Magnetic Resonance Imaging Role in Diagnosis of Perianal Fistula

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Abstract

Background: MRI has been found to accurately delineate the presence and course of a primary fistulous track, and also demonstrates the presence and site of any secondary extensions and accompanying abscess**.** MR imaging allows identification of infected tracks and abscesses that would otherwise remain undetected. Furthermore, radiologists can provide detailed anatomic descriptions of the relationship between the fistula and the anal sphincter complex, thereby allowing surgeons to choose the best surgical treatment, significantly reducing recurrence of the disease or possible secondary effects of surgery, such as fecal incontinence. MRI is considered the "gold standard" for imaging fistula anatomy. It provides excellent soft tissue resolution in multiple planes without the need for ionizing radiation. It is indicated for all recurrent fistulas and primary fistulas that appear to be complex after examination under anesthesia or endoanal ultrasound. Unfortunately, some patients have implants that preclude MRI or they find the procedure intolerable.

Keywords: Magnetic Resonance Imaging, Perianal Fistula

Introduction

Knowledge of the anatomy of the anal sphincter complex and surrounding spaces is crucial for image interpretation. The anal canal extends from the levatorani 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 anal region is composed of the anal canal, the anal verge, and the anal margin. The anal canal extends from the dentate line, which is at the inferior margin of the anal columns of Morgagni, to the anal verge and measures approximately 4 cm. However, functionally accepted boundaries extend from the anorectal junction above, which is defined by the puborectalis muscle, to the anal verge below. **(1).**

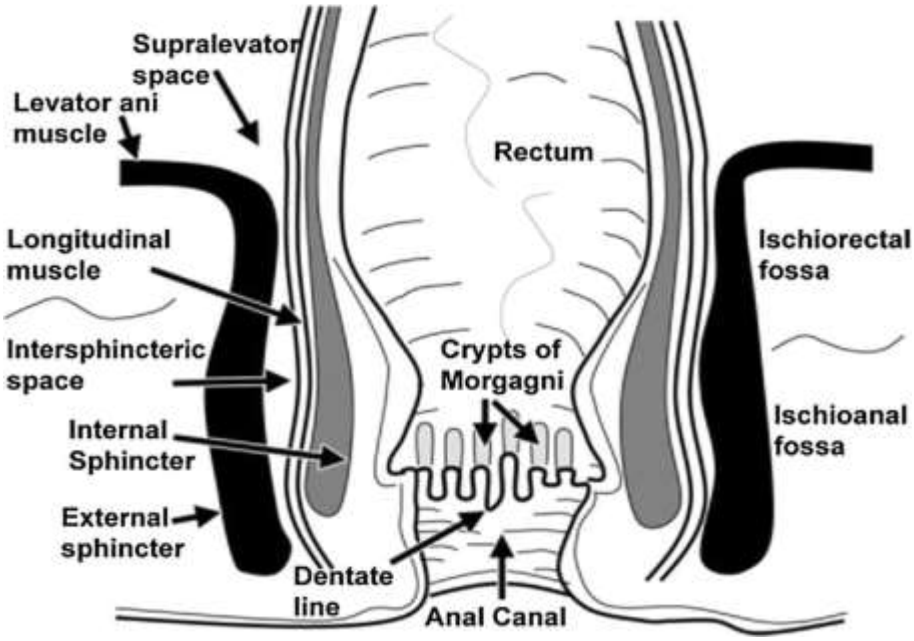

Figure 1
Diagrammatic representation to demonstrate normal anatomy in a coronal section

The anal canal is the terminal part of the large intestine. It lies between the rectum above and the anal verge in the perineum below. The demarcation between the rectum and the anal canal is the anorectal junction, where the puborectalis muscle forms a U-shaped sling posteriorly. Anal verge (anal margin, anus) is an opening surrounded by the perianal skin overlying the subcutaneous external anal sphincter (EAS) at the most distal portion of the anal canal. Since the anal verge can be readily seen during inspection, it serves as the reference line for the position of all other anorectal structures detected in various examination methods **(2)**.

