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MRI OF PERIANAL FISTULA: THE RELEVANT ANATOMY, IMAGING PROTOCOLS & SEQUENCES AND WHAT THE SURGEONS NEED TO KNOW

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ABSTRACT

Objective: To describe the relevant anatomy and MR imaging protocols and sequenes for assessing the perianal fistula and to identify the accuracy of MRI in evaluating the perianal fistula. **Materials and Methods:** This was a retrospective study involving 30 patients with clinically suspected perianal fistula referred for MR evaluation. All patients were examined on 1.5 T MRI (Philips Achieva 16 Ch.) scanner with external coiling. MR findings were then compared with the operative findings. Statistical analysis included percentage frequency, sensitivity and specificity. **Results:** The most common age group to be affected was the 4th decade (30%). Out of the total 30 patients, 28 (93%) were males and 2 (7%) were females. 23 patients had primary fistulas while 3 had undergone previous fistula surgery and presented with recurrence. 19 patients (73%) had intersphincteric fistula while 7 patients (27%) had transsphincteric fistula. 3 patients had perianal abscesses with no evidence of fistula. There was one false positive and one false negative case. As per our study MRI had a sensitivity and specificity of 96.15% and 75% respectively. **Conclusion:** MRI is an excellent tool for assessing perianal fistulae, in terms of it anatomy, extent of disease and it's relation to the anal sphincters. MRI provides useful and accurate information for surgical planning, thereby decreasing the tendency for recurrence and also in avoiding complications such as fecal incontinence.

KEYWORDS: Perianal fistulae, MRI, Intersphincteric, Transsphincteric, Suprasphincteric.

BACKGROUND

Fistula is defined as an abnormal tract connecting two hollow organs or one hollow organ with the skin. Anal fistula affects roughly 10 persons in 100,000. Men are three times more likely to be affected than women, due to the higher abundance of anal glands. The commonest age group is the 4th decade. The disease usually begins as an abscess and later on develops into a fistula in about 60% of the cases. Other established etiologies include trauma during childbirth, Crohn's disease and malignancies. MRI is the best imaging modality for pre-op assessment of anal fistulas. It provides accurate information regarding disease extent and also predicts the prognosis. It is also extremely useful in monitoring treatment response.[1] In this study we review the important anatomy of the perianal region and evaluate the accuracy of MRI in the pre-operative evaluation of perianal fistula and the important information required by surgeons from the radiologists.

MATERIALS AND METHODS

The study population included 30 patients whose MRI images (done from January 2013 to June 2014) were evaluated retrospectively. Patients with clinically suspected perianal fistula referred to the MRI division of our department were included in the study. All the patients had undergone MRI on 1.5 T MRI (Philips Achieva 16 Ch.) scanner with external coiling. Imaging sequences used were T_1WI, T_2WI, Inversion recovery (STIR) & post contrast T_1W fat suppressed sequences in axial, oblique coronal and sometimes sagittal planes. Gadopentate dimeglumine 0.1 mmol/kg was used as contrast administered intravenously. Slice thickness of 4mm and F.O.V 25x25 was used. Imaging matrix was 256x256. MRI images were then evaluated for the presence of primary fistulous tract, internal opening and its relation to the anal sphincters, secondary extensions and presence of any abscesses/collections. These findings were then finally compared with the operative findings. Statistical analysis included percentage frequency, sensitivity and specificity.

RESULTS

30 patients were included in the study with age ranging from 25 to 67. Out of the total 30 patients, 28 (93%) were males and 2 (7%) were females. The most common age group to be affected was the 4th decade (30%), followed equally by the 5th (20%) and 6th (20%) decade age group **(Figure 1)**. 23 patients (76%) had primary fistulas while 3 patients (1%) had undergone previous fistula surgery and presented with recurrence **(Figure 2)**. Four patients showed no fistula on imaging. Following were the types of fistulas seen in our study- intersphincteric-17 cases (65%), transsphincteric- 7 cases (27%), extrasphincteric- 1 case (4%), Suprasphincteric- 1 case (4%) **[Figure 3]**. 21patients had single fistula, while 5 had secondary tracks **(Figure 4)**. All except one of the patients had single external openings. 3 patients had perianal abscesses with no evidence of fistula. There was one false positive and one false negative case. As per our study MRI had a sensitivity and specificity of 96.15% and 75% respectively, with a positive predictive value of 96.15% and a negative predictive value of 75%. **(Table 1).**

