Rectal Imaging: Part 2, Perianal Fistula Evaluation on Pelvic MRI—What the Radiologist Needs to Know

**OBJECTIVE.** The purpose of this article is to provide an overview of pelvic MRI for the evaluation of perianal fistulas, with a description of the technique, illustration of relevant normal anatomy, and examples of various fistula types.

**CONCLUSION.** MRI evaluation of perianal fistulas can be challenging, and knowledge of relevant pelvic anatomy and fistula classification remains crucial in the diagnosis. MRI is highly accurate for fistula depiction and, by providing an accurate assessment of disease status and extension, can help surgical planning to minimize recurrence and detect clinically unapparent disease.

**Interpretation of perianal fistula MRI requires knowledge of relevant pelvic anatomy, pathophysiology, and classification of fistula types, and its implication for therapy.**

Incomplete treatment due to deep extension and involvement of the anal and pelvic musculature and perianal spaces can lead to significant morbidity. Pelvic MRI offers the ability to obtain high-spatial-resolution images and multiplanar capabilities, offering exquisite details of the pelvis, making it the preferable imaging modality for detection and assessment of perianal fistulas.

**Anatomy**

Knowledge of the anatomy of the anal sphincter complex and surrounding spaces is crucial for image interpretation (Figs. 1 and 2). The anal canal extends from the levator ani muscle cranially to the anal verge caudally and is surrounded by the internal and external anal sphincters. The internal sphincter is the inferior extension of the inner circular smooth muscle of the rectum and is primarily responsible for resting involuntary anal continence [1]. The external sphincter is composed of striated skeletal muscle, which is contiguous with both the levator ani and puborectalis muscles superiorly and is primarily responsible for voluntary continence. As such, injury to the external sphincter during surgery (e.g., episiotomy) can lead to fecal incontinence. The internal and external sphincters are separated by the intersphincteric space, which is composed of loose fat-containing areolar tissue. Surrounding the anal canal, superficial to the sphincter complex and inferior to the puborectalis, are two contiguous pyramidal fat-containing spaces known as the ischiorectal space cranially and the ischioanal space caudally.

**Pathophysiology**

The mucosal surface of the proximal anal canal is lined by a series of longitudinal mucosal columns, known as the columns of Morgagni [2]. The spaces between the columns are known as the anal sinuses (or crypts of Morgagni), which receive drainage from the anal glands. Distally, the columns are connected to each other circumferentially by small anal valves, which collectively form the dentate line. Up to 90% of perianal fistulas are believed to arise secondary to impaired drainage of the anal glands, according to the “cryptoglandular hypothesis” [3, 4]. Infection and anal gland drainage obstruction may lead to an acute perianal abscess. Some abscesses may resolve spontaneously via internal drainage into the anal canal, whereas others may require surgical incision and drainage [5]. Abscesses that are inadequately or incompletely drained will persist and may ultimately seek additional drainage pathways through the intersphincteric space or across the sphincter complex and, in the process, create fistulous tracts. As such, perianal abscess and perianal fistula are thought to be...
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acute and chronic manifestations of the same disease process, and as many as 87% of patients with acute perianal abscess may subsequently develop a fistula [6, 7].

The remaining 10% of cases result from other causes, such as Crohn disease, tuberculosis, diverticulitis, pelvic infection, trauma, anorectal cancer, or radiation therapy. Perianal fistulas frequently complicate Crohn disease, with a cumulative incidence of up to 26% after 20 years [8], and are more likely to be encountered in radiologic practice because of their complexity and propensity for incomplete response to therapy and recurrence.

**Therapy**

Management of idiopathic perianal fistulas is primarily surgical and involves a fistulotomy or fistulectomy of the tracts, combined with drainage of associated sites of infection [6]. To maximize success, the surgeon must assess the relationship of the fistula to the sphincter complex to best preserve anal continence and to identify secondary tracts or abscesses, which, when untreated, are the primary source of recurrence [9].

