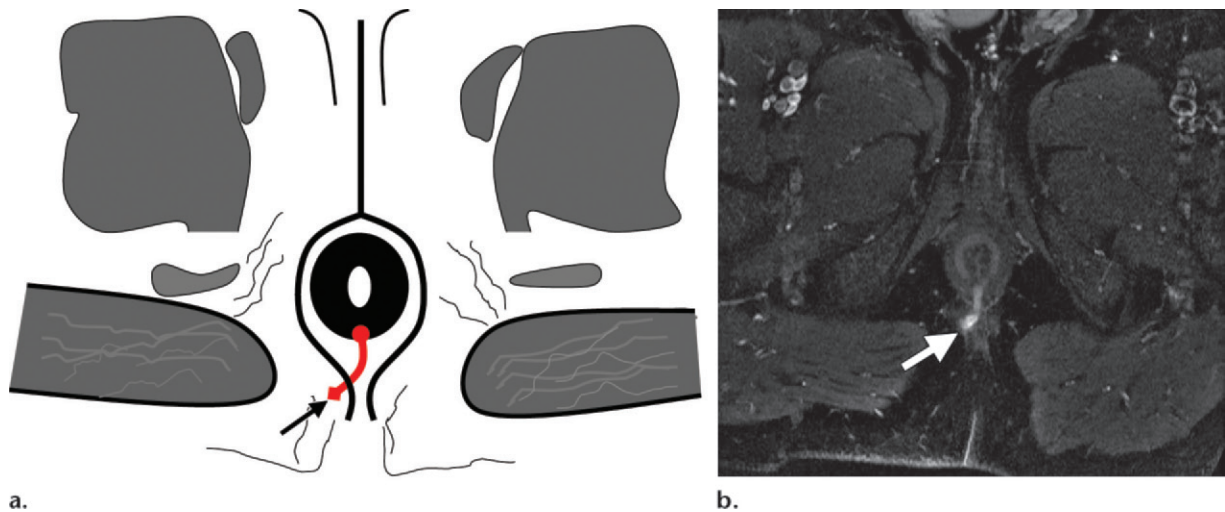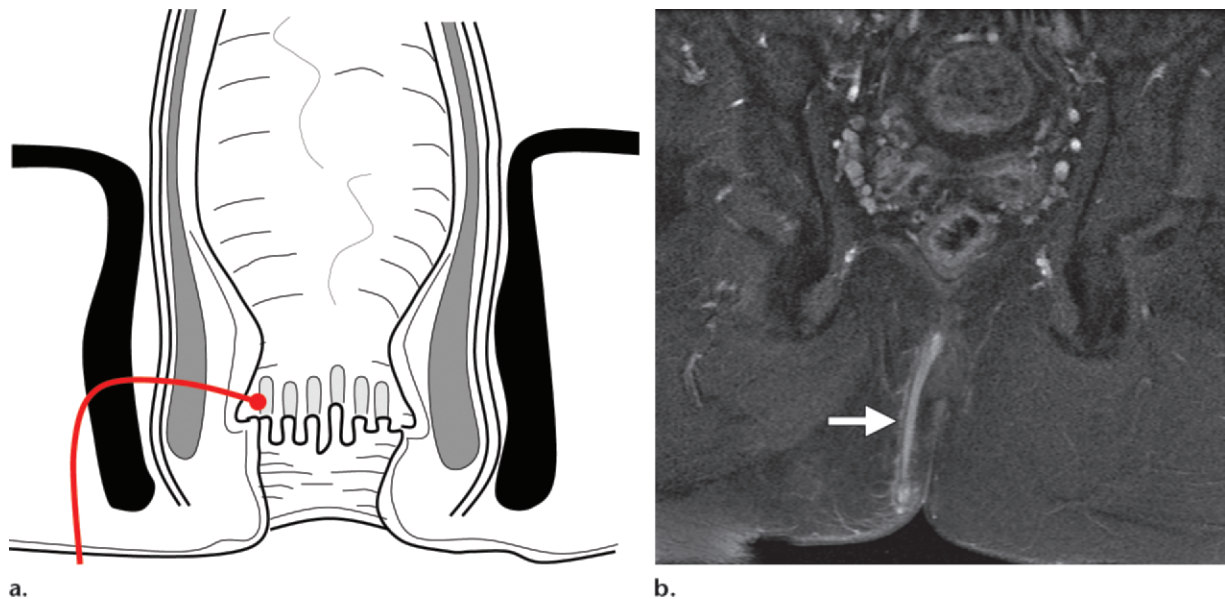
Figure 11. Grade 2: intersphincteric fistula with an abscess (same patient as in Fig 10). **(a)** Coronal drawing of the anal canal shows the abscess in the intersphincteric space (arrow), bounded by the external sphincter. **(b)** Coronal contrast-enhanced fat-suppressed T1-weighted MR image shows the right intersphincteric abscess (arrow) without a fistulous track or abscess in the right ischiorectal fossa.

a. b.

Figure 12. Grade 3: transsphincteric fistula. **(a)** Axial drawing of the anal canal shows a posterior transsphincteric fistula (arrow) with the internal opening at the 6-o'clock position. **(b)** Axial contrast-enhanced fat-suppressed T1-weighted MR image shows the transsphincteric fistula (arrow) crossing the external sphincter.

a. b.