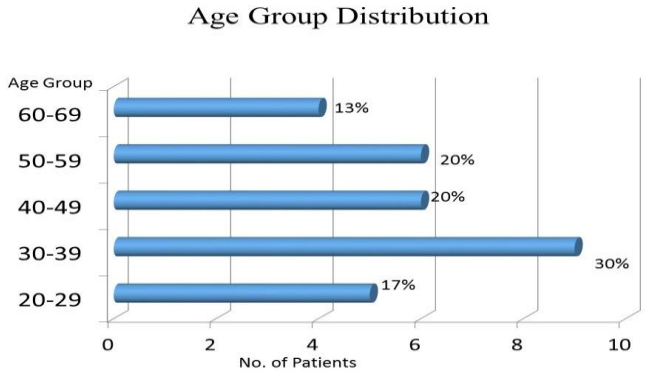

Figure 1. Graph showing distribution of the various age groups of our patients included in our study.

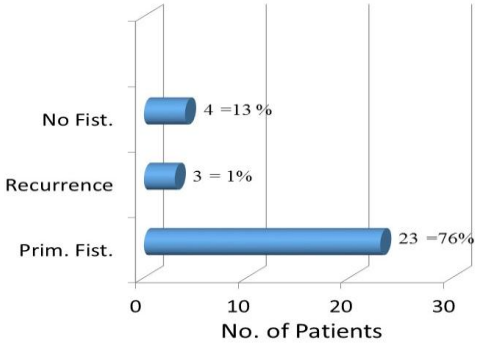

Figure 2. Graph showing the no. of patients with primary and recurrent fistula.

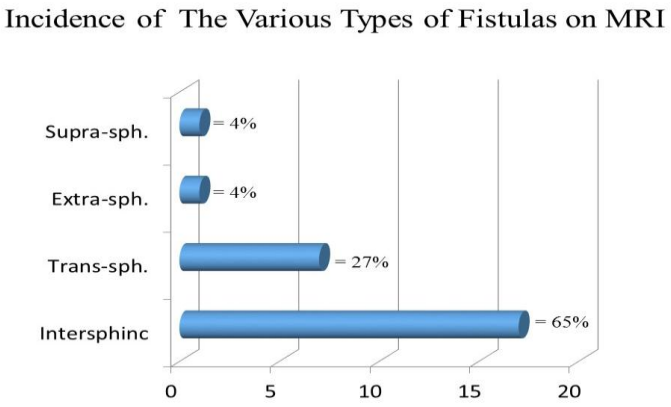

Figure 3. Graph showing the incidence of various types of fistula in our study.

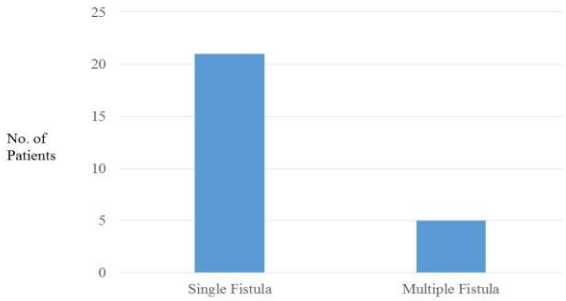

Figure 4. Graph showing the number of patients with single vs. multiple (secondary) fistulas.

Figure 5. MRI post contrast axial and oblique coronal sections T1 weighted images showing the relevant perianal anatomy- internal sphincter (thick white arrow), external sphincter (thick black arrow), intersphincteric space (thin arrow), ischioanal fossa (asterix) and levator ani muscles (arrow heads).

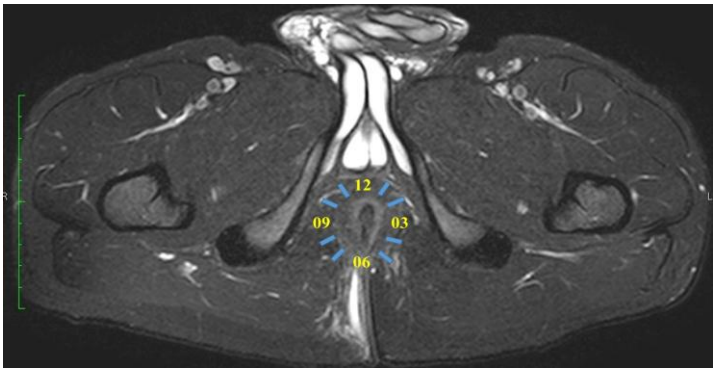

Figure 6. The "Anal Clock" scheme used for mentioning the internal opening of a fistula on imaging.