Management of perianal fistula in patients with Crohn disease frequently requires a combination of medical and surgical therapy [10]. MRI has been shown to accurately depict the extent of disease at initial presentation and reveals clinically occult features [6], which helps reduce recurrence and prevent undesirable outcomes that may result from either underappreciation of the extent and complexity of disease or unnecessarily aggressive surgery [2].

**MRI Evaluation of Perianal Fistulas**

MRI is highly accurate for depiction of both the primary tract (sensitivity, 100%; specificity, 86%) and abscesses (sensitivity, 96%; specificity, 97%) [11]. Both 1.5- and 3-T MRI systems can be used to obtain high-resolution images of the pelvis. More recently, there has been more interest in the applications of 3-T systems in abdominal imaging secondary to its ability to offer increased signal-to-noise ratio at the higher field strength, even at higher matrix [12, 13]. The increased signal-to-noise ratio can be used either to shorten acquisition time or to achieve higher spatial resolution, or both, which may lead to improving image quality and clinical diagnosis as compared with the 1.5-T systems [14, 15]. It should be noted that several modifications in the examination protocols may be required when interpolating from the 1.5- to 3-T systems, with optimized imaging parameters and sequence designs to address commonly encountered problems in 3-T systems, such as increased susceptibility, B1 field inhomogeneity, and increased specific absorption rate [13].

Compared with endorectal ultrasound, MRI offers a wider FOV and is more suited for assessment of complex branching tracts, lateral extension into the perianal spaces, and cranial extension above the levator ani. MRI has also been shown to be better than surgical exploration in predicting outcome [16].

**MRI Technique**

The pelvic MRI protocol for perianal fistula evaluation (Table 1) consists of T1-weighted and high-spatial-resolution T2-weighted imaging sequences without fat saturation for delineation of the muscle groups, fat planes, and the fistula tract. T2-weighted imaging with fat suppression (and STIR) is used to assess edema and fluid-containing tracts and cavities, whereas fat-suppressed T1-weighted unenhanced and contrast-enhanced sequences are used to assess the presence and degree of inflammation. Diffusion-weighted imaging has been shown to increase the radiologist’s level of confidence and to add value to fat-suppressed T2-weighted and gadolinium-enhanced imaging in the diagnosis of anal fistulae. It may be used as an adjunct to T2-weighted imaging, especially for patients who have risk factors for IV contrast agents [17].

**Fistula Classification**

Initial classification of perianal fistulas was based on surgical anatomy described by Parks et al. [18]. Morris et al. [19] subsequently modified the classification system on the basis of radiologic anatomy on pelvic MRI. The pelvic MRI protocol for perianal fistula evaluation (Table 1) consists of T1-weighted and high-spatial-resolution T2-weighted imaging sequences without fat saturation for delineation of the muscle groups, fat planes, and the fistula tract. T2-weighted imaging with fat suppression (and STIR) is used to assess edema and fluid-containing tracts and cavities, whereas fat-suppressed T1-weighted unenhanced and contrast-enhanced sequences are used to assess the presence and degree of inflammation. Diffusion-weighted imaging has been shown to increase the radiologist’s level of confidence and to add value to fat-suppressed T2-weighted and gadolinium-enhanced imaging in the diagnosis of anal fistulae. It may be used as an adjunct to T2-weighted imaging, especially for patients who have risk factors for IV contrast agents [17].