Figure 13. Grade 3: transsphincteric fistula (same patient as in Fig 12). **(a)** Coronal drawing of the anal canal shows the right transsphincteric fistula. **(b)** Coronal contrast-enhanced fat-suppressed T1-weighted MR image shows the highly enhancing transsphincteric fistula (arrow) from the dentate line to the skin, passing through the ischioanal fossa and piercing the external sphincter.

Grade 3: Transsphincteric Fistula.—A grade 3 fistula pierces both layers of the sphincter complex and takes a downward course through the ischiorectal and ischioanal fossae before reaching the perineal skin. It may provoke inflammatory changes in the fat of the ischiorectal and ischioanal fossae, although it is not complicated by secondary tracks or abscesses in these areas. A transsphincteric fistula is distinguished by location of the enteric entry point in the middle third of the anal
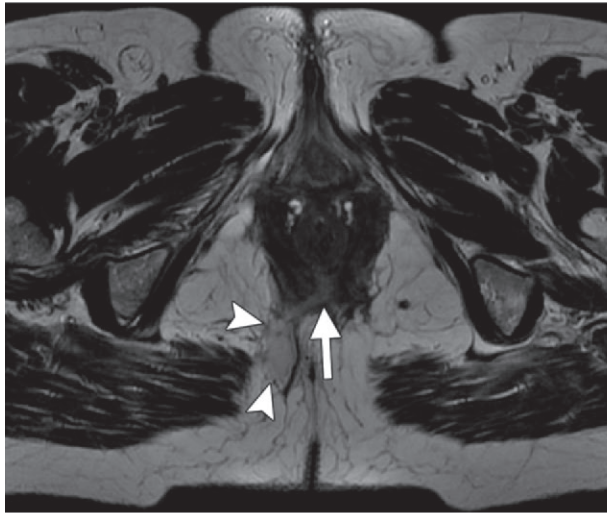
canal, at the level of the dentate line, which is best evaluated in the coronal plane (Figs 12, 13).

Grade 4: Transsphincteric Fistula with an Abscess or Secondary Track in the Ischiorectal or Ischioanal Fossa.—In a grade 4 fistula, the track crosses the external sphincter to reach the ischiorectal and ischioanal fossae, where it is complicated by an abscess or extension (Figs 14, 15).
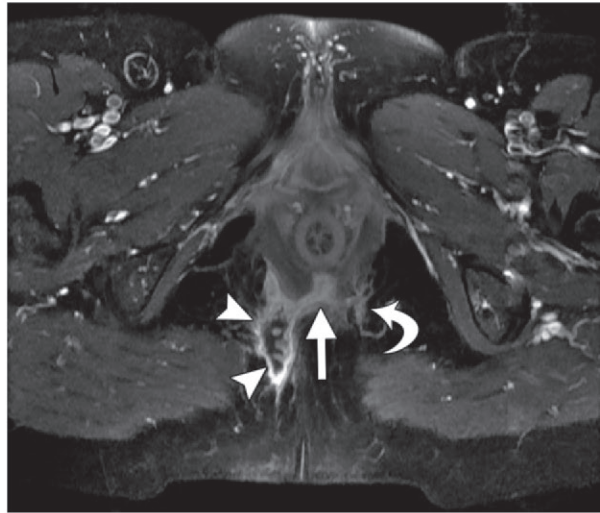
Figure 14. Grade 4: transsphincteric fistula with an abscess or secondary track in the ischiorectal or ischioanal fossa. **(a)** Axial drawing of the anal canal shows a posterior transsphincteric fistula with an abscess in the right ischiorectal fossa. **(b)** Axial T2-weighted MR image shows the transsphincteric fistula crossing the external sphincter at the 6-o'clock position (arrow) and a high-signal-intensity fluid collection in the right ischiorectal fossa (arrowheads). **(c)** Axial contrast-enhanced fat-suppressed T1-weighted MR image shows the posterior transsphincteric fistula (straight arrow), the abscess in the right ischiorectal fossa with nonenhancing pus in the cavity (arrowheads), and a secondary extension in the left ischiorectal fossa (curved arrow).

