Magnetic resonance imaging in Crohn's disease
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Pictorial essay: MR imaging of perianal Crohn’s disease

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INTRODUCTION

MR imaging is an effective imaging modality in the evaluation of patients with perianal Crohn’s disease. Perianal fistulas are reported to occur in up to 38% of patients (1). MR imaging is important as it can accurately demonstrate localization and extent of disease including clinically undetected fistula or abscess (2, 3), and can guide surgery (4). Here the spectrum of perianal fistulizing disease in patients with Crohn’s disease as seen on MRI is presented with an image-based approach of reading these examinations.

ANATOMY

The inner layer of the anorectal canal consists of squamous and columnar epithelium with the transitional zone at the dentate line. At this level the anal glands that reach to the intersphincteric space empty into the crypts. The etiology of Crohn’s perianal fistulas may be a fistula arising from inflammation or infection of these anal glands and/or penetration of fissures or ulcers in the anorectal canal (1, 5, 6). The muscular component of the anal sphincter consists of an inner layer of circular smooth muscle (internal anal sphincter), extending downward from the rectum, and an outer striated muscular layer extending downward from the levator ani muscle, comprising superiorly the puborectalis muscle and inferiorly the external anal sphincter (fig. 1A). In between these layers is the fat-containing intersphincteric space, including the continuation of smooth muscle fibers of the longitudinal muscle of the rectal wall (fig. 1B). Outside the anal sphincter is the fat-containing ischioanal space.

IMAGING SEQUENCES AND PLANES

In Table 1 a MR imaging protocol is proposed. This protocol primarily comprises T2-weighted fast spin echo (FSE) sequences, as these sequences result in adequate contrast between sphincter components, fistula and scar tissue. On T2-weighted sequences the internal sphincter has a homogeneous structure and is hyperintense compared with the external sphincter. The intersphincteric space displays signal intensity equal to the surrounding fat next to hypointense longitudinal muscle fibers, although this thin layer may not be discernable on external phased array MRI. The striated external anal sphincter, puborectal and levator ani muscles are relatively hypointense. At T1-weighted FSE sequences there is relatively little contrast difference between the sphincter muscles, except for avid enhancement of the internal sphincter after administration of intravenous contrast medium.

Preferably a sagittal T2-weighted sequence is performed first. This non-angulated sequence can be used to orientate axial and coronal sequences at the anal canal, which has the advantage of imaging in surgically relevant planes. A fat saturated axial T2-weighted sequence is advised for optimized conspicuity of fluid and inflammatory
changes (fig. 2). Contrast-enhanced (fat saturated) T1-weighted sequence is helpful in differentiating between abscess and inflammatory changes, as pus does not enhance after administration of intravenous contrast whereas inflammatory tissue does enhance (fig. 3, fig. 4). A recommendation is to perform a similar (“native”) sequence before contrast administration to differentiate whether an area of intermediate or high signal intensity on the enhanced series is in fact hemorrhagic/proteinaceous fluid (which is also hyperintense on unenhanced T1-weighted images) or enhancing inflammatory tissue (which is hypointense on unenhanced T1-weighted images and shows enhancement after contrast administration).

The MR examinations shown here were performed at 1.5 Tesla. External phased array coils are preferred in Crohn’s disease as tracks and abscesses may be present or extend outside the field of view of an endoluminal coil. For ano- or rectovaginal fistulas the higher spatial resolution of endoluminal MRI may be advantageous as these tracks often are short, thin-walled, collapsed and surrounded by the hyperintense veins of the ano-(recto)vaginal septum, rendering these fistulas more difficult to identify (fig. 5).

### SYSTEMATIC APPROACH

We propose an approach that first determines the presence and extension of fistula(s) on the axial sequences, supplemented with the sequences in the longitudinal plane (fig. 6). For reporting location of fistula tracks and openings we suggest using a clock face referring to the patient in the classic lithotomy position, as this is a nomenclature commonly used by surgeons. The use of regions (e.g. right anterolateral, left posterior) is a valuable alternative.

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**Table 1:** MR imaging protocol for perianal fistulas at 1.5T using external phased array coils.