**TABLE 1: Pelvic MRI Protocols for Perianal Fistula Evaluation**

<table>
<thead>
<tr>
<th>Sequences and Slice Orientation</th>
<th>No. of Signal Averages</th>
<th>FOV (mm)</th>
<th>Imaging Plane Direction</th>
<th>Acquired Matrix (Frequency × Phase)</th>
<th>Slice Thickness (mm)</th>
<th>TR/TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal single-shot turbo spin-echo (fast spin-echo) (localizer)</td>
<td>2</td>
<td>340 × 380</td>
<td>Right-left × foot-head</td>
<td>316 × 247</td>
<td>5, no gap</td>
<td>3000–5000/180</td>
</tr>
<tr>
<td>Axial high-resolution T2-weighted turbo spin-echo (fast spin-echo)</td>
<td>2</td>
<td>360 × 340</td>
<td>Right-left × anterior-posterior</td>
<td>800 × 759</td>
<td>4, no gap</td>
<td>3000–5000/80</td>
</tr>
<tr>
<td>Sagittal T2-weighted turbo spin-echo (fast spin-echo) with fat suppression</td>
<td>3</td>
<td>200 × 200</td>
<td>Foot-head × anterior-posterior</td>
<td>400 × 233</td>
<td>6, no gap</td>
<td>3000–5000/80</td>
</tr>
<tr>
<td>Axial T2-weighted turbo spin-echo (fast spin-echo) with fat suppression</td>
<td>4</td>
<td>200 × 160</td>
<td>Right-left × anterior-posterior</td>
<td>256 × 133</td>
<td>4, no gap</td>
<td>3000–5000/80</td>
</tr>
<tr>
<td>Axial STIR (optional)</td>
<td>1</td>
<td>200 × 160</td>
<td>Right-left × anterior-posterior</td>
<td>256 × 149</td>
<td>4, no gap</td>
<td>2500–6000/30</td>
</tr>
<tr>
<td>Axial T1-weighted turbo spin-echo (fast spin-echo)</td>
<td>2</td>
<td>200 × 160</td>
<td>Right-left × anterior-posterior</td>
<td>400 × 226</td>
<td>4, no gap</td>
<td>500–800/11</td>
</tr>
<tr>
<td>Axial T1-weighted 3D gradient-recalled echo with fat suppression with and without IV contrast agent</td>
<td>4</td>
<td>200 × 160</td>
<td>Right-left × anterior-posterior</td>
<td>224 × 178</td>
<td>1.8</td>
<td>3.6/1.8</td>
</tr>
<tr>
<td>Sagittal 3D gradient-recalled echo with fat suppression</td>
<td>4</td>
<td>200 × 160</td>
<td>Foot-head × anterior-posterior</td>
<td>224 × 178</td>
<td>1.8</td>
<td>3.6/1.8</td>
</tr>
<tr>
<td>Coronal 3D gradient-recalled echo with fat suppression (optional)</td>
<td>3</td>
<td>200 × 200</td>
<td>Foot-head × right-left</td>
<td>224 × 222</td>
<td>1.8</td>
<td>3.6/1.8</td>
</tr>
</tbody>
</table>

Note—All parameters presented are taken from protocol designed for a 3-T scanner.
MRI of Perianal Fistula

MRI, which is known as the St. James’ University Hospital Classification and has been widely adopted since (Fig. 3). Both classification schemes rely on the relationship of the fistula tract to the sphincter complex, integrity of the external anal sphincter, the presence of secondary tracts or abscesses, and cranial extension into the pelvis. The St. James’ University Hospital MRI classification of perianal fistula is divided as described in the following subsections.

Grade 1: Simple Linear Intersphincteric Fistula

A grade 1 fistula arises from the anal canal, penetrates the internal anal sphincter, and extends caudally through the intersphincteric space to its cutaneous opening (Fig. 4). There are no secondary tracts, cranial extension above the levator ani, or associated abscess. The tracts are confined by the external sphincter with no disruption of the external sphincter.

Grade 2: Intersphincteric Fistula With Intersphincteric Abscess or Secondary Fistulous Tract

Grade 2 consists of an intersphincteric fistula with associated abscess or secondary tract (Fig. 5). Similar to grade 1, the primary tract, secondary tract, or abscess cavity all lie within the intersphincteric space, confined by the external sphincter. The “horse-shoe” fistula subtype has a secondary tract that crosses the midline and surrounds both sides of the internal sphincter.