Figure 15. Grade 4: transsphincteric fistula with an abscess or secondary track in the ischiorectal or ischioanal fossa (same patient as in Fig 14). **(a)** Coronal drawing of the anal canal shows the transsphincteric fistula and the abscess in the right ischiorectal fossa. **(b)** Coronal contrast-enhanced fat-suppressed T1-weighted MR image shows the abscess in the right ischiorectal fossa with nonenhancing pus in the cavity (arrowheads) and the secondary extension in rhe left ischiorectal fossa (arrow).
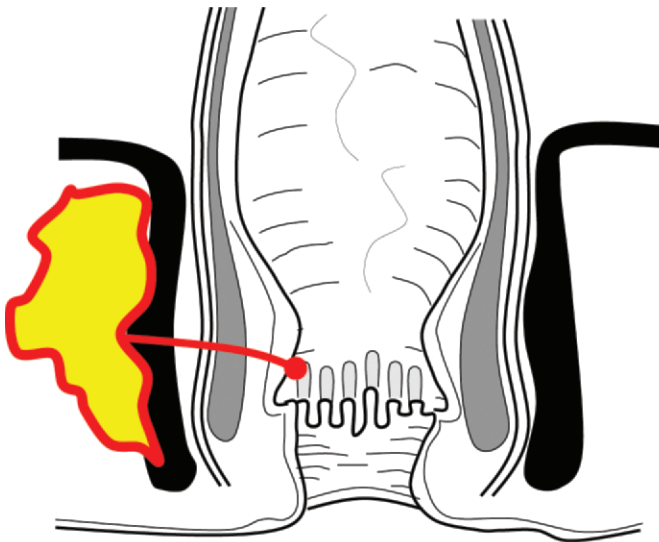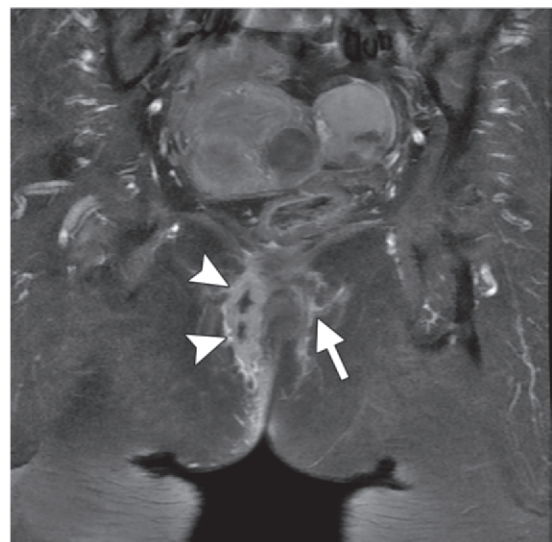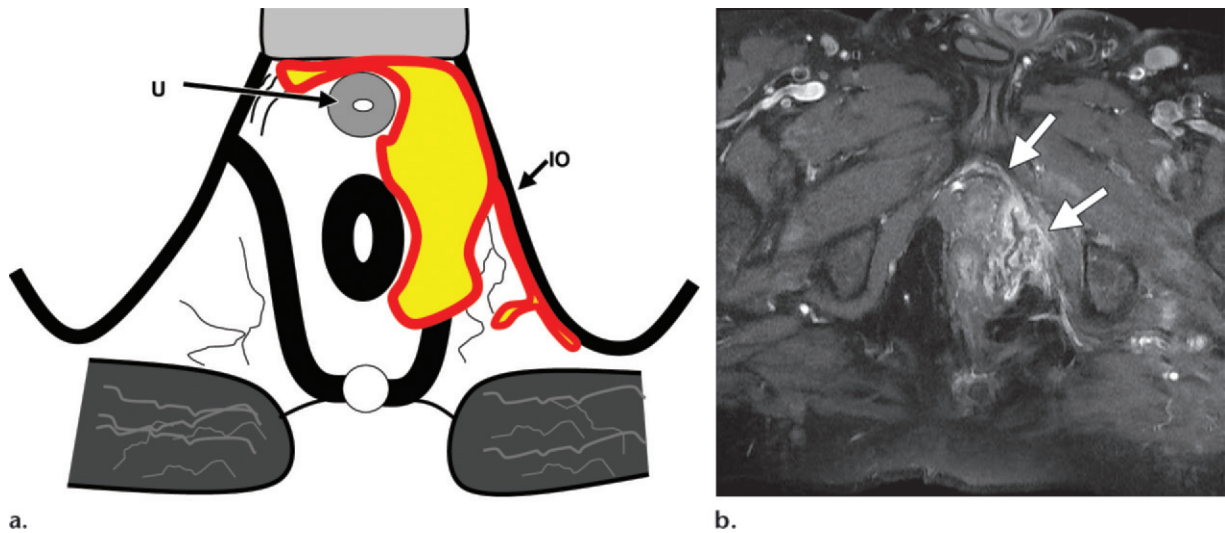
Figure 16. Grade 5: supralevator and translevator disease. **(a)** Axial drawing of the anal canal shows a supralevator abscess located at the urethra *(U)*, the left side of the anal canal, and the left internal obturator muscle *(IO)*. **(b)** Axial contrast-enhanced fat-suppressed T1-weighted MR image shows the left supralevator abscess with inflammatory changes in the left internal obturator muscle (arrows).

Figure 17. Grade 5: supralevator and translevator disease (same patient as in Fig 16). **(a)** Coronal drawing of the anal canal shows the left supralevator abscess with a left translevator fistula. **(b)** Coronal contrast-enhanced fat-suppressed T1-weighted MR image shows the left supralevator abscess with inflammatory changes surrounding the rectum and the left translevator fistula crossing the ischiorectal fossa (arrowheads).

