Crohn disease's perianal complications and MRI: what, when, why.

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Learning objectives

To illustrate:
- What Crohn disease (CD)'s perianal complications are;
- When the magnetic resonance imaging (MRI) is indicated in CD;
- Why the use of MRI with external phased-array multi-coils is better than other imaging modalities; MRI technique and findings, and Radiologist's report keypoints are also illustrated.
Background

CD is a chronic, transmural inflammatory disorder of unknown cause with an onset usually in early adulthood. Predominantly affects the small bowel (up to 80% of cases), but any part of the gastrointestinal tract may be involved; often affects the colon and the perineal soft tissues.

Most common CD’perianal complications are fistulas and abscesses, affecting 25% to 50% of patients; perianal fistulas may even precede the intestinal manifestations (up to 25% of patients). An increased incidence of perianal manifestations is observed as the disease is located more distally in the colon.

Normal anal/perianal anatomy and physiology

The anorectal epithelium consists of a squamous and a columnar part, with the transitional zone at the **dentate line**; at this level, the anal glands empty into the anorectal crypts.

The muscular components of the anal sphincter are:
- The **Internal sphincter**. It is composed of smooth muscle continuous with the circular smooth muscle of the rectum. It is an involuntary muscle responsible for 85% of resting anal tone. In most individuals, it can be divided without causing a loss of continence;
- The **External sphincter**. It is composed of striated muscle continuous with the puborectalis and levator ani muscles. It contributes only 15% of resting anal tone, but its voluntary contractions resist defecation. External sphincter’s division can lead to incontinence.

The **intersphincteric space** is a fat-containing space between these muscular layers, including the continuation of smooth-muscle fibers of the longitudinal muscle of the rectal wall (does not contribute to the function of the anal sphincter).

The **levator ani muscle** includes: - the puborectalis muscle superiorly and the external anal sphincter inferiorly; - the pubococcygeus (anterior) and the iliococcygeus (posterior) muscles in the horizontal part.

Outside the anal sphincter is the fat containing **ischioanal space**. (fig 1)
Pathology

A fistula is an abnormal tract that connects two epithelial surface; perianal fistulas or fistula in ano connect usually the anal canal to the perianal skin. So it is possible to distinguish an internal enteric opening in the anal canal, a fistulous track and an external opening.

An abscess is a well-defined, encapsulated collection of pus.

The causes of CD's perianal fistulas may be: - inflammation or infection of the intersphincteric anal glands ("cryptoglandular hypothesis"), surrounded by lymphoid aggregates - penetration of fissures or ulcers in the anorectal canal.

The process can penetrate the internal sphincter to lie in the intersphincteric plane, assuming than different courses to reach the skin: - it may travel in the intersphincteric plane (intersphincteric fistulization); - it may pass through both layers of the anal sphincter to enter the ischioanal/rectal fossa (trans-sphincteric fistulization); - it may tracks upward over the sphincter complex to enter the ischioanal/rectal fossa (suprasphincteric...
fistulization). Sometime sepsis arising within the pelvis may track down to the skin through the ischioanal/rectal fossa (extrasphincteric fistulization). Unabated infections may result in ramifications, known as "extensions", with the morphology of secondary tracts or abscesses. These "complex fistulas" are often associated with CD fistulas. The extensions may be intersphincteric, ischioanal or supralevator (pararectal). Failure in accurate treatment of the secondary extensions may be responsible for recurrence.

Treatment

Patients with active penetrating disease in absence of an abscess are treated with medical therapy (antibiotics and biological therapy, generally avoiding steroids). Infliximab (antiTNF#) has been shown to determine improvement or closure of fistulous track; the presence of abscesses is a contraindication to Infliximab therapy. Surgery is required in fistulating disease that is no responsive to medical therapy and if a fistula connects to the genitourinary tract. The surgical objectives are: - to eradicate the tract and extensions (reduce recurrence); - to preserve external sphincter (preserve continence).

The surgical approach depends on the nature of the primary fistula and any secondary fistulous track or abscesses. Treatment usually involves laying open the fistula by means of surgical incision (fistulotomy or fistulectomy): for simple intersphincteric fistulization the surgeon divides only the internal sphincter, instead the trans-sphincteric fistulas must be excised by dividing both layers of the sphincter, thus risking fecal incontinence. The height of the internal opening relative to the anal canal and sphincters is also crucial; the higher is the opening, the more sphincter will be divided. For trans-sphincteric and extrasphincteric fistulization more complex surgery may be required.