Grade 3: Transspincteric Fistula

A grade 3 fistula arises from the anal canal, penetrates both the internal and external anal sphincters, and extends through the ischiorectal or ischioanal fossae in its path-way to its cutaneous opening (Fig. 6). There is no associated secondary tract, abscess, or extension cranial to the levator ani.

Grade 4: Transspincteric Fistula With Abscess or Secondary Tract Within the Ischioanal or Ischiorectal Fossa

A grade 4 fistula consists of a transspincteric fistula complicated by secondary tracts or abscesses (Fig. 7). The abscess may occur anywhere along the primary tract, secondary tracts, or within the ischioanal or ischiorectal fossae, but not above the levator ani.

Grade 5: Supralevator and Translevator Disease

Grade 5 fistulas encompass a variety of complex tracts characterized by their extension above the levator ani that can be extrasphincteric and suprasphincteric (Fig. 8). Suprasphincteric fistulas arise from the anal canal, penetrate the internal sphincter, and then ascend within the intersphincteric space into the sublevator space. The fistula then pierces the levator ani as it descends through the ischiofascial fossa en route to its cutaneous opening. Extrasphincteric fistulas are a separate entity caused by primary pelvic disease (e.g., Crohn disease, diverticulitis, or carcinoma) that extends caudally through the levator plate, traverses the ischiorectal fossa, and terminates at the cutaneous opening. Most importantly, an extrasphincteric fistula does not involve the internal or external anal sphincters.

Others (Not Specifically Described in the Parks or St. James’ Classification)

Submucosal fistulas are superficial tracts that arise inferiorly from the anal canal and extend to the skin surface without involving the internal or external anal sphincters [20]. Superficial tracts without an internal opening or communication with the anal canal are classified as sinus tracts [2] (Fig. 9).

MRI Interpretation

Interpretation of pelvic MRI in patients with suspected or known perianal fistula is discussed in the following subsections [2, 19].

Fistula Detection and Tract Activity

Active fistula tract appears as a hypointense linear structure on T1-weighted imaging and hyperintense on T2-weighted imaging (best visualized with fat saturation) relative to muscle and enhances with IV contrast agent. Granulation tissue with increased vascularity is thought to account for the T2-weighted imaging hyperintensity and contrast enhancement [6]. Inactive tracts are also hypointense on T1-weighted imaging but lack the associated T2-weighted imaging hyperintensity and contrast enhancement. Tissues surrounding the tract may also show hyperintensity on T2-weighted imaging if there is edema or inflammation. MRI can be used to assess treatment response, as suggested by Savoye-Collet et al. [21]. The authors suggested that a loss of T2-weighted imaging hyperintense signal precedes lack of enhancement and proposed a predictable stepwise response to therapy, first as reduced pus production and then as diminished inflammation within the fistula. These stepwise changes also correlated well with clinical response, suggesting that MRI follow-up may be used to guide therapy. Additionally, deep-tissue healing, as visualized by MRI, typically takes longer than the superficial healing that is apparent by clinical examination, thus offering better assessment of residual or incompletely treated disease [22]. In patients with prior surgery, it is important to note the associated findings, such as fat packing (hyperintense on T1-weighted imaging); surgical drains, particularly setons (linear low signal on T1- and T2-weighted imaging); and gas foci (focal low signal intensity on T1- and T2-weighted imaging).

Tract Course

Once a fistula tract is detected, its relationship to the sphincter complex and location of the internal and external openings should be described by the radiologist interpreting the MRI examination. The internal opening can be described according to anterior-posterior and right-left locations or according to the “anal clock” with the patient in the supine position (Fig. 10). Most perianal fistulas arise at the dentate line posteriorly [19]. Finally, the integrity of the levator ani should be scrutinized to assess for suprasphincteric or translevator disease.

Detection of Secondary Tracts or Abscesses

Secondary tracts will have features similar to those of the primary tract, and their course should be defined relative to the sphincters, levator ani, and overlying skin. Perianal abscesses may occur anywhere along a fistula tract and typically have central hyperintense signal on T2-weighted imaging corresponding to pus with peripheral rim enhancement secondary to the fibrous wall and surrounding inflammation. Any tracts that cross the levator ani warrant careful evaluation of the pelvis to assess for a primary pelvic source.