The anal verge is a band of squamous epithelial tissue that lacks hair follicles and extends from the intersphincteric groove onto the perianal skin. The anal margin, or perianal skin, is identified by keratinized epithelium containing hair follicles and encompasses a radius of 5 cm from the anal verge. The muscles surrounding the anal canal control continence and can be separated into the internal anal sphincter and the external anal sphincter **(3)**.

The external anal sphincter **(3)** is contiguous with the levatorani and puborectalis muscles superiorly, is innervated by branches of the pudendal nerve and the perineal branch of the S4 nerve root, and contributes to voluntary control of fecal continence **(4)**.

On phased-array 3-T MRI, the mean length of the anal canal as measured from the anorectal junction to the caudal tip of the subcutaneous EAS is 4.4 cm **(5)**.

3.2 <u>Causes, signs & symptoms</u>:

- **<u>Causes</u>:** Local infection related to an anal fissure, carcinoma or foreign body may also cause a fistula. 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. The fistula and anal gland obstruction are thought to be a result of several inflammatory conditions and events, including Crohn's disease, pelvic infection, tuberculosis, diverticulitis, trauma during childbirth, pelvic malignancy, and radiation therapy, that extends caudally through the levator plate, traverses the ischio-rectal fossa, and terminates at the cutaneous opening. Most importantly, an extrasphincteric fistula does not involve the internal or external anal sphincters **(4)**.
- **<u>Signs &symptoms</u>:** Signs and symptoms of fistula-in-ano, in order of prevalence, include the perianal discharge, pain, swelling, bleeding diarrhea, skin excoriation & external opening **(6)**.

3.3. <u>Pathogenesis</u>:

An anal fistula is a tunnel-like tract between the lining of the anal canal and the skin around the anus. A fistula forms usually after an anal abscess has drained spontaneously or following surgical drainage. Because the tract is lined with chronic infection it tends not to heal and there is a persistent discharge of pus. This may settle temporarily with or without antibiotics but then recurs. A fistula title is descriptive of its position in relationship to the sphincters such as superficial or deep, intersphincteric, transsphincteric, suprasphincteric. The higher and more complex the fistula the more difficult to treat.

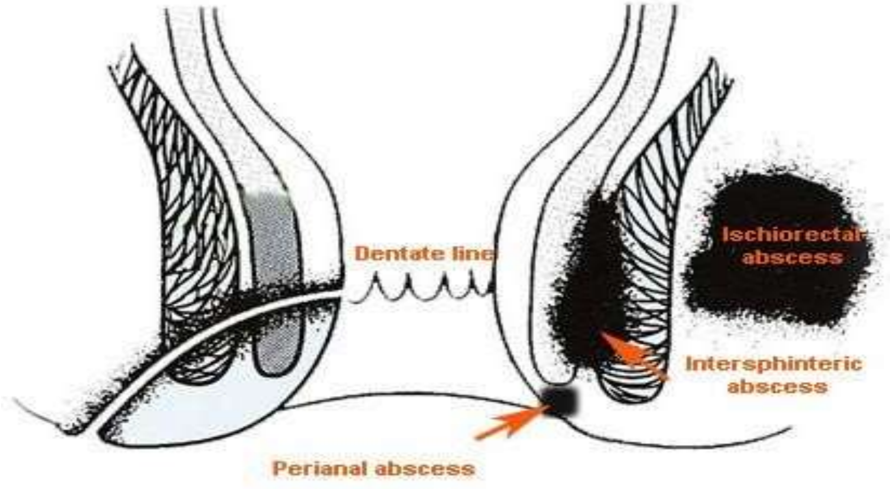

Figure 5

Intersphincteric, ischiorectal abscess

How do anorectal fistulas develop?