Smaller perianal abscesses may be treated with antibiotics or with an incision and a drainage tube. An abscess that is both above and below the levator any muscle must be managed from both sides of the muscle, often surgically, because the levator plate forms a barrier to drainage. Aggressive surgical interventions should not be performed in the case of active proctitis because the healing rates have been shown to be lower in these patients.

Diagnosis

To classify CD's perianal complications surgeons use examination under anesthesia (EUA), performed with palpation and with or without probing. To surpass the low accuracy of clinical examination various imaging techniques were developed. The ideal imaging test for perianal CD:
- has good sensitivity and specificity to demonstrate the transmural extent of inflammation (fistulas) and extraintestinal complications (abscesses);
- allows differentiation between active disease, that can be managed medically, and disease that requires surgery;
- can depict the anatomy of the entire pelvic floor, to delineate the full extent of the lesions (fistulas and extensions) and their relationships with the pelvic anatomy (preoperative information);
is well tolerated by patients, because CD symptomatic patients often have anal stenosis or local pain;
- is free of ionizing radiation, because CD commonly affects young adults and its relapsing and remitting nature requires frequent imaging examinations to monitor disease activity and severity. The use of immune-modulating drugs has increased the need for accurate assessment of disease severity.
Routine imaging modalities used to assess this region include barium studies, sigmoidoscopy, fistulography and ultrasound (US). All these examinations: - are limited in their ability to depict the anatomy of the entire pelvic floor, - endoanal US has a limited field of view; - are uncomfortable for the patient.
The advantage of cross-sectional imaging, computed tomography (CT) and MRI, is its capacity to demonstrate the transmural extent of inflammation and extraintestinal complications (wide field of view), providing also multiplanar information in surgical relevant planes. However, for its characteristics, MRI is the technique of choice for patients with CD (tab 1).

<table>
<thead>
<tr>
<th>CT</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low contrast resolution. The attenuation values of the anal sphincter and pelvic floor is similar to that of the fistulas so it is difficult to characterize these structures; it cannot distinguish active disease from fibrosis.</td>
<td>High tissue contrast. It is helpful in the detection of fistulas and abscesses, and in the differentiation between fibrotic and inflammatory tissue.</td>
</tr>
</tbody>
</table>

Tab 1: CT versus MR imaging characteristics.

MRI can be made with endoanal or external coils; the method of choice will be the use of external phased-array multi-coils (tab 2).

<table>
<thead>
<tr>
<th>Endoanal coils</th>
<th>External coils (body coil and phased-array multi-coils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High spatial resolution.</td>
<td>Good spatial resolution,</td>
</tr>
</tbody>
</table>
It is ideal:
- to distinguish the internal from the external sphincter;
- for the demonstration of the internal opening and of recto/ano-vaginal fistulas;
- for the simultaneous information on the degree of sphincter disruption (useful in patients who have undergone previous surgery).

with the use of phased-array multi-coils because of the increasing of signal-to-noise ratio.

<table>
<thead>
<tr>
<th>Limited field of view; moreover the use of endoanal probe can produce pelvic anatomy distortion.</th>
<th>Superior field of view; it allows a better imaging of fistula tract and the visualization of the perianal region and the entire pelvic region in a single investigation (visualization of extensions and simultaneous intrapelvic disease; define anatomic relationships).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorly tolerated in symptomatic patients, because of the use of endoanal probe.</td>
<td>Well tolerated by patients.</td>
</tr>
<tr>
<td>Specific anal coils (smaller than rectal coils) remain relatively unavailable.</td>
<td>Used in standard practice.</td>
</tr>
</tbody>
</table>

Tab 2: Comparison between MRI with endoanal or external coils

MRI may quantify CD's clinical activity. Increased enhancement on T1-weighted post-contrast images is indicative of active inflammation (increased tissue perfusion and vascular permeability); it provides little information about tissue behavior because is performed after most of the contrast material distribution has been accomplished and some of the contrast material has already washed out. With dynamic contrast material - enhanced MRI, images are acquired during the delivery of the contrast material in the tissue of interest highlighting the dynamic response of the tissue to the inflow of blood and the subsequent distribution in the extracellular fluid space.
Because inflammatory tissues usually have high signal intensity at diffusion-weighted imaging, it may be a promising sequence for diagnosis of anal fistulas, particularly in patients with risk factors for contrast material's adverse effect.
Fig. 1: Normal anal/perianal anatomy.