Conclusion

Adequate understanding of relevant pelvic anatomy and fistula classification on MRI examinations is essential in providing proper assessment of perianal fistulas. Evaluation of clinically undetectable disease has a significant bearing on guiding medical and surgical therapy and can help minimize recurrence and better predict outcome compared with surgical exploration.

Acknowledgments

We thank Carolyn Nowak from the University of Michigan Health System for all medical illustrations used in this article.
References

Fig. 1—Coronal illustration of relevant anorectal anatomy for MRI evaluation of perianal fistulas. Anal canal extends from levator ani muscle to anal verge and is surrounded by both internal and external sphincter. Internal and external sphincter are separated by intersphincteric space. Ischioanal space and ischiococcygeal space are superficial to sphincter complex and inferior to puborectalis. (Drawing by Nowak C)
MRI of Perianal Fistula

Fig. 2—Depictions of anorectal anatomy.
A–D, Illustrations in coronal (A) and axial (B) planes with corresponding coronal T1-weighted 3D gradient-recalled echo contrast-enhanced (C) and axial T1-weighted unenhanced (D) images show pertinent structures for perianal fistula evaluation, including internal (1) and external (2) sphincters, levator ani (3, A and C), intersphincteric space (dashed lines, A and B; solid lines, C and D), and ischioanal and ischiorectal fossae (4). (Drawings by Nowak C)

Fig. 3—Coronal illustration shows types of perianal fistulas according to St. James’ classification. Simple intersphincteric (1) and intersphincteric with abscess (2) fistulas are both confined by external anal sphincter, whereas simple transsphincteric (3) and transsphincteric with abscess (4) fistulas both involve ischiorectal or ischioanal fossae. Extension above levator ani characterizes supralevator fistulas, such as suprasphincteric fistulas (5), which arise from anal canal before ascending to supralevator space, and extrasphtincteric fistulas (6), which result from pelvic infection extending inferiorly across levator ani and do not involve anal sphincter complex. (Drawing by Nowak C)
Fig. 4—25-year-old man with Crohn disease and grade 1 simple intersphincteric fistula.

A and B, Coronal (A) and axial (B) illustrations of perianal region depict grade 1 simple intersphincteric fistula, which arises from anal canal, penetrates internal anal sphincter (1), and then extends through intersphincteric space (dashed line, B) to skin. Fistula tract does not involve external sphincter (2). (Drawings by Nowak C)

C–E, Axial T2-weighted images with fat suppression (C and D) and coronal T1-weighted contrast-enhanced image (E) similarly illustrate simple intersphincteric fistula (arrow, C, D, and E) that traverses internal anal sphincter (arrow, C; arrowhead, E) and then extends to skin without crossing the external anal sphincter (arrowhead, E) or involving ischiorectal or ischioanal spaces (asterisks, C and D). Fistula tract shows high signal intensity on T2-weighted imaging, consistent with active disease.
Fig. 5—39-year-old man with Crohn disease and grade 2 intersphincteric fistula and small intersphincteric abscess. 

A and B, Coronal and axial illustrations of the perianal region depict a grade 2 intersphincteric fistula, which arises from the anal canal, penetrates the internal anal sphincter (1), forms an abscess in the intersphincteric space, then extends through the intersphincteric space to the skin. The abscess and fistula tract do not extend beyond the external sphincter (2).