Most (~90% in most case series) anal fistulas are idiopathic. Infection of glands in the intersphincteric space of the anal canal is thought to underlie both acute anorectal abscesses and anal fistulas the "crypto glandular hypothesis." The exact cause or mechanism of infection has not been fully elucidated, but it spreads through pathways of least resistance, and in so doing creates a track that persists thereafter. Hence, a common presentation is an acute abscess that fails to heal after surgical drainage or recurs at the same site. It is not clear why certain cases of perianal sepsis are limited to abscess formation whereas others are associated with fistula formation. A recent review of perianal abscess and fistula quotes a fistula formation rate of 26-37% after perianal abscess **(7)**.

3.4. <u>Classification</u>:

Classification of fistula in ano is of immense importance as it gives accurate anatomical description for the fistulous tract which is helpful to a surgeon in planning the operative cure of the disease **(8)**.

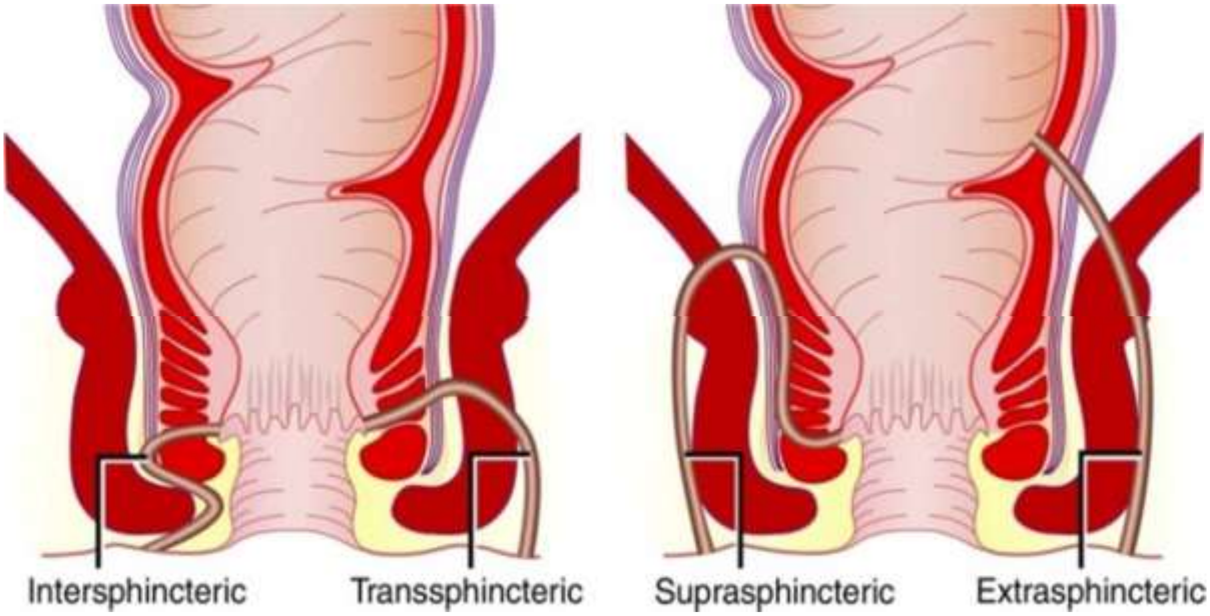

Figure 2 Illustrations in coronal plane show classification of fistula in ano according to Parks

Several classification systems have been developed in an attempt to quantify disease extent and severity of fistula in ano. Parks Classification is the most common classification used for fistulas-in-ano. Classification of fistula in ano is used to determine (surgical) therapy, make a prognosis concerning recurrence and fecal incontinence. The study aimed to evaluate the patterns of fistula in ano (FIA) in our local population using Parks Classification and the simplest system of classification. Fistulae were classified using Park′s classification depending on its location in relation to the anal sphincter muscles and the simplest system of classification of perianal fistulae that divides fistulae into either low or high depending on their relationship to the dentate line. **(9)**.

This classification system defines four types of fistula-in-ano that result from crypto glandular infections: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric while The simplest system of classification of perianal fistulae is to divide fistulas into either low or high, depending on their relationship to the dentate line, fistulae that originate below the dentate line are considered to be low fistulae, whereas those above or at the dentate line are considered to be high fistulae **(9)**.