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<table>
<thead>
<tr>
<th>Sequence</th>
<th>Technique</th>
<th>Plane</th>
<th>TR/TE ms</th>
<th>TI ms</th>
<th>FA°</th>
<th>FOV cm</th>
<th>Section thickness mm</th>
<th>Spacing mm</th>
<th>Matrix</th>
<th>NEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2w FSE</td>
<td>sag</td>
<td>4000-5000/85</td>
<td>560/11</td>
<td>/</td>
<td>90</td>
<td>25X25</td>
<td>4</td>
<td>1</td>
<td>384X224</td>
<td>3</td>
</tr>
<tr>
<td>T1w FSE</td>
<td>oblique ax</td>
<td>4000-5000/85</td>
<td>24X24</td>
<td>4</td>
<td>90</td>
<td>24X24</td>
<td>4</td>
<td>1</td>
<td>320X224</td>
<td>2</td>
</tr>
<tr>
<td>T2w FSE FS</td>
<td>oblique ax</td>
<td>4000-5000/85</td>
<td>30X30</td>
<td>4</td>
<td>90</td>
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<td>T2w FSE</td>
<td>oblique cor</td>
<td>4000-5000/85</td>
<td>4000-5000/85</td>
<td>4</td>
<td>12</td>
<td>34X34</td>
<td>3</td>
<td>-1.5</td>
<td>224X288</td>
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<tr>
<td>T2w FSE FS</td>
<td>oblique cor</td>
<td>4000-5000/85</td>
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<tr>
<td>T1w FSE</td>
<td>sag</td>
<td>4000-5000/85</td>
<td>4.1/2.1</td>
<td>15</td>
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<td>3</td>
<td>224X288</td>
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</tr>
</tbody>
</table>

Tab. 3: Suggested MRI protocol. Parameters were established with a 1.5 - T system. T1w = T1-weighted, T2w = T2-weighted, FSE = fast spin echo, FS = fat-saturated, FSPGR = fast spoiled gradient echo, c.e.= contrast enhancement, ax = axial, sag = sagittal, cor = coronal, TR = repetition time, TE = echo time, TI = inversion time, FA° = flip angle, FOV = field of view, NEX = number of excitations.
**Sequences** They should guarantee: - anatomic precision; - highlight of inflammation/infestation.

- **T2-weighted (T2w) fast spin-echo (FSE) sequences**, with and without **fat saturation (FS)** (alternatively STIR images), produce a clear depiction of pathological processes because of adequate contrast between fluid/inflammation (hyperintense), muscular tissue (hypointense), fat (especially with fat-suppression because appears hypointense) and fibrotic tissue (hypointense). T2w sequences without fat-suppression give more detailed information on the anatomic relationships of the tract and surrounding structure, because of excellent soft-tissue contrast.

- **Contrast-enhanced FS T1-weighted (T1w) gradient-echo (GRE) sequences** can help to: - differentiate between fluid and inflammatory changes (both hyperintense in T2w sequences, but fluid does not enhance after administration of contrast material, whereas inflammatory tissue does enhance) - distinguish residual disease activity from fibrosis in previously operated;

- **Unenhanced T1w FSE sequences** provide an excellent anatomic overview. These images are also helpful in postoperative assessment to distinguish: - haemorrhagic/proteinaceous fluid (hyperintense) from residual inflammatory tissue (hypointense); - fat-containing grafts, often placed to fill cavities (hyperintense), from active disease (hypointense).

**Imaging planes**

Because the anal canal is tilted forward from the vertical by approximately 45°, oblique transverse and coronal planes oriented orthogonal and parallel, respectively, to the anal sphincter are necessary to obtain imaging in surgically relevant planes; this sequences are planned using a midline sagittal image, so it is useful performing first a sagittal T2w FSE sequence.

- **Transverse images** are useful to visualize: - the primary tract (inter or transphincteric fistulization); - the radial site of the internal opening;

- **Coronal and Sagittal images** best depict: - the levator plate and the height of fistula internal opening (supra or extra-sphincteric fistulization); - the extensions.

The *imaged volume* should extend several centimeters above the levator ani and include the whole presacral space and the entire perineum (transverse images = from L-5 to the anus; sagittal images = both acetabula). However any visible tract must be followed to its termination if this has not been included on the standard image volume.