<table>
<thead>
<tr>
<th>SEQUENCE</th>
<th>Loc 3 plane</th>
<th>SAG T2 FSE</th>
<th>COR T2 FSE</th>
<th>AX T2 FSE</th>
<th>AX T2 FSE fat sat</th>
<th>AX T1 FSE fat sat + iv contrast</th>
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</table>
Firstly the track should be identified and followed throughout its entire course. Identification of the track is most easily performed at fat saturated sequences, whereas the T2-weighted sequences without fat suppression give detailed information on the relationship of the track and surrounding anatomical structures (see fig. 2, 4). In the case of multiple tracks verification of communication between tracks is relevant. Tracks are described following the terminology described by Parks (7) (fig. 7, fig. 8).

Secondly the presence of abscesses and blind tracks should be studied. These findings also are most prominent at fat-suppressed sequences, with T2-weighted sequences for determining the relationship between the abnormality and the surrounding structures (fig. 9, Fig. 10A + B).

Thirdly the presence and extension of fistulous disease in the levator ani muscle or the suprarelevator and perirectal space should be checked supplementary to the first two steps. This evaluation is performed primarily on longitudinal sequences, especially the coronal sequence. This step is important to secure detection of the clinically important extension above the levator ani muscle (fig. 10C + D). Abscesses and fistulas located above the levator plate are much harder to detect clinically and are difficult to reach peroperatively, requiring a surgical approach.

The fourth step is the identification of the internal opening(s). On theoretical grounds the internal opening can be expected at the level of the dentate line (i.e. approximately two cm superior to the lower edge of the anal sphincter), this being the level at which the intersphincteric anal glands empty into the crypts (3). In practice internal openings are also identified at other levels (Fig. 11, Fig. 12).

The fifth and final step includes the evaluation for ancillary findings, such as bone marrow edema or cancer (Fig. 13, Fig 14).

**PITFALLS**

Veins can be mistaken for fistulas, but in contrast to fistulas, veins usually are thin-walled, tortuous, symmetrical structures. A pilonidal sinus may resemble a fistula, but several findings, such as extension to the intersphincteric space in fistulas, help to discriminate (Fig. 15) (8). Hemorrhoids and anal tags may resemble small submucosal fluid collections, but are easily diagnosed at clinical examination. Furthermore hemorrhoids can be traced until their origin – a vein- can be seen. Clinical findings and results of other examinations (e.g. colonoscopy) can well aid in presenting the correct diagnosis.
a. Coronal T2-weighted endoanal image shows normal sphincter anatomy with the relatively hyperintense internal sphincter (I) and hypointense external sphincter (E). The puborectalis muscle (P) joins the levator plate (L) superiorly. The horizontal part of the levator plate is constituted by the pubococcygeus (anterior) and iliococcygeus (posterior) muscles. To prevent confusion these will be named “levator ani” in the legends. The shape of the puborectalis muscle shown is a physiological variation. Often the puborectalis muscle is more closely fused with the external sphincter (see Fig. 6B). The fat-containing ischio-anal space (IAS) is hyperintense. C= endoanal coil

b. Axial endoanal T2-weighted image shows normal anatomy of the sphincter complex; the external (E) and internal (I) sphincter are distinguishable from each other due to their substantial contrast difference. The fat-containing intersphincteric space (ISS) is bright on this T2-w image (small open arrow) whereas the longitudinal muscle layer (LML) situated in the intersphincteric space is hypointense (open arrow). C= endoanal coil

Figure 1: 35-year old healthy woman.

Figure 2: 14-year old boy suspected of Crohn’s disease with a perianal fistula.

a. Axial T2-weighted image shows a fistula caudally from the anal sphincter coursing from perineum to scrotum. The track is hardly visible (arrows) due to the equal intensities of fistula and surrounding fat. G= gluteus muscle

b. Axial fat saturated T2-weighted image (same level as in A.) in which the diagnosis is much easier as the brightness of the fluid-filled fistula (arrows) stands out against the suppressed fat. G= gluteus muscle
Figure 3: 29-year old man with longstanding Crohn’s disease.