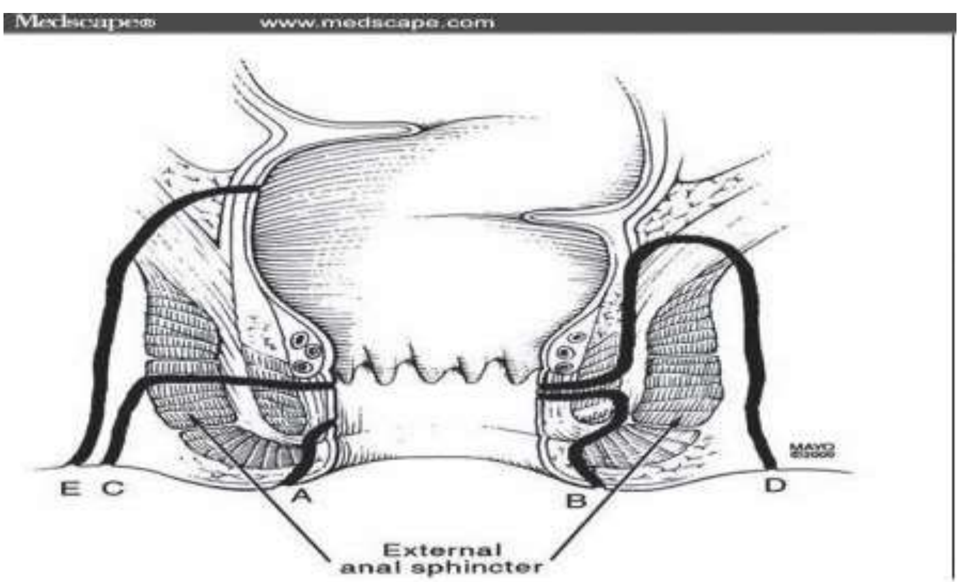

Figure 3Fistula classification.
A: Low fistula not involving muscle. **B: Intersphincteric fistula.**
C: Trans-sphincteric fistula. **D: Suprasphincteric fistula.**
E: Extrasphincteric fistula.

The radiological equivalent of the Parks classification system is known as St James' University Hospital (SJUH) grading scheme **(10)** which is based upon the MRI imaging appearance of perianal fistulae in the axial and coronal planes. The added feature of this classification is the identification of secondary extensions as well as complications such as an abscess. This system recognizes six types:
Grade 0 refers to a normal appearing anal canal; Grade 1 represents a simple intersphincteric fistula, while Grade 2 represents an intersphincteric fistula with a secondary tract or abscess; Grade 3 fistula refer to simple transphincteric fistulae, while Grade 4 represents a more complicated transphincteric process with a secondary tract or abscess; finally, a Grade 5 fistula represents a complicated abscess with a supra or translevator component.

To understand the many new approaches to anal fistulae, some explanation of their classification is needed. Understanding anal anatomy is the key to understand anal fistulae. In most surgical texts, fistulae are discussed in two groups. The first group contains 'low' or 'simple' fistulae, which are intersphincteric or trans-sphincteric fistulae involving only the lower one-third of the sphincter complex. Alternatively, they may not involve any muscle. The second group contains 'high' or 'complex' fistulae. These are the remainder of intersphincteric and transsphincteric fistulae, and also Suprasphincteric and extrasphincteric fistulae **(11)**.

Location of Anal Fistulas: The Anal Clock

Anal fistulas are classified according to their progression relative to the anal sphincter and pelvic floor structures. To characterize a perianal fistula, it is essential to adequately describe the point of origin in the anal canal and the path of the fistula with respect to the pelvic anatomic boundaries. To locate the point of origin and describe the direction of the fistulous track, we use an "anal clock" scheme, which is the same as that used by surgeons to describe injuries around the anal region. With the patient in the lithotomy position, the anterior perineum is located at 12 o'clock and the natal cleft is at 6 o'clock, with the left lateral aspect of the anal canal at 3 o'clock and the right lateral aspect at 9 o'clock **(10)**. These descriptions correspond exactly with the view of the anal canal on axial MR images obtained with the patient in the decubitus supine position. Secondary tracks or ramifications may be found within the intersphincteric plane, the ischio-rectal fossa, or the supra-levator space.
''Horseshoe'' tracks may pass circumferentially in these planes and may cross the midline **(12)**.

