International Journal of Leading Research Publication
IJLRP

© IJLRP | ISSN (O) - 2582-8010
June 2024 | Vol. 4 Issue. 10
www.ijlrp.com

Magnetic Resonance Imaging for Perianal Fistulizing Disease: Evaluation Methods and Anatomical Insights

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ABSTRACT

Following clinical assessment and radiological evaluation with ultrasound and MR fistulogram, the diagnosis confirmed was a utero-cutaneous fistula. To address this, a complete resection of the fistulous tract was performed, along with closure of the uterine defect and placement of a supportive omentum patch. The presence of the utero-cutaneous fistula was confirmed intraoperatively by injecting methylene blue dye. Utero-cutaneous fistula is a rare complication that can occur after a caesarean section (Thipphavong et al., 2019).

Initially, plain radiography, combined with contrasted examinations and fistulograms, was commonly used to study fistulas. These traditional methods remain valuable. However, advancements in imaging techniques over the past 15 years, including endoscopy, ultrasound, and cross-sectional imaging, have significantly improved diagnostic capabilities.

In evaluating acquired enterocutaneous fistulas, various imaging modalities play key roles both diagnostically and therapeutically. Among these, gadolinium-enhanced T1-weighted imaging (Gd-T1WI) is particularly effective in visualizing bladder fistulas, showing superior detail compared to T1-weighted or T2-weighted imaging. Non-bladder fistulas can be identified by all imaging procedures with varying levels of effectiveness. Perianal fistulas are the most clearly visualized on MR images, with consistent performance across different MR sequences.

Keywords: Obstetrics and gynaecology; Surgery.

INTRODUCTION

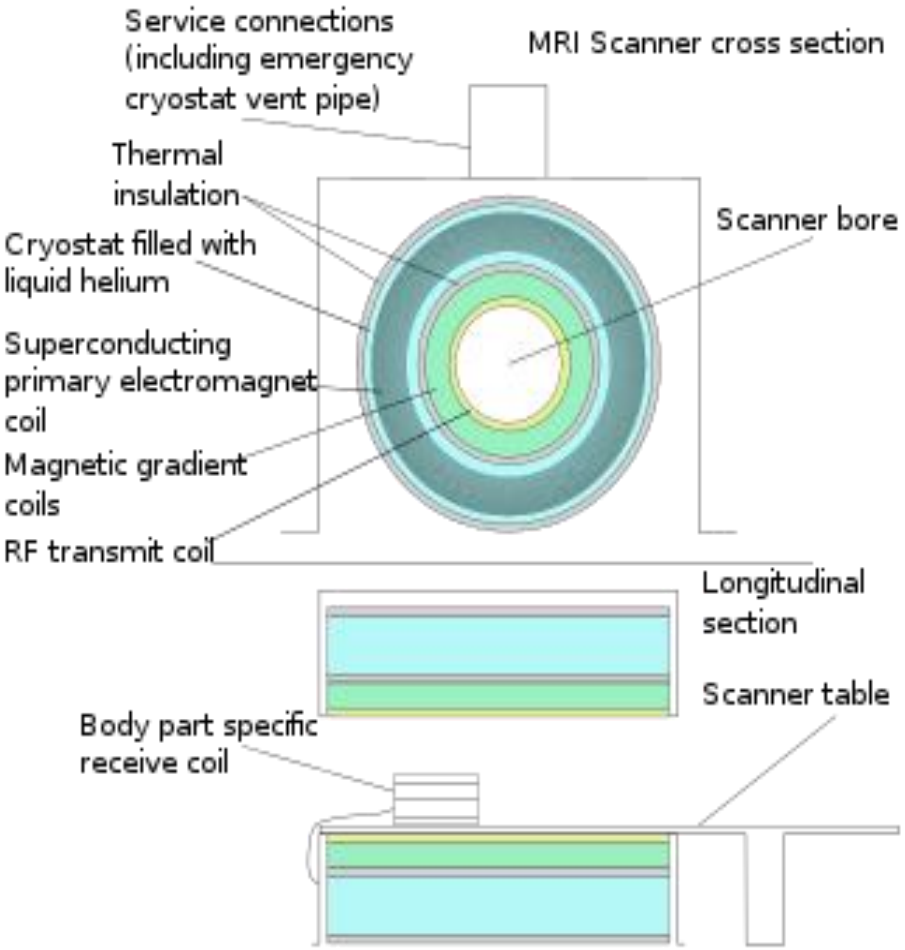
Magnetic Resonance Imaging (MRI) is the most effective imaging technique for evaluating anal fistulas before surgery. MRI is a diagnostic imaging method that provides detailed pictures of the body's anatomy and physiological processes without using X-rays or ionizing radiation, unlike computed tomography (CT) or positron emission tomography (PET) scans. MRI utilizes strong magnetic fields, magnetic field gradients, and radio waves to create images of internal organs. It is commonly used in hospitals and clinics for diagnosing, staging, and monitoring diseases. Compared to CT scans, MRI offers superior contrast for soft tissues such as those in the brain or abdomen. However, MRI may be less comfortable for patients due to the typically longer and noisier procedure within a narrow, enclosed space, though "open" MRI systems can alleviate some of this discomfort. Additionally, the presence of metal implants or other non-removable metal objects in the body can pose risks and may preclude some individuals from safely undergoing an MRI.