a. Axial fat saturated T2-weighted image shows a large horseshoe-shaped structure (arrows). A typical horseshoe abscess extends on both sides of the anal midline and has one internal opening. This abscess extends both superior and inferior to the levator ani muscle. Shown here is the infralevatoric location (supralevatoric location shown in figure 10. A and B).
G= gluteus muscle, IO= internal obturator muscle

b. Axial fat saturated T1-weighted image after administration of intravenous contrast medium shows the structure again: the larger part of it fully enhances (large arrow) indicating the presence of inflammatory tissue. The right leg however partly just shows enhancement of the rim (small arrow), indicating the presence of fluid in the center with a rim of inflammatory tissue.
G= gluteus muscle, IO= internal obturator muscle

Figure 4: 43-year old man with extensive Crohn’s disease who underwent proctocolectomy with placement of an ileostomy.

a. Axial T2-weighted image shows a hyperintense collection (arrow).
G= gluteus muscle, B= bladder

b. Axial fat saturated T2-weighted image shows the hyperintense structure (arrow) indicating this could either be a fluid-filled lesion (abscess) or granulation tissue.
G= gluteus muscle, B= bladder

c. Axial fat saturated T1-weighted image after administration of intravenous contrast medium shows strong enhancement of the rim of the lesion whereas the core does not enhance, indicating the presence of fluid in the center with a rim of inflammatory tissue (arrow).
G= gluteus muscle, B= bladder
Figure 5: 20-year old woman with longstanding Crohn’s disease who had undergone seton placement for an anovaginal fistula.

a. Axial T2-weighted endoanal image shows the anovaginal fistula (large arrow) coursing into the anal canal (small arrow). The seton can be seen as a hypointense structure within the hyperintense track.

I= internal sphincter, E= external sphincter, C= endoanal coil

b. Axial T2-weighted endoanal image inferior to A. shows the two branches (arrows) of the anovaginal fistula.

I= internal sphincter, E= external sphincter, C= endoanal coil

c. Sagittal T2-weighted image shows the path of the anovaginal fistula well (arrows).
E= external sphincter, P= puborectalis muscle, L= levator ani muscle

Figure 6: 33-year old man with Crohn’s disease with distinct perianal fistulas and abscesses despite infliximab treatment.

a. Axial T2-weighted image shows three fistulas. The fistula on the right at 7 o’clock (small arrow) is classified as transsphincteric, as is the fistula on the left at 3 o’clock (curved arrow). They both track through the external sphincter (E) into the intersphincteric space. The fistula dorsally in the midline (12 o’clock; large arrow) at this point courses outside the sphincter complex and extends through the external sphincter at a more superior level (not shown).

G= gluteus muscle

b. Coronal T2-weighted image shows two of the three fistulas (arrows). This sequence demonstrates the intersphincteric course of these transsphincteric fistulas.

G= gluteus muscle, IO= internal obturator muscle, L= levator ani muscle
Figure 7: The Parks’ classification

(Es) An extrasphincteric fistula tracks outside of the external anal sphincter and penetrates the levator muscle into the rectum.

(Ts) A transsphincteric fistula tracks from the intersphincteric space through the external anal sphincter.

(Sf) A superficial fistula tracks below both the internal anal sphincter and external anal sphincter complexes.

(Is) An intersphincteric fistula tracks between the internal anal sphincter and the external anal sphincter in the intersphincteric space.

(Ss) A suprasphincteric fistula leaves the intersphincteric space over the top of the puborectalis and penetrates the levator muscle before tracking down to the skin.

Figure 8: 21-year old man with complex fistulating Crohn’s disease.

Coronal T2-w image shows a “high” transsphincteric fistula (arrow) meaning that the internal sphincter is penetrated at a higher level than the dentate line. The internal opening into the rectum (R) is not clearly visible but most probably is at the level of the levator ani muscle (L). The inferior part of the track comprises scar tissue (open arrow).

B = bladder, G = gluteus muscle, IO = internal obturator muscle.
Figure 9: 33-year old man who underwent proctocolectomy and pouch reconstruction for Crohn’s disease with complaints indicating the presence of an abscess despite earlier incision and drainage.

a. Axial T2-weighted image shows a very large abscess (A) displacing the sphincter complex to the left and extending into the right gluteus muscle (open arrow). In the left buttock an abscess can be seen as well (solid arrow) situated in the ischioanal fat adjoining the gluteus muscle (G).

b. Axial fat saturated T2-weighted image shows the abscess (A) more clearly as the bright signal of the fat, in which the abscess is located, is suppressed. The abscess on the left (solid arrow) is more prominently seen as well.