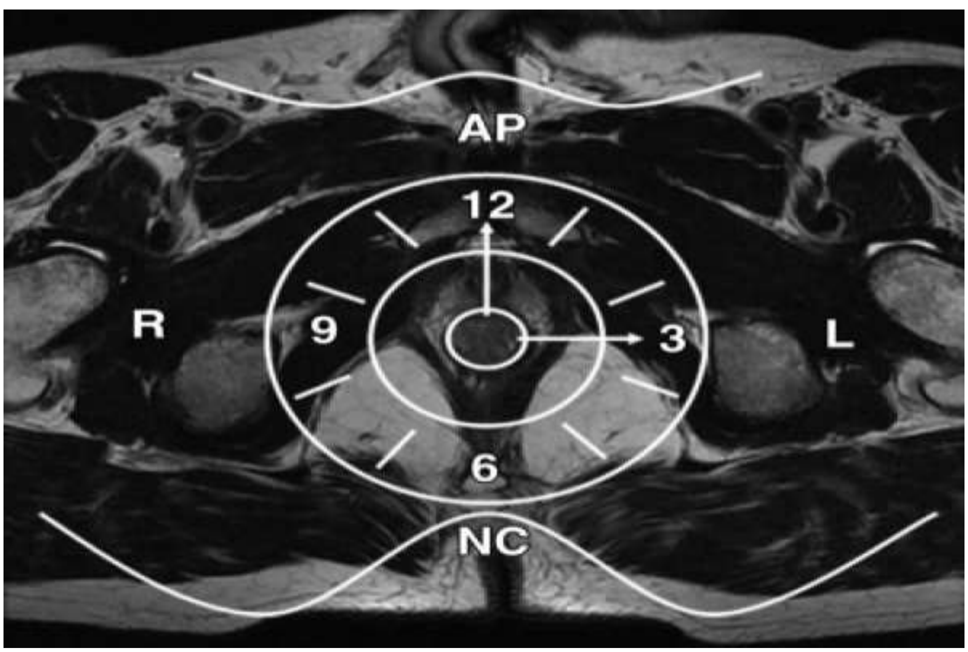

Figure 4 Anal clock.
Axial T2-weighted MR image of the male perineum shows: The anal clock diagram used to correctly locate anal fistulas with respect to the anal canal. (AP: Anterior perineum, L: Left aspect of the anal canal, NC: Natal cleft, R: Right aspect of the anal canal).

Imaging with Computerized Tomography (CT), ultrasound, Magnetic Resonance Imaging (MRI), or fistulography, has proven useful in the assessment of occult anorectal abscess, recurrent fistula-in-ano, and perianal Crohn's disease **(13)**.

Fistulography has two major drawbacks: 1st the difficulty of assessing secondary extensions owing to lack of proper filling with contrast material and 2nd inability to visualize the anal sphincters and hence determines their relationship to the fistula **(14)**.

However, the use of contrast material leads to increased cost and its use may be contraindicated in a subset of patients with impaired renal function due to concerns about development of nephrogenic systemic fibrosis (NSF) **(15)**.

3.5. MRI Role:

MRI has been found to accurately delineate the presence and course of a primary fistulous track, and also demonstrates the presence and site of any secondary extensions and accompanying abscess **(16)**.

MR imaging allows identification of infected tracks and abscesses that would otherwise remain undetected. Furthermore, radiologists can provide detailed anatomic descriptions of the relationship between the fistula and the anal sphincter complex, thereby allowing surgeons to choose the best surgical treatment, significantly reducing recurrence of the disease or possible secondary effects of surgery, such as fecal incontinence **(17)**.