Grade 5: Supralevator and Translevator Disease.—In rare cases, perianal fistulous disease extends above the insertion point of the levator ani muscle. As in the Parks classification, supralevator fistulas extend upward through the intersphincteric plane, pass over the top of the levator ani and puborectalis muscles, then descend through the ischiorectal and ischioanal fossae to reach the skin. In translevator disease, the fistulous track extends directly from its origin in the pelvis to the perineal skin through the ischiorectal and ischioanal fossae, with no involvement of the anal canal. These fistulas indicate the existence of primary pelvic disease with extension through the levator plate (Figs 16, 17).
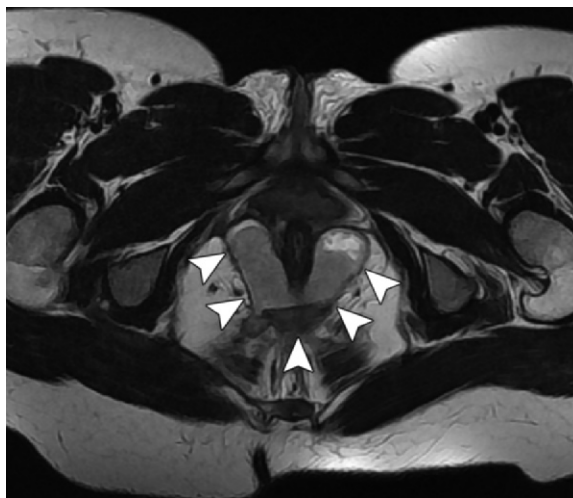
MR Imaging Appearance of Perianal Fistulas

During the past 2 years, we studied 188 patients who were referred for MR imaging by the surgical department at our institution. MR imaging was performed by using the Signa Excite 1.5-T system (GE Healthcare) with a phased-array coil and no patient preparation. Local infection of the anal gland without a fistulous track (anal cryptitis) was found in four patients, and six patients had a pilonidal sinus. Ultimately, we identified a total of 199 fistulas in 178 patients.

The fistulas were classified with the St James's University Hospital MR imaging–based grading system. Of the 178 patients, 44 (24.7%) had a grade 1 or simple linear intersphincteric fistula; 33 (18.5%) had a grade 2 or intersphincteric fistula with an abscess or secondary track; 43 (24.2%) had a grade 3 or transsphincteric fistula; 45 (25.3%) had a grade 4 or transsphincteric fistula with an abscess or secondary track in the ischiorectal or ischioanal fossa; and 13 (7.3%) had grade 5 or supralevator and translevator disease.

Among these patients, 18 had two or more fistulas. The most common fistulas in our study were grade 3 and grade 4, perhaps because the patients had a prolonged course and had responded poorly to medical treatment before undergoing surgery. This may also account for the small number of low-grade fistulas, as patients with grade 1 fistulas respond better to other treatments and therefore do not require MR imaging.

Characteristic MR imaging findings are obtained for perianal fistulas and abscesses with the different sequences of the protocol described in the Table. Unenhanced T1-weighted images provide an excellent anatomic overview of the sphincter complex, levator plate, and ischiorectal fossa. Fistulous tracks, inflammation, and abscesses 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. At immediate postoperative evaluation, hemorrhage produces high signal intensity on T1-weighted images and thus may be differentiated from the residual tracks.

T2-weighted images provide good contrast between the hyperintense fluid in the track and the hypointense fibrous wall of the fistula and allow adequate differentiation of the anatomic
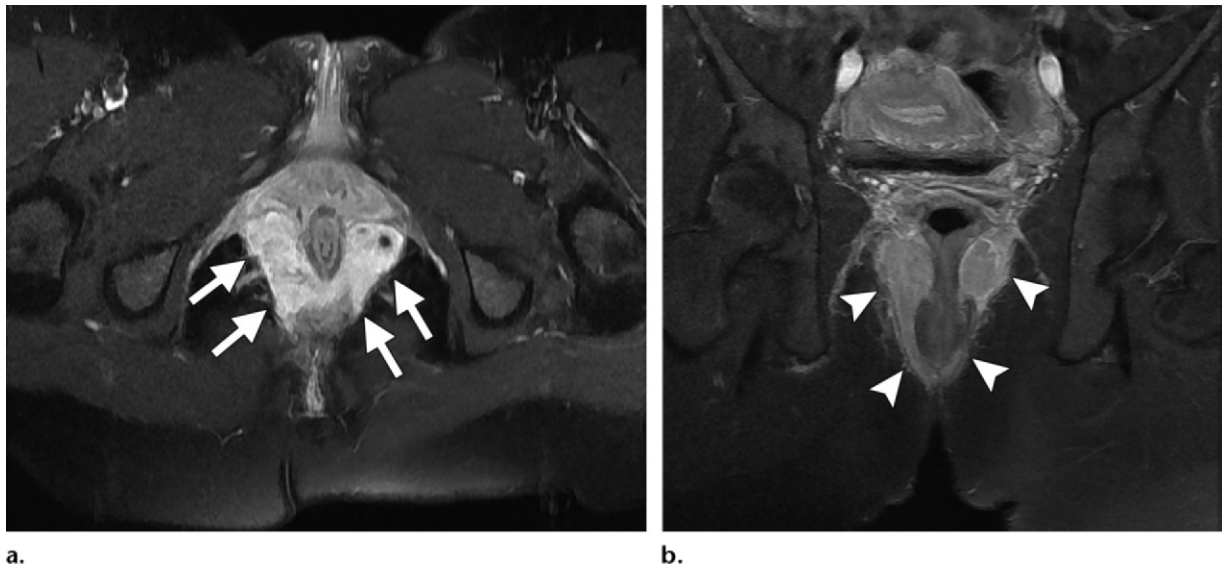

Figure 18. Horseshoe abscess. Axial T2-weighted MR image shows a horseshoe abscess with a fluid-fluid level in both ischiorectal fossae (arrowheads). The abscess has high signal intensity due to pus and a liquid-liquid level due to detritus.

boundaries between the internal and external sphincters. Active fistulous tracks and extensions have high signal intensity on T2-weighted images, while the sphincters and muscles have low signal intensity (Fig 18). Chronic fistulous tracks or scars appear as areas of low signal intensity on both T1- and T2-weighted images. Abscesses also have high signal intensity on T2-weighted images due to the presence of pus in the central cavity (Figs 10b, 14b, 18).