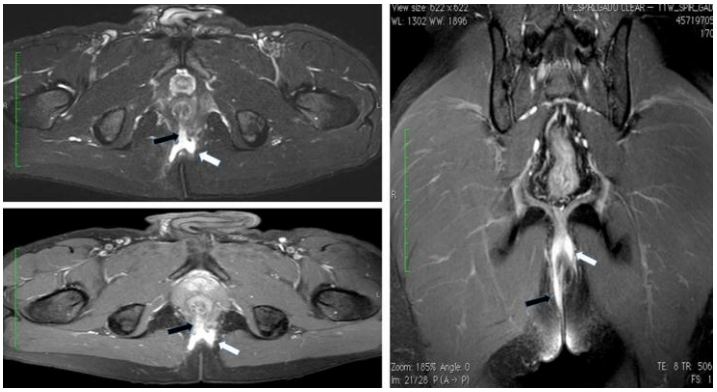

Figure 7. Axial T2-WI and Post contrast axial and oblique coronal T1 fat saturation sequences showing a hyperintense fistulous tract (black arrow) with the external opening in the right side of the perianal region crossing the external sphincter and entering the interspehincteric space at 6 o' clock position (Grade 2). A secondary track is seen in the left perianal region.

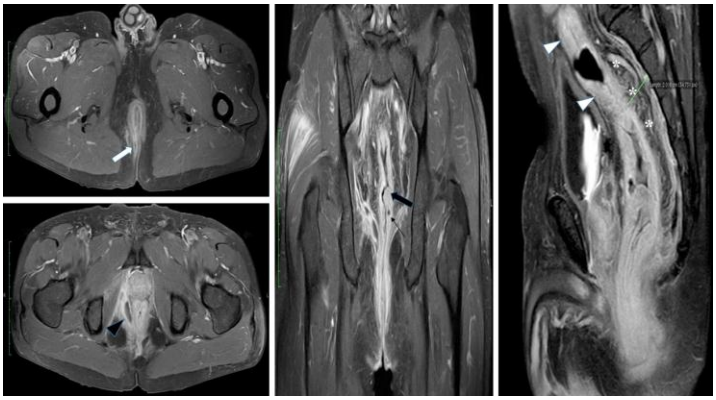

Figure 8. Grade 4 transphincteric fistula in 52 year old male with axial T2 and post contrast axial, oblique coronal and sagittal T1 fat saturation sequences showing a hyperintense fistulous track (white arrow) traversing the external sphincter to reach the internal sphincter at 6 o'clock position. A right sided ischioanal abscess (black arrowhead) was also noted. The patient was a case of Crohn's disease with rectal polyps (black thick arrow), ulcer (black thin arrow), thickened sigmoid colon (white arrow heads) with skip areas and widened pre-sacral space measuring more than 2 cm.

Table 1: Table showing the sensitivity and specificity of our study.

TEST	DISEASE PRESENT	n	DISEASE ABSENT	n	TOTAL
Positive	True Positive	a= 25	False Positive	b= 01	a+b= 26
Negative	False Negative	C= 01	True Negative	d= 03	c+d= 04
Total		a+c= 26		b+d= 04	

Table 2: Relevant MRI sequences for imaging of perianal fistula as proposed by Criado and *et al.*

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 x 29	26 x 26	26 x 26	26 x 26	24 x 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 x 256	384 x 224	320 x 256	384 x 224	512 x 224
NSA	2	2	4	2	2

Ref: *de Miguel Criado J, del Salto LG, Rivas PF, del Hoyo LF, Velasco LG, de las Vacas MI, Marco Sanz AG, Paradela MM, Moreno EF. MR imaging evaluation of perianal fistulas: spectrum of imaging features. Radiographics. 2012 Jan-Feb;32(1):175-94.*