MRI is considered the "gold standard" for imaging fistula anatomy. It provides excellent soft tissue resolution in multiple planes without the need for ionizing radiation. It is indicated for all recurrent fistulas and primary fistulas that appear to be complex after examination under anesthesia or endoanal ultrasound. Unfortunately, some patients have implants that preclude MRI or they find the procedure intolerable. In these cases, thin slice spiral computed tomography may be useful and may also be informative if abdominal or pelvic sources of sepsis are suspected; its value is otherwise limited. Similarly, fistulography has been superseded by endoanal ultrasound and MRI, and its role is limited to cases where an extrasphincteric track is suspected. A recent metaanalysis of four studies confirmed that endoanal ultrasound and MRI had similar sensitivity for detecting fistulas (87%), but that MRI had a higher specificity (69% *v* 43%) **(18)**.

DWI can help diagnose small or multiple lesions that may be overlooked on fat-suppressed T2-weighted images alone. Overlooking a lesion on imaging is generally the most important cause of recurrence in patients who undergo surgical treatment. Also, DWI can be used for follow-up of anal fistulas during the postoperative period, especially when digital rectal examination is not feasible have also suggested the potential application of DWI (with measurement of the apparent diffusion coefficient [ADC]) for assessment of fistula activity. They reported that ADC measurements may be particularly helpful in excluding active inflammation **(**. In their feasibility study to assess disease activity, an optimal cutoff ADC of 1.109 yielded a sensitivity of 95.7%, a specificity of 50%, a positive predictive value of 71%, and a negative predictive value of 90% **(19)**.

Imaging of the bowel with DWI remains challenging, however, because of its relatively long acquisition times, sensitivity to bowel motion and the presence of T2 shine through effects that are frequently encountered in the bowel lumen. However, recent technical refinements have improved the feasibility of using DWI to evaluate the bowel, and several recent studies have evaluated its accuracy and performances in CD patients **(20)**.

3.6. MRI Appearance:

Traditional limitations of MRI cited in the past are a relatively high cost, low spatial resolution, susceptibility to artifacts and lack of widespread availability. However, the advent of major improvements in hardware and software in recent years, have largely overcome these technical limitations **(21)**.

T2-weighted sequences provide high contrast for anatomical assessment of the different layers of the anal sphincter, whereas gadolinium-enhanced T1-weighted sequences reveal areas with increased vascularity such as the wall of active fistulas and abscesses **(14)**.

The external sphincter is hypointense on T2-weighted MR images and can be easily recognized by its contrast in signal intensity from the surrounding high-signal-intensity intersphincteric fat plane medially and the ischioanal and ischiorectal fat laterally **(22)**.

Diffusion-weighted MRI may be the next improvement in scanning techniques to yield better images, but this is only available in a few centers **(23)**.

Active fistula tract appears as a hypo intense linear structure onT1weighted imaging and hyper intense 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 hyper intensity and contrast enhancement **(14)**. Inactive tracts are also hypo intense on T1- weighted imaging but lack the associated T2weighted imaging hyper intensity and contrast enhancement. Tissues surrounding the tract may also show hyper intensity on T2-weighted imaging if there is edema or inflammation.

It has been demonstrated that active inflammation can be identified with the use of T2-weighted and gadolinium chelate-enhanced T1weighted images. Active inflammation is hyperintense on T2-weighted images, since it is full of pus and granulation tissues **(14)**. Active granulation tissues show contrast enhancement on gadolinium chelate enhanced T1-weighted images; however, fluid enclosed in the fistula shows hypointense signals. On the other hand, hyperintense signal changes may extend outside the fistula tract as surrounding soft tissue inflammation **(14)**.

As a result, both fistula and surrounding soft tissue are similarly observed with hyperintense signal on fat-suppressed T2-weighted images. However, fistula displays hyper signal on DWI so that it can be clearly differentiated from surrounding structures and the extent can be more easily visualized. This is attributed to the fact that the fistula/background contrast ratio is high on DWI. However, images with a high spatial resolution are needed in order to provide a better anatomic orientation during the preoperative period, due to the low spatial resolution of DWI. Consequently, DWI is used together with fat-suppressed T2-weighted images in order to identify the fistula tract and to characterize the active inflammation areas **(23)**.