How MRI Works:

1. **Hydrogen Atom Alignment:** The human body, which is predominantly composed of water molecules containing hydrogen atoms, aligns these hydrogen atoms with a strong magnetic field when placed inside the MRI machine.
2. **Radiofrequency Pulse:** A radiofrequency pulse is applied, causing the aligned hydrogen atoms to absorb energy and temporarily shift from their aligned position.
3. **Relaxation:** Once the radiofrequency pulse is turned off, the hydrogen atoms return to their original alignment, releasing the absorbed energy. This released energy is then detected by coils within the MRI machine.
4. **Image Reconstruction:** A computer analyzes the amount of released energy and the time it takes for the hydrogen atoms to realign, constructing detailed images of the body's internal structures.

MRI is particularly effective for imaging soft tissues, such as the brain, spinal cord, muscles, ligaments, and organs like the heart, liver, and kidneys. It offers detailed imaging without ionizing radiation, making it a valuable tool for diagnosing

various conditions, including tumors, injuries, and neurological disorders. MRI machines come in several configurations: traditional closed-bore systems, open-bore systems (which are less claustrophobic), and portable MRI machines for specific uses.



ANATOMY

The anal sphincter complex consists of two main components: the internal and external anal sphincters. The external sphincter is a striated muscle encircling the anus and is under voluntary control, while the internal sphincter is a circular muscle situated closer to the interior of the anal canal and is under involuntary control. Anal fistulas can be classified into four primary types:

- **Intersphincteric Fistula:** This is the most common type, located between the internal and external sphincters, with the external opening situated near the anus.
- **Trans-sphincteric Fistula:** This type crosses the external sphincter, opening more laterally, and is often associated with horseshoe-shaped abscesses.
- **Suprasphincteric Fistula:** This fistula extends above the puborectalis muscle, tracking laterally close to the levator ani muscle.
- **Extrasphincteric Fistula:** The least common type, it traverses the ischiorectal fossa and the levator ani muscle, then enters the rectal wall above the dentate line.

Boundaries of the Anus: The anal canal begins at the anal verge, the lowest point of the external sphincter. Its radiologic upper boundary is defined by the upper portion of the puborectalis muscle. The anus is surrounded on both sides by the ischioanal fossa, which is part of the infralevator section of the gastrointestinal tract. Occasionally, the ischiorectal fossa is incorrectly referred to as the ischioanal fossa.

Muscular Wall of the Anus: The puborectalis muscle fibers continue into the pelvic floor, while the external sphincter is a voluntary, striated muscle extending 1.5–2 cm upward. The pelvic floor muscle is termed the levator ani for radiologic purposes. Like the rest of the gastrointestinal tract, the rectum is covered by the muscular propria layer, which consists of an outer longitudinal layer and an inner circular layer. The internal sphincter and the circular muscle are connected. The external sphincter contributes about 15% to the anus's resting tone, with the involuntary internal sphincter accounting for the remaining 85%. Injury to the external sphincter can result in fecal incontinence, and its contraction can obstruct bowel movements.

Pathophysiology: An anal fistula is characterized by granulation and inflammatory tissue, forming an epithelialized connection between the anal canal and the external perianal region. Healing is impeded by distal obstruction, leading to the accumulation of debris in the fistula tract and blockage. Seton therapy can aid in fistula healing by enabling continuous drainage and typically promoting fistula migration.