On gadolinium-enhanced fat-suppressed T1-weighted images, fistulous tracks and active granulation tissue demonstrate intense enhancement, while fluid in the track remains hypointense (Figs 9b, 13b). A possible cause of high signal intensity within the fistulous track on contrast-enhanced fat-suppressed T1-weighted images is hemorrhagic material from recent surgical intervention; however, this finding does not represent contrast enhancement. Unenhanced T1-weighted images may be helpful in differentiation between hemorrhagic material and active granulation tissue, with high signal intensity in the track being due to hemorrhage and low signal intensity being due to fluid or pus (36).

On contrast-enhanced fat-suppressed T1-weighted images, abscesses demonstrate a central area of low signal intensity due to pus that is surrounded by intense ring enhancement (Figs 14c, 15b, 16b, 19). Normal anorectal structures

a.   **b.**

Figure 19.   Horseshoe abscess (same patient as in Fig 18). Axial **(a)** and coronal **(b)** contrast-enhanced fat-suppressed T1-weighted MR images show a horseshoe abscess in the ischiorectal and ischioanal fossae (arrows in **a,** arrowheads in **b**). The abscess has intense enhancement due to the presence of active inflammatory tissue.

do not enhance substantially, except for the internal anal sphincter and blood vessels, including hemorrhoidal vessels, which should not be confused with fistulous tracks or fluid collections. Chronic fistulas and scar tissue do not enhance with gadolinium contrast material. At contrast-enhanced fat-suppressed T1-weighted imaging, we can clearly define a fistula as well as its extensions and its relationship to the anal canal, particularly to the external sphincter. It is relatively easy to determine whether a fistula is contained within the external sphincter or has extended beyond it (36,48).

Fibrotic fistula tracks appear as linear structures of low signal intensity on T1- and T2-weighted images with no enhancement after administration of contrast material (26).

Usefulness of MR Imaging in Management of Perianal Fistulas

MR imaging has a critical role in helping determine the proper treatment of perianal fistulas because treatment strategies must be individualized according to the type of perianal fistula and the degree of involvement of surrounding pelvic structures.

Clinical examination can often be difficult because of induration and inflammation in patients with anal sepsis. Previous fistula surgery, the complexity of the fistula track, lack of identifica-

tion of the internal fistulous opening, wrongly diagnosed primary tracks, and missed secondary tracks have been identified as independent risk factors associated with a poor outcome after surgery (50).

At MR imaging, identification and localization of the entire cryptoglandular fistula, including the external opening, the primary track, secondary tracks, abscesses, and the internal opening, are essential for fistula classification and treatment. Inadequate assessment of the fistula may result in a simple fistula developing into a complex fistula, and failure to recognize secondary extensions can result in recurrent sepsis and an unnecessarily protracted clinical course.

To preserve continence, accurate presurgical definition of the relationship of the fistulous track to the anal sphincters is of great importance before performance of any sphincter-interrupting procedure. The information obtained with MR imaging appears to be a more powerful predictor of postoperative outcome than the information gained from surgical exploration (31,50).

The grades of perianal fistulas in the MR imaging–based classification demonstrate significant correlation with patient outcome, and there is a significant difference between the MR imaging–based grades of perianal fistulas in

terms of satisfactory or unsatisfactory outcome. Classification of perianal fistulas is also important because treatment differs between different types of fistulous tracks (31). Simple submucosal, intersphincteric, or low transsphincteric tracks affecting the distal third of the anal canal can be treated with fistulotomy without a significant effect on continence. In cases of higher or complex fistulas, retention of continence is a problem.

For eradication of sepsis, it is often necessary to divide the external sphincter by excision or incision of the fistulous track. The treatment of perianal abscesses due to either crytoglandular disease or Crohn disease simply consists of incision and drainage. Fecal deviating colostomy is reserved for patients with uncontrollable extensive perianal fistulous disease and severe clinical symptoms, which are usually associated with proctitis due to Crohn disease (51).

To try to preserve continence, there are multiple therapeutic options that do not involve division of the anal sphincter complex, particularly for initial treatment attempts. A seton is a thread that is placed through the fistulous track in place of performing incision of the fistula to provide drainage. Setons may be placed to allow continuous drainage and can be used as a primary treatment or as temporary therapy to reduce the severity of the fistula. Use of fibrin plugs and use of glue to achieve track closure are newer treatment options (52).

For patients with Crohn disease–related fistulas, the usual first-line therapy is antibiotics, although recurrence after discontinuation is common. Purine analogs (azathioprine, 6-mercaptopurine) are effective in treatment and maintaining remission. Anti–tumor necrosis factor (TNF) antibodies (infliximab) have been introduced with good clinical results. MR imaging also plays an important role in evaluation of the response to medical therapies.