The use of DWI helps quantify this restriction of motion. DWI is performed by using a T2-weighted fat-suppressed MR sequence with the addition of a diffusion gradient, which is quantified by a diffusion coefficient called “b-value”. By increasing the diffusion coefficient, the signal in areas of free diffusion decreases more rapidly, while in regions where diffusion is restricted the signal decreases more slowly. The acquired images must be post- processed to extract parametric maps representing the different factors of the fitted equation. The most commonly used technique, available on all commercially available MR scanners, is the mono-exponential fitting method, which provides a single parametric map called the apparent diffusion coefficient (ADC) map **(24)**.

Recent studies have suggested that (DWI) sequences, which reflects motion of water molecules and their interactions with macromolecules and cell membranes, may be helpful for the diagnosis of anal fistulas **(19)**, and abscesses complicating anal fistulas by revealing restricted diffusion of water molecules due to viscous pus **(25)**.

3.7. <u>MR Imaging Technique</u>:

Most authors recommend that patients fast before DW-MRE, with a delay varying from 2 to 6 hours. It is assumed that fasting helps limit peristaltic movements of the bowel and maximizes the contrast between the lumen and the bowel wall. **(25)**.

MR imaging performed with surface coils provides excellent anatomic detail of the anal sphincters and the anatomic boundaries of the pelvis. High-resolution T2- weighted MR images are the standard of reference in the evaluation of pathologic conditions of the anal canal **(22)**. These images are ideally obtained with 3-mmthick sections by using a small field of view. The anal canal is tilted forward in the sagittal plane; thus, appropriate angulation of the oblique axial images orthogonal to the plane of the anal canal and of oblique coronal images parallel to the plane of the anal canal is essential for the proper assessment of the sphincter complex **(26)**.

The protocol used at our institution for the evaluation of anal disease includes oblique axial T1-weighted fast spin-echo MR pulse sequences, oblique axial and coronal T2-weighted fast spin-echo sequences, fat-saturated T2-weighted sequences that use short inversion time inversion recovery or spectrally adiabatic inversion recovery, and oblique axial and oblique coronal fat-saturated T1-weighted fast spinecho sequences. The three-dimensional isovoxel

T2-weighted fast spinecho sequence provides source data for post processing with image reformatting techniques to obtain reformatted images in any desired plane. Diffusion-weighted MR imaging is routinely performed for the evaluation of pathologic conditions of the anal canal**.** Commonly used *b* values include 0, 400, and 800 sec/mm^2, followed by reconstruction of an apparent diffusion coefficient map **(4)**.

Most published studies suggest that DWI examinations should be performed with a low b-value (0 - 50 mm²/s) and a high b value (800 to 1000 mm²/s) depending on the MR equipment. The transverse plane for DW image acquisition is less sensitive to motion artifacts and should be preferred imaging plane. Bowel distention and the administration of antiperistaltic agents are recommended by all authors in recent studies and help improve image quality. There is currently no accepted optimal cut-off ADC value to discriminate between active and non-active CD, but DWI using high bvalue images can be used to help depict inflammatory bowel segments and complications such as fistulas and abscesses. The use of diffusion weighted imaging (DWI) sequences represents a new possibility of expanding the ability of MRI, which can give additional information about the changes of the inflammatory bowel disease **(27)**.

Imaging of the bowel with DWI remains challenging, however, because of its relatively long acquisition times, sensitivity to bowel motion and the presence of T2 shine through effects that are frequently encountered in the bowel lumen. However, recent technical refinements have improved the feasibility of using DWI to evaluate the bowel, and several recent studies have evaluated its accuracy and performances in CD patients **(20)**.

MRI can be used to assess treatment response, as suggested by **Savoye-Collet *et al.*, (28)**. Loss of T2-weighted imaging hyper intense signal precedes lack of enhancement and proposed a predictable stepwise response to therapy. These stepwise changes 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. In patients with prior surgery, it is important to note the associated findings, such as fat packing (hyper intense 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) **(4)**.

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