**Imaging findings**

**Normal anal/perianal anatomy**

- **External sphincter and levator ani**: - T2w images = relatively hypointense; - Contrast enhanced FS T1w images = no enhancement.

- **Intersphinteric space and ischiatic fossa**: - without fat suppression = hyperintense; - with fat suppression = hypointense. (figs 2, 3)
Fig. 2: MRI normal anal/perianal anatomy, coronal view.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fistulas

- T2w images, without and with fat suppression. Their signal intensity depends on their fluid/inflammatory content (hyperintense) and the extent of surrounding fibrosis (hypointense). Active tracts are hyperintense longitudinal structures (filled with pus and granulation tissue) surrounded by hypointense fibrous walls; chronic tracts are hypointense.
- Contrast enhanced FS T1w images: in active fistulas track's walls and active granulation tissue will enhance, while the fluid in the tract itself remains hypointense. Chronic fistulas have an homogeneous contrast enhancement because of the presence of granulation tissue without fluid in the tract.
- T1w images: active and chronic tracts are hypointense. (fig 4)
The internal opening in the anal canal is usually at the level of the dentate line (see "cryptoglandular hypothesis"); in most cases it is at the middle of anal posterior margin, because anal glands are more abundant posteriorly. Unfortunately the dentate line cannot be identified as a discrete anatomic entity, but lies at approximately the mid-anal canal level (or 2 cm proximal to the anal verge). Surgeons describe the site and direction of fistulous tracks by referring to the "anal clock", that is the view of the anal region with the patient in the lithotomy position usually used for fistula surgery. At 12 o'clock is the anterior perineum and at 6 o'clock the natal cleft; 3 o'clock refers to the left lateral aspect and 9 o'clock to the right of the anal canal. It corresponds with the view of the anal canal on axial MR images. (fig 5)
Fig. 5: 5. Anal clock orientation of the anal/perianal region.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT

Parks et al. described the course and relationships of perianal fistulas to the sphincter complex and assigned all fistulas into one of four groups:
- Intersphincteric fistula (most common), tracks between internal and external anal sphincters in the intersphincteric space;
- Trans-sphincteric fistula, tracks from intersphincteric space through external anal sphincter;
- Supra-sphincteric fistula, leaves intersphincteric space over the top of puborectalis muscle and penetrates levator ani muscle before tracking to the skin;
- Extra-sphincteric fistula, tracks outside of the external anal sphincter passing through the ischioanal/rectal fossa and levator ani muscle then into the rectum. Absence of intersphincteric inflammation. (fig 6)
Fig. 6: 6. Park's perianal fistulas classification.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT

The cutaneous opening is evident to the surgeon and thus of little importance for the radiologist to demonstrate.

Extensions

Extensions may have the morphology of secondary tracks or abscesses and may be intersphinteric, ischioanal or supraelevator (pararectal); the commonest site is the ischioanal fossa, especially one that arises from the apex of a trans-sphincteric fistula. Extensions also occur in the horizontal plane and are known as "horseshoe" if there is ramification on each side of the internal opening.

Abscesses
- do not conform to normal peritoneal reflections (unlike free fluid);
- T1w and T2w images: signal intensity characteristics of fluid (high on T2w images, low on T1w images). Abscess content is often heterogeneous due to the presence of solid and gas components (hypointense on T2w images);
- Contrast enhanced FS T1w images: pus in the central cavity remains unenhanced and it is surrounded by brightly enhancing rim of the wall.
Characteristically, the abscesses associated with intersphincteric fistulas are perianal or within the intersphincteric space, while those one associated with trans-sphincteric fistulas are in ischioanal/rectal fossas. (fig 7)

![MRI Abscess semiotics](image)

**Fig. 7**: 7. MRI abscess semiotics.

**References**: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT

*Morris et al.* proposed an imaging-based classification, the St James'University Hospital classification, that relates the Parks surgical classification to anatomy seen at MR imaging and deals not only with the demonstration of the primary fistulous track but also with secondary ramifications and abscesses:
- **Grade 1**: simple linear intersphinteric fistula (figs 8, 9);
- **Grade 2**: intersphincteric fistula with abscesses or secondary track (also these processes are confined within the sphincter complex). Extensions may be of the "horseshoe" type (figs 10, 11, 12);
- **Grade 3**: trans-sphincteric fistula (fig 13);

- **Grade 4**: trans-sphincteric fistula with abscesses or secondary track within the ischioanal or ischiorectal fossa. The abscess may manifest as an expansion along the primary track or as a structure distorting or filling the ischioanal/rectal fossa (figs 14, 15, 16);

- **Grade 5**: supralevator and transelevator disease (comprising suprasphincteric and extrasphincteric fistulas) (figs 17, 18).