MR imaging has been used in monitoring the response of fistulous tracks to medical treatment in patients with Crohn disease, including evaluating the response of perianal Crohn disease to infliximab therapy and determining the extent of obliteration of fistula tracks in patients treated with instillation of fibrin sealant (52–55). MR imaging demonstrates that skin healing may not be an appropriate determinant of outcome in patients with fistulous disease treated with infliximab. Despite closure of draining external orifices after infliximab therapy, fistula tracks persist with varying degrees of residual inflammation, which may cause recurrent fistulas and pelvic abscesses (55).

In patients with Crohn disease, MR imaging has proved to be a suitable technique for evaluation of perianal fistulas treated with infliximab during the 1st year of follow-up. During long-term follow-up, the improvements observed at MR imaging correlate with the clinical and endoscopic response to infliximab in only 50% of patients (54).

Finally, MR imaging–guided surgery of anal fistulas is feasible. Preoperative and intraoperative MR imaging techniques can be used to identify extension of the fistula track and septic foci and ensure the adequacy of the surgical procedure. Use of MR imaging can thus prevent incomplete procedures and the necessity for second surgeries. MR imaging may become particularly useful in surgery of recurrent or complex anal fistulas and may lead to fewer recurrences (56).

Conclusions

MR imaging has emerged as the imaging technique of choice for preoperative evaluation of perianal fistulas, providing a highly accurate, rapid, and noninvasive means of performing presurgical assessment. MR imaging provides precise definition of the fistulous track, along with its relationship to pelvic structures, and allows identification of secondary fistulas or abscesses. Accordingly, MR imaging provides accurate information for appropriate surgical treatment, decreasing the incidence of recurrence and allowing side effects such as fecal incontinence to be avoided.

Radiologists should be familiar with the anatomic and pathologic findings of perianal fistulas and classify them using the St James's University Hospital MR imaging–based grading system. In this way, appropriate surgical management can be planned and recurrences can be prevented.

References

1. Sainio P. Fistula-in-ano in a defined population: incidence and epidemiological aspects. Ann Chir Gynaecol 1984;73(4):219–224.
2. Lilius HG. Fistula-in-ano, an investigation of human foetal anal ducts and intramuscular glands and a clinical study of 150 patients. Acta Chir Scand Suppl 1968;383:7–88.
3. Seow-Choen, Phillips RK. Insights gained from the management of problematical anal fistulae at St. Mark's Hospital, 1984-88. Br J Surg 1991;78(5): 539–541.
4. Beckingham IJ, Spencer JA, Ward J, Dyke GW, Adams C, Ambrose NS. Prospective evaluation of dynamic contrast enhanced magnetic resonance imaging in the evaluation of fistula in ano. Br J Surg 1996;83(10):1396–1398.

5. Buchanan G, Halligan S, Williams A, et al. Effect of MRI on clinical outcome of recurrent fistula-in-ano. Lancet 2002;360(9346):1661–1662.

6. Milligan ET, Morgan CN. Surgical anatomy of the anal canal: with special reference to anorectal fistula. Lancet 1934;224(5804):1150–1156.

7. Woodburne RT. Essentials of human anatomy. 7th ed. Oxford, England: Oxford University Press, 1983.

8. Eisenhammer S. A new approach to the anorectal fistulous abscess based on the high intermuscular lesion. Surg Gynecol Obstet 1958;106(5):595–599.

9. Lunniss PJ, Phillips RK. Anatomy and function of the anal longitudinal muscle. Br J Surg 1992;79(9): 882–884.

10. Parks AG. Pathogenesis and treatment of fistula-in-ano. BMJ 1961;1(5224):463–469.

11. Chiari H. Uber die nalen divertikel der rectumshleimhaut undo ihre beziehung zu den anal fisteln. Wien Med Press 1878;19:1482–1483.

12. McColl I. The comparative anatomy and pathology of anal glands. Arris and Gale lecture delivered at the Royal College of Surgeons of England on 25th February 1965. Ann R Coll Surg Engl 1967;40(1): 36–67.

13. Practice parameters for treatment of fistula-in-ano: supporting documentation. The Standards Practice Task Force. The American Society of Colon and Rectal Surgeons. Dis Colon Rectum 1996;39(12): 1363–1372.

14. Kuijpers HC, Schulpen T. Fistulography for fistula-in-ano: is it useful? Dis Colon Rectum 1985;28(2): 103–104.

15. Halligan S, Stoker J. Imaging of fistula in ano. Radiology 2006;239(1):18–33.

16. Guillaumin E, Jeffrey RB Jr, Shea WJ, Asling CW, Goldberg HI. Perirectal inflammatory disease: CT findings. Radiology 1986;161(1):153–157.

17. Yousem DM, Fishman EK, Jones B. Crohn disease: perirectal and perianal findings at CT. Radiology 1988;167(2):331–334.

18. Law PJ, Bartram CI. Anal endosonography: technique and normal anatomy. Gastrointest Radiol 1989;14(4):349–353.

19. Van Outryve M, Pelckmans P, Fierens H, Van Maercke Y. Transrectal ultrasonographic examination of the anal sphincter. Acta Gastroenterol Belg 1994;57(1):26–27.