Histopathology: Histological examination of fistula tissue should be conducted if there is suspicion of an atypical cause, such as an infection or malignancy. Generally, tissue from anal fistula surgery is not routinely sent for pathological analysis unless there is an indication of an underlying process.

Differential diagnosis for anal fistula

- Anal fissure
- Anal warts
- Condyloma acuminate
- Haemorrhoids
- Perianal abscess
- Solitary rectal ulcer syndrome

In addition to these, there are infectious, benign, and malignant processes which may present as or appear as an anal fistula such as

- Crohn’s disease
- Hidradenitis suppurativa
- Anal cancer
- Atypical presentation of anal sexually transmitted diseases can mimic Anorectal fistula. Anorectal sexually transmitted infections include syphilis, herpes, gonorrhoea, or chlamydia as well as granuloma inguinal caused by Calymmatobacterium granulomatosis
- HIV positive patients presenting with symptoms of anal fistula, the diagnosis of potential Kaposi sarcoma, as well as lymphoma.

Findings

At the level of the rectum, there are three key pelvic spaces: the infralevator space, which is bordered by the levator ani muscle; the supralevator space; and the peritoneal space. The supralevator space is further divided into the perirectal portion, which contains connective tissue and ureters, and the perirectal portion, which contains fat, separated by the perirectal fascia. On a coronal plane, the levator ani muscle appears V-shaped, while on a sagittal plane, it shows a linear hypo-intensity.

The initial step in evaluating pelvic anatomy is to obtain an unenhanced T1-weighted (T1w) image, which provides a general overview. This imaging reveals structures such as the ischiorectal fossa, the sphincter complex, and the levator plate. If a fistula is present, it will appear on the T1w image as a region of low or intermediate signal, blending with the

© IJLRP | ISSN (O) - 2582-8010
June 2024 | Vol. 4 Issue. 10
www.ijlrp.com

normal anatomical structures. One advantage of T1-weighted sequences is their ability to highlight hemorrhage, which appears as areas of high signal intensity, particularly useful in postoperative evaluations.

T2-weighted (T2w) imaging provides crucial information about the condition of fibrosis, both before and after contrast enhancement. Active fistulas are well-visualized on T2w images, especially when combined with fat suppression sequences, which helps distinguish them from chronic fibrous tracts that appear as low-signal areas in both T1w and T2w images. Abscesses, in contrast, show high signal intensity. Accurate assessment of the extension of fistulous tracts into the supralevator area is vital, as it can impact surgical planning. Fistulas that extend below or above the levator ani muscle may require treatment from both sides, indicating the severity of the condition (Reginelli et al., 2020).

SEQUENCE

The most commonly used MRI sequences for evaluating fistulas are T2-weighted images, with or without various types of fat saturation, and T1-weighted images, both before and after gadolinium enhancement and with fat saturation. On T2-weighted images, fistulas typically appear as a central tract with high signal intensity, encircled by a relatively low-signal-intensity wall. The high-signal intensity within the tract represents the true lumen and granulation tissue, while the low-signal intensity surrounding it indicates fibrotic tissue. As fibrosis progresses, the high signal intensity of the lumen diminishes, reflecting the chronic phase of the fistula.

When using turbo-spin-echo (TSE) T2-weighted sequences, incorporating fat suppression is essential. This is because the intense signal from surrounding fat can obscure the high-signal intensity of the fistula, making it more challenging to detect.

Fig. Sagittal T2-weighted image with fat-saturation

MRI PULSE SEQUENCE	PLANE	COMMENTS
T2-weighted without fat suppression	SagittalOblique coronal Oblique axial	Straight axial and coronal can be alternatives to oblique planesAxial should have small FOV for maximum resolution

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June 2024 | Vol. 4 Issue. 10
www.ijlrp.com

T2-weighted with fat suppression	Oblique axial	Match plane and FOV to T2 without fat suppressionFluid-sensitive sequence to detect T2 bright fistulas, sinus tracts, abscesses, edema, and internal opening
T1-weighted with fat suppression	Oblique axialOblique coronal	atch axial plane and FOV to T2-weighted imagingAxial imaging pre- and postcontrast, coronal postcontrastContrast enhancement detects inflammation, delineates fistula course, confirms abscess, and facilitates detection of internal opening

(Santillan et al., in 2021)

Abscess: Any widening of the primary or the secondary tract could be considered an abscess. There is no clear-cut definition of when a fistula is large enough to be called an abscess; the arbitrary limit of 1 cm can be used.