G= gluteus muscle

c. Axial fat saturated T1-weighted image after administration of intravenous contrast medium very clearly shows rim enhancement of both the lesion on the left (arrow) and on the right (A), indicating the presence of a large amount of pus.

G= gluteus muscle

Figure 10: 29-year old man with Crohn’s disease (same patient as in figure 3)

a. Axial T2-weighted image shows the supralevatoric location of the horseshoe abscess (arrows) with spread of the left leg anteriorly as much as the periprostatic vessels. G= gluteus muscle, IO= internal obturator muscle

b. Axial fat saturated T2-weighted image shows the abscess (arrows), but exact size and location are more conspicuous here due to the suppression of the surrounding fat. G= gluteus muscle, IO= internal obturator muscle

c. Coronal T2-w image of the same patient but imaged on a different date (nine months later) to verify if improvement occurred after placement of setons for drainage. A fistula (arrow) can be seen in the rectum (R) superior to the levator ani muscle (L). The large abscess seen earlier had greatly diminished in size (not shown). G= gluteus muscle

d. The fistula (arrow) is now seen in a more anterior image of the same series. In this image the internal opening is very clearly seen (arrow) with the fistula coursing towards the left levator ani muscle. G= gluteus muscle, R= rectum
**Figure 11:** 40-year old woman with Crohn’s disease who underwent multiple surgical procedures several years earlier for perianal fistulas and experienced relapse of disease.

Endoanal coronal T2-weighted image shows a very broad transsphincteric fistula (large solid arrows) with the internal opening (open arrow) higher than the dentate line (which cannot be visualized on MRI). Inferiorly fibrous tissue can be seen (small arrow).

L = levator ani muscle, P = puborectalis muscle, E = external sphincter

**Figure 12:** 19-year old woman with Crohn’s disease.

Coronal endoanal T2-weighted image shows a small intersphincteric abscess on the left with a slight extension suprarevatorically (curved arrow). From this abscess a gracile intersphincteric track (large solid arrow) courses caudally into the anus with a subtle internal opening (open arrow) at approximately the level of the dentate line. On the right a second track can be seen (small solid arrow) following an intersphincteric path just as the fistula on the left.

C = coil, L = levator ani muscle, IAS = ischial anal space
Figure 13: 39-year old man with complex fistulating Crohn’s disease, barely responding to infliximab. The patient complained of pain localized at the left ischial tuberosity.

Axial fat saturated T2-weighted image shows a fistula (small arrow) in the right gluteus muscle as well as a fistula dorsally of the ischial tuberosity on the left (large arrow). The ischial tuberosity shows bone marrow edema (curved arrow) contiguous with the fistula. The pain the patient perceived is probably caused by reactive edema or osteomyelitis of the ischial tuberosity.

Figure 14: 56-year old woman with a permanent ileostomy due to Crohn’s disease with discharge of pus and mucus rectally ascribed to her vast and complex perianal fistulous disease. Digital rectal examination was impossible to perform due to profound perianal pain. During an operation scheduled for excision of fistulas a large rectal tumor was revealed.

a. Axial T2-weighted image shows a large lesion isointense in comparison with the surrounding fat (solid arrows). Features differentiating between an abscess and a mucous tumor are amongst others the presence of a stalk (open arrow) and the streakiness of the structure seen on the fat saturated T2-weighted images (not shown).

b. Microscopic specimen of the tumor after resection. HE coloring, 200 x enlarged. After microscopic evaluation the tumor turned out to be a moderately differentiated mucinous adenocarcinoma.
Figure 15: 17-year old woman suspected of having perianal Crohn’s disease with a clinically proven pilonidal sinus.

a. Axial fat saturated T2-weighted image shows a perianal fistula (arrow) coursing from the anal cleft to the dorsal side of the anal sphincter (arrowhead).

G= gluteus muscle

b. A more cranial image in the same series shows a hyperintense structure (arrow) with no relation to the sphincter complex ending blindly in the soft tissue of the buttock. This most probably is a pilonidal sinus since no related intersphincteric sepsis can be seen and the lesion is located in the midline of the anal cleft. The clinical report in which the presence of a pilonidal sinus in this location is mentioned, aids in providing the correct diagnosis.

REFERENCES