20. Van Outryve MJ, Pelckmans PA, Michielsen PP, Van Maercke YM. Value of transrectal ultrasonography in Crohn's disease. Gastroenterology 1991;101(5): 1171–1177.

21. Buchanan GN, Halligan S, Bartram CI, Williams AB, Tarroni D, Cohen CR. Clinical examination, endosonography, and MR imaging in preoperative assessment of fistula in ano: comparison with outcome-based reference standard. Radiology 2004; 233(3):674–681.

22. Lunniss PJ, Armstrong P, Barker PG, Reznek RH, Phillips RK. Magnetic resonance imaging of anal fistulae. Lancet 1992;340(8816):394–396.

23. Lunniss PJ, Barker PG, Sultan AH, et al. Magnetic resonance imaging of fistula-in-ano. Dis Colon Rectum 1994;37(7):708–718.

24. Beets-Tan RG, Beets GL, van der Hoop AG, et al. Preoperative MR imaging of anal fistulas: does it really help the surgeon? Radiology 2001;218(1): 75–84.

25. Sahni VA, Ahmad R, Burling D. Which method is best for imaging of perianal fistula? Abdom Imaging 2008;33(1):26–30.

26. Bartram C, Buchanan G. Imaging anal fistula. Radiol Clin North Am 2003;41(2):443–457.

27. deSouza NM, Puni R, Gilderdale DJ, Bydder GM. Magnetic resonance imaging of the anal sphincter using an internal coil. Magn Reson Q 1995;11(1): 45–56.

28. Halligan S, Bartram CI. MR imaging of fistula in ano: are endoanal coils the gold standard? AJR Am J Roentgenol 1998;171(2):407–412.

29. deSouza NM, Gilderdale DJ, Coutts GA, Puni R, Steiner RE. MRI of fistula-in-ano: a comparison of endoanal coil with external phased array coil techniques. J Comput Assist Tomogr 1998;22(3): 357–363.

30. Halligan S, Buchanan G. MR imaging of fistula-in-ano. Eur J Radiol 2003;47(2):98–107.

31. Spencer JA, Chapple K, Wilson D, Ward J, Windsor AC, Ambrose NS. Outcome after surgery for perianal fistula: predictive value of MR imaging. AJR Am J Roentgenol 1998;171(2):403–406.

32. Ziech M, Felt-Bersma R, Stoker J. Imaging of perianal fistulas. Clin Gastroenterol Hepatol 2009;7 (10):1037–1045.

33. Barker PG, Lunniss PJ, Armstrong P, Reznek RH, Cottam K, Phillips RK. Magnetic resonance imaging of fistula-in-ano: technique, interpretation and accuracy. Clin Radiol 1994;49(1):7–13.

34. Delfaut EM, Beltran J, Johnson G, Rousseau J, Marchandise X, Cotten A. Fat suppression in MR imaging: techniques and pitfalls. RadioGraphics 1999;19(2):373–382.

35. Haggett PJ, Moore NR, Shearman JD, Travis SP, Jewell DP, Mortensen NJ. Pelvic and perineal complications of Crohn's disease: assessment using magnetic resonance imaging. Gut 1995;36(3): 407–410.

36. Spencer JA, Ward J, Beckingham IJ, Adams C, Ambrose NS. Dynamic contrast-enhanced MR imaging of perianal fistulas. AJR Am J Roentgenol 1996;167 (3):735–741.

37. Haramati N, Penrod B, Staron RB, Barax CN. Surgical sutures: MR artifacts and sequence dependence. J Magn Reson Imaging 1994;4(2):209–211.

38. Yang RK, Roth CG, Ward RJ, deJesus JO, Mitchell DG. Optimizing abdominal MR imaging: approaches to common problems. RadioGraphics 2010;30(1):185–199.

39. Viano AM, Gronemeyer SA, Haliloglu M, Hoffer FA. Improved MR imaging for patients with metallic implants. Magn Reson Imaging 2000;18(3): 287–295.

40. Kim H, Lim JS, Choi JY, et al. Rectal cancer: comparison of accuracy of local-regional staging with two- and three-dimensional preoperative 3-T MR imaging. Radiology 2010;254(2):485–492.

41. Lichy MP, Wietek BM, Mugler JP 3rd, et al. Magnetic resonance imaging of the body trunk using a single-slab, 3-dimensional, T2-weighted turbo-spin-echo sequence with high sampling efficiency (SPACE) for high spatial resolution imaging: initial clinical experiences. Invest Radiol 2005;40(12): 754–760.

42. Proscia N, Jaffe TA, Neville AM, Wang CL, Dale BM, Merkle EM. MRI of the pelvis in women: 3D versus 2D T2-weighted technique. AJR Am J Roentgenol 2010;195(1):254–259.

43. Schaefer O, Lohrmann C, Langer M. Assessment of anal fistulas with high-resolution subtraction MR-fistulography: comparison with surgical findings. J Magn Reson Imaging 2004;19(1):91–98.

44. Hori M, Oto A, Orrin S, Suzuki K, Baron RL. Diffusion-weighted MRI: a new tool for the diagnosis of fistula in ano. J Magn Reson Imaging 2009;30(5):1021–1026.