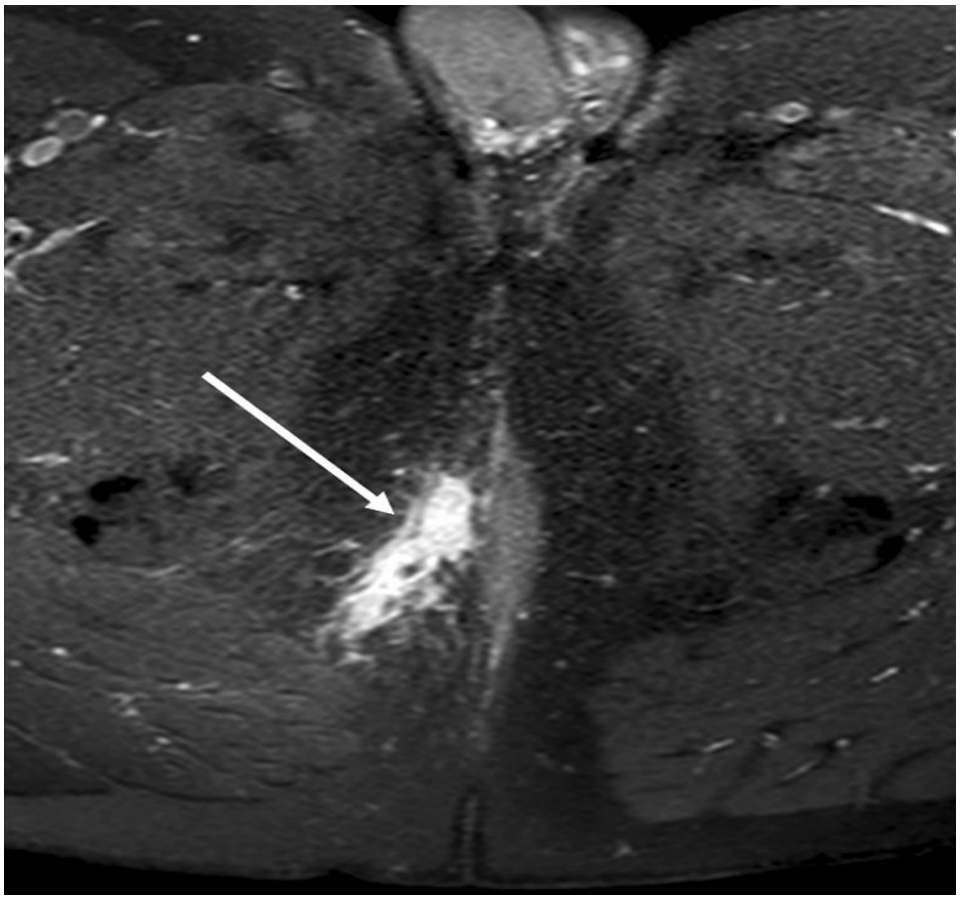

Fig. T1-weighted image with fat-saturation after gadolinium contrast enhancement. Inflammation around a fistula is depicted by avid contrast enhancement (white arrow).

Fistula Openings:

Typically, the external openings of anal fistulas are easy for both patients and surgeons to locate, although the precise location is often less critical. According to Goodsall's rule, a fistula that opens posteriorly in the midline and behind the transverse anal line will also open posteriorly into the anal canal. Conversely, a radial tract is usually associated with an

anterior opening. However, anterior fistulas more than 3 cm from the anus may have a curved trajectory, similar to posterior fistulas. (Torkzad et al., 2010)

Discussion:

MRI often lags behind clinical improvement due to its reliance on both inflammatory and structural parameters, making it less accurate for prognostication or assessing progress over time. Following the initiation of hospital drainage and medication therapy, inflammatory characteristics, such as tissue edema and high signal intensity on T2-weighted imaging, are valuable for monitoring Crohn's disease patients. Inflammatory activity in fistulas has been identified as crucial for evaluating and tracking perianal Crohn's disease. Consensus discussions led to the identification of essential characteristics of anorectal fistulas that should be reported on all MRIs. The expert panel agreed on key features that influence management decisions, applicable to all patients regardless of their clinical history or treatment center. (Iqbal et al., 2022)