Table 3. Newer MRI Sequences for evaluating perianal fistulas

New Sequences	Advantages
Three-dimensional (3D) T2-weighted turbo spin echo (TSE) sequences	-A single 3D TSE sequence can provide reformatted images in axial, coronal and sagittal planes thereby negating the need for three 2D sequences images in these planes. - Non operator dependence in acquiring images in any obliquity, ability to cover a larger volume, allows thin sections to be obtained with no intersection gaps, reduced imaging time and a higher signal to noise ratio.
Digital subtraction MR Fistulography	- This sequence is based on enhancement of the abnormally inflamed fibrous walls of the fistula or abscess following contrast administration on T1 weighted images. - Following image subtraction the fistulas appeared as hyperintense fluid filled tubular structures containing hypointense fluid, surrounded by low signal intensity fat
Diffusion Weighted Imaging (DWI) sequences	- Inflammatory tissues appear hyperintense on DWI sequences. Hence it may be used as an adjunct to T2 weighted images and especially in those patients with, contrast allergy and/ or renal failure.

Dynamic Contrast Enhanced (DCE) MRI	- Especially useful in assessing disease activity in Crohns disease. - This sequence involves obtaining time intensity curves to identify whether a fistula is active or not by measuring the volume of enhancing pixels.
Evaluation of perianal fistula by 3T MRI	- Provides a higher field strength, which in turn gives a better SNR, reduced imaging time and higher temporal and spatial resolution. The higher spatial resolution obtained with a 3T MRI improves the ability to identify the lesions as well provide better reformatted images with finer details.

Table 4: Information to be included in the radiology report for the surgeon

1. Location of the fistula	- The "Anal Clock" scheme should be used to describe tract location at the external opening, the extra and inter- sphincteric course and the internal opening with respect to the anal canal. - Distance from the anal verge must also be included
2. Course of the fistula	- The description should be comprehensible to the surgeon. - Course description should begin at the external opening, following the course and ending at the internal opening, i.e. "out to in"
3. Relation of the fistula to the sphincter	- Fistulous involvement of the sphincter is a risk factor for incomplete healing, recurrence and sphincter injury. This in turn can lead to post-operative incontinence, and the potential need for diverting colostomy to allow healing.
4. Fistula- simple or complex?	- Simple Fistula: Minimal or no involvement of external sphincter or puborectalis e.g. Intersphincteric, low lying Transsphincteric - Complex Fistula: Involvement of > 30% of external sphincter. Suprasphincteric/Extrasphincteric or high fistulas (proximal to dentate line). Fistulas with multiple, hidden or blind-ending tracts. Horseshoe tracts / collections. Deep abscess formation.

DISCUSSION

Fistula is defined as abnormal communication between two organs, or from surface of the skin to a deeper viscera. Perianal fistula is an inflammatory condition affecting the perianal region that can cause significant morbidity Its prevalence is nearly 0.01% with a male to female ratio of 2:1. Patients commonly present with the chief complaints of anal discharge (65%) and/or local pain. It has a tendency to recur thereby necessitating repeated surgical management.[2]

Causes and etio-pathogenesis of perianal fistulas

Conditions that can lead to fistulous formation within the perianal region include- Crohns disease, Tuberculosis, Pelvic infection, trauma such as child birth, diverticulitis, malignancy and following radiotherapy. The majority are idiopathic, representing a chronic phase of anal gland sepsis. The most widely accepted theory for the etio-pathogenesis of perianal fistula is the cryptoglandular hypothesis, although this theory is unable to explain fistula formation in inflammatory conditions such as Crohns disease and diverticulitis which can cause an extrasphincteric fistula. According to the cryptoglandular hypothesis, an initial infection of the intersphincteric gland leads to the formation of a fistula or an abscess when the draining ducts become occluded. A persistent abscess or a recurrent discharging fistula occurs, when the infection of the primary site in the intersphincteric plane becomes chronic. A superficially located abscess is more likely to discharge into the anal canal, while those located deeper to the internal sphincter tend to rupture and track along the least path of resistance within the intersphincteric space finally leading to the formation of a fistulous tract with the superficial skin. A transsphincteric fistula occurs when the infection penetrates through both the layers of the external sphincter, entering the ischiorectal fossa leading to inflammation and abscess formation.[3, 4]