45. Horsthuis K, Lavini C, Bipat S, Stokkers PC, Stoker J. Perianal Crohn disease: evaluation of dynamic contrast-enhanced MR imaging as an indicator of disease activity. Radiology 2009;251(2):380–387.

46. Barth MM, Smith MP, Pedrosa I, Lenkinski RE, Rofsky NM. Body MR imaging at 3.0 T: understanding the opportunities and challenges. RadioGraphics 2007;27(5):1445–1462; discussion 1462–1464.

47. Chang KJ, Kamel IR, Macura KJ, Bluemke DA. 3.0-T MR imaging of the abdomen: comparison with 1.5 T. RadioGraphics 2008;28(7):1983–1998.

48. Morris J, Spencer JA, Ambrose NS. MR imaging classification of perianal fistulas and its implications for patient management. RadioGraphics 2000;20(3):623–635; discussion 635–637.

49. Parks AG, Gordon PH, Hardcastle JD. A classification of fistula-in-ano. Br J Surg 1976;63(1):1–12.

50. Chapple KS, Spencer JA, Windsor AC, Wilson D, Ward J, Ambrose NS. Prognostic value of magnetic resonance imaging in the management of fistula-in-ano. Dis Colon Rectum 2000;43(4):511–516.

51. Hussain SM, Outwater EK, Joekes EC, et al. Clinical and MR imaging features of cryptoglandular and Crohn's fistulas and abscesses. Abdom Imaging 2000;25(1):67–74.

52. Buchanan GN, Bartram CI, Phillips RK, et al. Efficacy of fibrin sealant in the management of complex anal fistula: a prospective trial. Dis Colon Rectum 2003;46(9):1167–1174.

53. Bell SJ, Halligan S, Windsor AC, Williams AB, Wiesel P, Kamm MA. Response of fistulating Crohn's disease to infliximab treatment assessed by magnetic resonance imaging. Aliment Pharmacol Ther 2003;17(3):387–393.

54. Karmiris K, Bielen D, Vanbeckevoort D, et al. Long-term monitoring of infliximab therapy for perianal fistulizing Crohn's disease by using magnetic resonance imaging. Clin Gastroenterol Hepatol 2011;9(2):130–136.

55. Van Assche G, Vanbeckevoort D, Bielen D, et al. Magnetic resonance imaging of the effects of infliximab on perianal fistulizing Crohn's disease. Am J Gastroenterol 2003;98(2):332–339.

56. Gould SW, Martin S, Agarwal T, Patel B, Gedroyc W, Darzi A. Image-guided surgery for anal fistula in a 0.5T interventional MRI unit. J Magn Reson Imaging 2002;16(3):267–276.

MR Imaging Evaluation of Perianal Fistulas: Spectrum of Imaging Features

Jaime de Miguel Criado, MD • Laura García del Salto, MD • Patricia Fraga Rivas, MD • Luis Felipe Aguilera del Hoyo, MD • Leticia Gutiérrez Velasco, MD • M. Isabel Díez Pérez de las Vacas, MD • Ana G. Marco Sanz, MD Marcos Manzano Paradela, MD • Eduardo Fraile Moreno, MD, PhD

RadioGraphics (side banner)

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The importance of MR imaging in this context lies in its ability to demonstrate hidden areas of sepsis and secondary extensions, both of which contribute to the high rate of recurrence after surgery (3). Furthermore, MR imaging can be used to define the anatomic relationships of the fistula to predict the likelihood of postoperative fecal incontinence.

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An important advantage of MR imaging in fistula evaluation is the ability to study the anal sphincter complex in any surgically relevant plane. For this reason, it is critical that imaging planes are correctly aligned with respect to the anal canal. The anal canal is tilted forward from the vertical by approximately 45° in the sagittal plane; thus, straight axial and coronal images will not allow correct evaluation of the source and the fistulous track. Therefore, it is necessary to obtain oblique axial and coronal images oriented orthogonal and parallel to the anal canal, respectively.

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Anal fistulas are classified according to their progression relative to the anal sphincter and pelvic floor structures. To characterize a perianal fistula, it is essential to adequately describe the point of origin in the anal canal and the path of the fistula with respect to the pelvic anatomic boundaries. To locate the point of origin and describe the direction of the fistulous track, we use an "anal clock" scheme, which is the same as that used by surgeons to describe injuries around the anal region (Fig 6).

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Fistulas may be classified according to the route taken by the main track running from the anal canal to the skin. Any anatomic system of classification of perianal fistulas must be based on the relationship between the primary track and the anal sphincter muscles, particularly since current treatment involves sectioning of these structures, the preservation of which is essential to maintain rectal continence, especially in reference to the external sphincter and puborectalis muscle.

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Because relevant MR imaging findings are not included in the Parks classification, an MR imaging–based classification was proposed that relates the Parks surgical classification to anatomic MR imaging findings in the axial and coronal planes. The St James's University Hospital classification was proposed by radiologists on the basis of imaging findings and does not represent an official surgical reference (48). In fact, the main role of radiologists in evaluation of perianal fistulas is to be descriptive and accurate in their reports, as details will be essential in future decisions about medical or surgical treatment.

This classification is simple to apply because it uses anatomic landmarks in the axial plane familiar to radiologists. Furthermore, the classification considers the primary fistulous track as well as secondary extensions and abscesses in evaluating and classifying fistulas.