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**Fig. 8**: 8. Grade 1 perianal fistula, simple linear intersphincteric fistula.

**References**: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 9: 9. Grade 1 perianal fistula, simple linear intersphincteric fistula.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Grade 2 perianal fistula: intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

**Fig. 10:** Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

**References:** Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 11: 11. Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 12: Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 13: 13. Grade 3 perianal fistula, trans-sphincteric fistula.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 14: Grade 4 perianal fistula, trans-sphincteric fistula with abscess or secondary fistulous track.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 15: 15. Grade 4 perianal fistula, trans-sphincteric fistula with abscess or secondary fistulous track.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Fig. 16: 16. Grade 4 perianal fistula, trans-sphincteric fistula with abscess or secondary fistulous track.

References: Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
**Fig. 17:** Grade 5 perianal fistula, supraelevator and transelevator disease.

**References:** Dipartimento di Bioimmagini e Scienze Radiologiche, Catholic University of Sacred Heart in Rome, Policlinico Agostino Gemelli - Rome/IT
Interpretation
The objectives in performing and interpreting any imaging study for perianal CD are:

1. To determine the relationship between any fistula and the anal sphincter complex. Identification of the tract is most easily performed on T2w sequences with and without fat suppression. The external anal sphincter is clearly visualized (it is hypointense, and its lateral border contrasts against the fat in the ischioanal fossa) so it is relatively easy to determine whether a fistula is contained by the external sphincter or has extended beyond it (intersphincteric VS transphincteric fistulization), a feature that can be easily appreciated on transverse or coronal views.

2. To identify the level and the radial site of internal opening (high chance of relapse if not treated). The vast majority of anal fistulas open into the anal canal at the level of the dentate line (see cryptoglandular hypothesis). Any tract that penetrates the pelvic floor above the level of the puborectalis muscle is potentially a suprasphincteric or extrasphincteric fistula, but the internal opening is anal in suprasphincteric and rectal in extrasphincteric fistulas.
It is useful to describe tracts in accordance with the terminology by Parks et al. and the radial site of fistula's internal opening with respect to the clock-face orientation.

3. To identify any extension, that need to be treated before starting medical therapy (abscesses) and to prevent recurrence. These findings also are most prominent on T2w sequences with and without fat-suppression, in multiple planes.

4. To evaluate disease activity, on contrast enhanced T1w sequences.

At the end of the report it is useful to classify the case according with St James’s University Hospital system.
Fig. 2: MRI normal anal/perianal anatomy, coronal view.

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Fig. 3: MRI normal anal/perianal anatomy, axial view.

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Fig. 4: 4. MRI fistula semiotics.

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Fig. 5: Anal clock orientation of the anal/perianal region.

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Fig. 7: MRI abscess semeiotics.

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Fig. 10. Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

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Fig. 11: Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.
Fig. 12: 12. Grade 2 perianal fistula, intersphincteric fistula with intersphincteric abscess or secondary fistulous track.

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**Fig. 13:** Grade 3 perianal fistula, trans-sphincteric fistula.

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Fig. 17: 17. Grade 5 perianal fistula, supralevator and transelevator disease.

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Fig. 18: 18. Grade 5 perianal fistula, supraelevator and transelevator disease.

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Conclusion

A good classification and anatomic description of perianal CD is crucial before starting any kind of therapy (medical or surgical). Cross-sectional imaging, CT or MRI, should be included in a comprehensive clinical evaluation of CD, especially before starting Infliximab therapy.

MRI is the method of choice for imaging anal fistulas; it has revolutionized the treatment of patients with fistula in ano, because it can be used to classify fistulas preoperatively with high accuracy, also alerting the surgeon to disease that would otherwise have been missed, and to define anatomic relationships to predict the likelihood of postoperative fecal incontinence. MRI and patient’s outcome are closely related because preoperative MRI could help identify features that cause postoperative recurrence. For this reason MRI pelvic study should be routine: - in patients presenting for the first time with a fistula and with known CD (since the preponderance of complex fistulas is increased); - in the preoperative evaluation of fistula in ano.

A new indication for MRI will be monitoring Infliximab therapy, since it seems that fistulas may persist in the face of clinical findings that suggest remission.
Personal Information

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