Surgical management typically involves excising perianal fistulous tracts and draining related abscesses while preserving the anal sphincter complex. Post-surgery, recurrence often stems from undetected or untreated abscesses and fistulas. Therefore, preoperative MRI is critical to prevent treatment failure, as it helps in identifying the fistulous tract relative to the anal sphincter complex, including its course, ramifications, and associated abscesses. MRI sequences, especially combined DWI-T2W imaging, provide superior visibility scores compared to DWI, T2W, and contrast-enhanced MRI (CEMRI) alone. While Grades 3 to 5 perianal fistulas often result in poor outcomes and increased likelihood of recurrence, Grades 1 and 2 are typically associated with better initial surgery outcomes. Thus, combined DWI-T2W images are often sufficient for evaluating perianal fistulas, and contrast-enhanced MRI may be less necessary. For patients with contraindications to MRI contrast agents, DWI, T2W, or combined DWI-T2W imaging remains crucial. (Boruah et al., 2021)

Our study, consistent with other research, shows that perianal fistulas predominantly affect adult males (9:1 male-to-female ratio) with a mean age of 40 years. The type of anal fistula and the distance from the external opening to the anal margin are strongly correlated. Most transsphincteric fistulas (90.7%), as well as all suprasphincteric (100%) and extrasphincteric (100%) fistulas, have openings located more distally (>3 cm) from the anal verge. In contrast, intersphincteric (95.7%) and low transsphincteric (71.8%) fistulas typically open nearer to the anal verge (≤3 cm). There are some exceptions, particularly involving external scrotal apertures on the posterior midline. MRI remains a key imaging modality for preoperative assessment and treatment of perianal fistulas, providing detailed visualization of fistulas, associated abscesses, and secondary extensions that other modalities may miss. MRI also offers valuable information on anatomical relationships essential for planning surgical intervention. High-field MRI systems, such as those with 1.5- or 3-Tesla strength and multichannel phased array coils, enhance the resolution and field of view. Accurate preoperative mapping of fistulas, significantly influencing surgical outcomes, relies heavily on MRI, particularly using T2-weighted turbo-spin-echo (TSE) and post-contrast fat-saturated T1-weighted TSE sequences. (Vo et al., 2019)

Anal fistulas, affecting about 0.01% of the population, are a significant source of morbidity, primarily in young adults and men. Up to 60% of Crohn's disease (CD) patients have perianal disease, with perianal fistulas accounting for 30% of cases. In some instances, perianal fistulas are the initial symptom of CD. An anal fistula is defined by an abnormal tract connecting the anal canal with the perianal skin. Despite surgery, some fistulas recur, often due to undiagnosed infections. Discharge and local pain are common symptoms. CD is a major inflammatory process leading to perianal fistulas. The most common type is intersphincteric fistulas, with a primary tract passing through the intersphincteric space. Transsphincteric fistulas, which traverse the external sphincter and extend into the ischioanal fossa, are less common. Both types may develop secondary tracks and abscesses. Fistulas can spread in the intersphincteric space, ischioanal space, or fossa, and can form horseshoe-shaped branches or abscesses around the inner entrance. (Alabiso et al., 2016)

Conclusion: The objective of this article is to examine MRI categorization systems, relevant anatomy, and MRI technology in the assessment of perianal fistulizing disease. We provide a comprehensive reporting framework for systematically evaluating perianal fistulas using MRI. Although MRI is not typically the primary imaging modality for fistulograms, it can offer valuable supplementary information in specific clinical situations, particularly when assessing soft tissue involvement, characterizing abnormalities, or planning surgical interventions. Currently, pelvic MRI is considered the gold standard for evaluating and measuring perianal disease in patients with Crohn's disease (CD). Classification systems such as the Parks and St. James systems are instrumental in determining the most effective surgical approach and assessing the fistula. MRI enables precise scheduling of procedures. Given MRI's crucial role in

managing these patients, radiologists must be well-versed in the findings and implications of perianal CD. The decision to incorporate MRI into the evaluation process should be guided by individual patient needs and clinical indications.

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