Anatomy ***(Figure 5)***

The anal canal is like a cylinder enclosed by two layers of muscles, namely the internal and external sphincter. The internal sphincter is made up of smooth muscle fibers, is involuntary and responsible for 85% of resting anal tone. The external sphincter on the other hand is a voluntary muscle made up of striated muscle and has attachments to the perineal body and urogenital diaphragm anteriorly and the anococcygeal ligament posteriorly. The external sphincter is responsible for only 15% of the resting tone of the anal canal. The internal sphincter can be incised or excised without risk of loss of continence, however this is not the case with the external sphincter. The intersphincteric space separates the two sphincters, and comprises of fat, areolar tissues and longitudinal muscle. The space acts a natural area of low resistance where infection and fistula can spread easily. The anal columns of Morgagni which are longitudinal mucosal folds form the upper half of the anal canal. The

anal valves in the lower part of the column form the cypts of Morgagni. The lower ends of these undulating anal valves form the dentate or pectinate line, which in turn forms the distal most region of anal transition zone, lying 2 cm superior to the anal verge.[2,3,5,6]

Location of Anal fistula and Their Classification
The "Anal Clock" scheme **(Figure 6)** is the technique used by both surgeons and radiologists to describe the site and direction of the fistulous track. In this technique, the patient is in a lithotomy position with the anterior perineum at 12 o' clock, the left lateral aspect of the anal canal at 3 o'clock, the natal cleft and right lateral aspect at 6 and 9 o' clock respectively.[1]

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.

Anatomic classification of perianal fistulas is based on the relationship of the primary track with that of the anal sphincter, especially since present treatment involves resectioning of these structures, which are pertinent to preservation of rectal continence. The two types of classification used for perianal fistulas are Parks and St. James.

Park and *et al* in 1976 described four classes of perianal fistula depending on the course and inner opening with respect to the anatomical landmarks.
- Type 1: (Intersphincteric): The track is located only in the intersphincteric space (70%)
- Type 2: (Transsphincteric): The track penetrates the external sphincter to enter the ischioanal fossa (23%).
- Type 3: (Suprasphincteric): similar to Type 2, however it loops higher up through the puborectalis muscle and then descends into the ischioanal space to its external opening (5%)
- Type 4: (Extrasphincteric): the whole fistulous course is located outside the external sphincter with the internal opening at the rectum (2%).

St. James University Hospital Classification grades perianal fistula into 5 subtypes
- Grade 1: Simple linear intersphincteric fistula
- Grade 2: Simple linear intersphincteric fistula + abscess or secondary track.
- Grade 3: Transsphincteric fistula.
- Grade 4: Transsphincteric fistula + abscess or secondary track in ischiorectal or ischioanal fossa
- Grade 5: Supralevator and translevator.

St. James classification is the preferred method of classification for perianal fistulas as relevant MR findings were not included in the Parks classification. The former classification was proposed by radiologists, which is simpler to apply using anatomical structures as landmarks which are readily identified on the MR axial plane while reporting. In addition to this, St. James classification also takes into account both the primary and secondary fistulous tracts as well as abscesses while evaluating and classifying fistulas.[4,7]

The role of MRI and its advantages over other modalities
Imaging modalities used prior to MRI for the evaluation of perianal fistulas included- conventional fistulography, CT with rectal and intravenous (i.v.) contrast and Endoanal ultrasound. Fistulography had two disadvantages- (1) difficulty in identifying secondary tracts due to poor opacification by the contrast and (2) poor depiction of the anal sphincters and hence demonstration of their relationship with the fistula.[8] Kuijpers and et al retrospectively reviewed images of 25 patients who underwent fistulography, to identify the utility of contrast enhanced fistulography in identifying perianal fistulas. To their disappointment they found an accurate diagnosis was seen in only 16% of the patients, indicating that this technique was inaccurate and unreliable.[9] CT with rectal and I.V contrast although may be useful in identifying moderate to large abscesses and inflammatory changes in the perianal region, but it has a poor soft tissue resolution thereby failing to identify small fistulas and abscesses.[10,11] Endoanal ultrasound is an excellent modality for evaluating the rectal wall, anal sphincters and their relationship with the intersphincteric fistula.[12] However, its limited field of view restricts its use in evaluating primary superficial, suprasphincteric, and extrasphincteric tracks or secondary extensions. Buchanan and et al in their study involving 108 patients with primary fistulous tracts, found that endoanal ultrasound managed to identify 81% of the tracts, while MRI was able to identify 91%. While the ability to identify internal openings were 91% and 97% for endoanal ultrasound and MRI respectively, thereby proving MRI to be superior in all respects.[13]

MRI Technique & Protocols MRI provides the advantage of multiplanar imaging with unparalleled soft tissue differentiation.[14] MRI is done using surface or body coils with no prior patient preparation.