C, D, and E, Axial T2-WI with fat suppression (C and D) and coronal T1-WI post contrast (E) similarly illustrate a grade 2 intersphincteric fistula that traverses the internal anal sphincter (1) and forms a small abscess in the intersphincteric space (arrow in D and E). The fistula tract is high signal intensity on T2-WI consistent with active disease. The external sphincter (2) is intact and there is no extension to the ischiorectal/ischioanal spaces (asterisks).
Fig. 6—31-year-old woman with Crohn disease, grade 3 transsphincteric fistula, and increasing rectal drainage. A and B, Coronal (A) and axial (B) illustrations of perianal region show grade 3 transsphincteric fistula (curved lines), which arises from anal canal, penetrates both internal (1) and external (2) anal sphincters, and then traverses ischiorectal and ischioanal fossae in its course to cutaneous opening. (Drawings by Nowak C) C–E, Axial T2-weighted images with fat suppression (C and D) and coronal T1-weighted 3D gradient-recalled echo contrast-enhanced image (E) similarly illustrate grade 3 transsphincteric fistula (arrowheads) that traverses internal anal sphincter (1, C) and external anal sphincter (2, C and E) before coursing through left ischiorectal and ischioanal spaces (asterisk, D) in its path to skin.
Fig. 7—28-year-old man with poorly controlled Crohn disease, frequent perirectal drainage, and grade 4 transsphincteric fistula with abscess. 

A and B, Coronal and axial illustrations of perianal region depict grade 4 transsphincteric fistula that arises from anal canal, penetrates both internal (1) and external (2) anal sphincters, and then forms abscess in ischioanal space before coursing to skin. (Drawings by Nowak C) 

C and D, Axial T1-weighted images with fat suppression after contrast administration similarly illustrate grade 4 transsphincteric fistula (arrowheads, C) that traverses internal (1, C) and external (2, C) anal sphincters with associated abscess (arrow, D) in left ischioanal space (asterisk, D). Fistula tract enhances, consistent with active disease. Abscess shows peripheral enhancement with central low signal, consistent with small focus of gas. 

E, Coronal T1-weighted fat-suppressed image obtained after contrast administration shows abscess (arrow) to be below levator ani (3 and curved line).
Fig. 8—37-year-old man with severe Crohn ileocolitis, rectal pain, perirectal induration, and grade 5 supralevator fistula. 

A, Coronal illustration of perianal region depicts grade 5 supralevator fistula that arises from anal canal, penetrates both internal (1) and external (2) anal sphincters, and then ascends into supralevator space where it forms abscess before descending through levator ani and coursing to skin. (Drawing by Nowak C)

B, Coronal T1-weighted 3D gradient-recalled echo image with fat suppression after contrast agent administration similarly depicts grade 5 supralevator fistula (arrowheads) that extends above levator ani (curved line).

C and D, Axial T2-weighted images with fat suppression show primary fistula (arrowheads, C) traversing internal (1, C) and external (2, C) anal sphincters, as well as multiple secondary tracts (arrows, D) within ischioanal spaces (asterisks, D). Fistula tract is high signal intensity on T2-weighted images and enhances after contrast administration, consistent with active inflammation.

Fig. 9—78-year-old man with masslike thickening in left perianal region and blind-ending sinus tract.

A, Coronal illustration of perianal region depicts sinus tract that extends from perianal skin to end blindly in ischioanal fat. Internal (1) and external (2) sphincters are entirely spared. (Drawing by Nowak C)

B, Axial T2-weighted image with fat suppression similarly illustrates blind-ending sinus tract (arrowheads) within left ischioanal fossa.

C, Axial T2-weighted image with fat suppression shows that internal (1) and external (2) anal sphincters are both normal.
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Fig. 10—Axial illustration shows "anal clock" when viewed with patient supine in lithotomy position. 12 o’clock position corresponds to anterior (A) midline or perineum, 3 o’clock corresponds to left (L) lateral aspect, 6 o’clock corresponds to posterior (P) midline or intergluteal cleft, and 9 o’clock corresponds to right (R) lateral aspect. (Drawing by Nowak C)

FOR YOUR INFORMATION

This article is part of a self-assessment module (SAM). Please also refer to "Rectal Imaging: Part 1, High-Resolution MRI of Carcinoma of the Rectum at 3 T," which can be found on page W35.

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