Although endoanal coils give higher resolution when compared with body coils, they have the disadvantage of limited field of view, which may restrict identification of sepsis or secondary supralevator and subcutaneous extension. And most importantly, endoanal coils are poorly tolerated by symptomatic patients.[15] Prior to the acquisition of imaging it is important to align the imaging planes with respect to the anal canal. As straight axial and coronal sections don't allow accurate evaluation of the origin and the fistulous tract (as anal canal is tilted 45° in the sagittal plane forward from the vertical), oblique axial and coronal images oriented orthogonal and parallel to the anal canal, respectively are

acquired. This is done by initially performing a sagittal fast spin-echo (FSE) T2-weighted sequence, which gives an overview of the pelvis. An accurate orientation of the anal canal is obtained from this sequence. It is imperative to include the levator muscle and entire perineum to locate all areas of infection and fistulous tracts that can cause recurrence. The most relevant sequences as proposed by Criado et al (and summarized in **Table 2**) for the evaluation of perianal fistulas are- 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. Other sequences such as Short Tau Inversion Recovery (STIR) and frequency-selective fat-satured T2-weighted FSE causes fat suppression of pelvic fat therby increasing the conspicuity of fluid filled fistulous tracts or abscesses.[16,17] Although STIR sequence gives a good fat suppressed signal, these images have poor spatial resolution when compared with frequency-selective fat-saturated T2-weighted FSE images, with the latter providing better anatomical information. Also, Spencer and *et al* in their prospective study found that STIR images were inferior to T1 weighted post contrast sequences in detecting subtle fluid collections or secondary extensions.[18] The disadvantage with frequency-selective fat-saturated T2-weighted FSE images is that the patient must be placed close to the center of the magnet to maximize the homogeneity and uniformity of the fat suppression.[19] In post-operative patients selection of the right sequence for imaging is important as foreign bodies such as sutures (e.g. seton, silk) can cause inhomogeneity of the magnetic field leading to susceptibility artifacts. In such situations frequency-selective fat-saturated T2-weighted FSE images are not useful as this sequences exacerbates the artifact even further. An alternative answer is to use STIR sequence, as it is less dependant on magnetic field homogeneity and can even be used with magnets with low field strength.[20-22] Potential newer sequences and recent advances **(Table 3)** which may help in identifying and diagnosing paerianal fistulas include: Three-dimensional (3D) T2-weighted turbo spinecho (TSE) sequences, Digital subtraction MR Fistulography, Diffusion Weighted Imaging (DWI) sequences, Dynamic Contrast Enhanced (DCE) MRI and evaluation of perianal fistula by 3T MRI.

Surgical Information To be Conveyed & Management of Perianal Fistula

Surgeons require a detailed report **(Table 4)** regarding the fistula with respect to location, its course, relationship to the sphincters and whether the fistula is simple or complex. Submucosal, intersphincteric or distal transsphincteric tracks affecting the lower one-third of the anal canal may treated by fistulotomy without significant risk of incontinence. However, in complex fistulas, division of external sphincter by incision or excision of the tract may be necessary to eradicate sepsis which can lead to incontinence. Incision and drainage is the simple treatment for perianal abscess secondary to glandular disease or Crohn's disease. In those patients with extensive and uncontrollable perianal fistula with proctitis, faecal deviating colostomy is an option.[23] Therapeutic options which do not involve incision of the anal sphincter in order to preserve anal continence include- placing a Seton (which is a thread) through the fistulous track to allow continuous drainage to reduce the severity of the fistula, use of fibrin plugs, glue etc. In those patients perianal fistulas secondary to Crohn's disease, first line therapy is antibiotics. However, recurrence is common following discontinuation, and remission can be maintained by use of Purine analogs such as azathioprine or 6-mercaptopurine. Other options include Anti–tumor necrosis factor (TNF) antibodies such as infliximab.[24]

CONCLUSION

MRI is a reliable and an excellent modality for assessing the perianal region and identifying perianal fistula. It provides an anatomical roadmap of the fistula thereby aiding the surgeon in a successful treatment of these patients. In addition to this, pre-op MRI is also useful in identifying secondary extensions and undetected infection such as an abscess there by diminishing the chance of recurrence following treatment. Therefore, MRI is the modality of choice in the preoperative evaluation of patients clinically suspected to have perianal fistulas, Crohns disease even those with recurrent anal fistulas.

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