ROLE OF 3 TESLA MAGNETIC RESONANCE IMAGING IN THE PREOPERATIVE EVALUATION OF PERIANAL FISTULAS - A ONE-YEAR HOSPITAL-BASED CROSS-SECTIONAL STUDY”

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LIST OF ABBREVIATONS

Abbreviation	Full Form
CD	Crohn’s Disease
DWI	Diffusion-Weighted Imaging
EAUS	Endoanal Ultrasound
EAS	External Anal Sphincter
IAS	Internal Anal Sphincter
MRI	Magnetic Resonance Imaging
NPV	Negative Predictive Value
PACS	Picture Archiving and Communication System
PPV	Positive Predictive Value
RF	Radiofrequency
SJUH	St. James’s University Hospital Classification
SPIR	Spectral Pre-saturation by Inversion Recovery
STIR	Short Tau Inversion Recovery
TE	Echo Time
VAAFT	Video-Assisted Anal Fistula Treatment
FLAIR	Fluid-Attenuated Inversion Recovery
TSE	Turbo Spin Echo
MPR	Multi-Planar Reconstruction
FiLaC	Fistula Laser Closure
T1W	T1-Weighted Imaging
T2W	T2-Weighted Imaging
CE-MRI	Contrast-Enhanced Magnetic Resonance Imaging
HRMRI	High-Resolution Magnetic Resonance Imaging
FSE	Fast Spin Echo
Gd	Gadolinium

ABSTRACT

Background

Perianal fistulas are abnormal connections between the anal canal and perianal skin, often associated with infections, trauma, or inflammatory conditions like Crohn's disease. Accurate preoperative evaluation is essential for determining the fistula's complexity and guiding surgical planning. While traditional imaging techniques such as endoanal ultrasound (EAUS) and computed tomography (CT) have limitations, 3 Tesla Magnetic Resonance Imaging (3T MRI) has emerged as the gold standard due to its superior soft tissue contrast and ability to delineate fistula tracts, abscesses, and sphincter involvement.

Objective

To evaluate the accuracy of MRI for the diagnosis and characterisation of perianal fistula before surgery.

To classify perianal fistula using 3T MRI according to the St.Jame's university hospital MR imaging classification of perianal fistula.

Materials and Methods

A hospital-based cross-sectional study was conducted over one year at KLES Dr. Prabhakar Kore Hospital and Research Centre. Patients aged 18 years and above with suspected perianal fistulas underwent standardized 3T MRI scans using T2-weighted and contrast-enhanced sequences. Exclusion criteria included prior fistula surgery, pregnancy, MRI contraindications, and

severe claustrophobia. MRI findings were analyzed and correlated with surgical observations.

Results

A total of 59 patients were enrolled, with a mean age of 42 ± 12 years. The study found that 3T MRI had a sensitivity of 94.0%, specificity of 85.0%, PPV of 96.0%, and NPV of 80.0%, with an overall diagnostic accuracy of 92.0%. Intersphincteric fistulas were the most common type (51%), followed by transsphincteric (34%). MRI successfully detected internal openings in 93% of cases and secondary tracts or abscesses were identified in 42%. MRI findings significantly influenced surgical planning, aiding in precise localization and appropriate intervention selection.

Conclusion

3T MRI is a highly effective tool for the preoperative evaluation of perianal fistulas, providing superior visualization of fistula anatomy and complications. Its use improves surgical outcomes by reducing recurrence rates and minimizing complications. Despite cost and availability challenges, integrating 3T MRI into routine clinical practice enhances diagnostic accuracy and treatment planning. Further research should optimize MRI protocols and expand accessibility for better patient care.

Keywords

Perianal fistula, 3 Tesla MRI, Fistula classification, St. James's classification, Surgical planning, Imaging modalities, Abscess detection.

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INTRODUCTION

Perianal fistulas are abnormal, often painful, connections that develop between the anal canal and the skin surrounding the anus. They typically arise due to an infection in one of the anal glands, leading to the formation of an abscess. As the abscess heals, it can create a channel, or fistula, which allows for the continuous drainage of pus or fluid [1]. This condition, which is most commonly associated with Crohn's disease, can also occur due to other causes, including infection, trauma, or surgical procedures. Perianal fistulas present significant challenges for both diagnosis and treatment, as the complexity of their structure and the surrounding anatomy can make it difficult to assess their full extent using traditional imaging methods.[1,2]

Accurate preoperative evaluation of perianal fistulas is crucial for determining the appropriate surgical approach and minimizing the risk of recurrence. The clinical examination, while important, often does not provide sufficient information about the fistula's exact location, number, and relationship with surrounding structures such as the sphincter muscles. Consequently, advanced imaging techniques are necessary to fully characterize these fistulas, guide treatment planning, and improve surgical outcomes.[2,3]

One such advanced imaging modality that has gained prominence in recent years is 3 Tesla Magnetic Resonance Imaging (3T MRI). The role of 3T MRI in the preoperative evaluation of perianal fistulas is invaluable due to its high-resolution imaging capabilities, which allow for a detailed and non-invasive assessment of the fistulas' complex anatomy. This imaging technique uses a magnetic field of 3 Tesla, which is significantly stronger than the traditional 1.5 Tesla MRI commonly used in clinical practice, providing sharper images and more detailed anatomical information.[3,4]

The primary advantage of 3T MRI in the evaluation of perianal fistulas lies in its ability to visualize the entire extent of the fistula tract and its relationship with critical anatomical structures, including the anal sphincters and the rectum. This is particularly important as the success of surgical intervention largely depends on the precise identification of these structures. A better understanding of the fistula's complexity enables the surgeon to choose the most appropriate technique, whether it be fistulotomy, seton placement, or other specialized procedures, while minimizing the risk of damaging vital sphincter muscles and reducing the likelihood of incontinence following surgery.[3-5]

Moreover, 3T MRI excels in detecting complex fistula tracts that may not be easily identified through simpler imaging techniques or during physical examination. It can reveal multiple internal openings, side branches, or extensions that may be missed otherwise. The increased sensitivity of 3T MRI allows for the detection of fistulas even in patients with recurrent or complicated cases, offering valuable insight into their pathophysiology.[5,6]

Another significant advantage of 3T MRI is its ability to assess the involvement of the anal sphincters. These muscles, responsible for controlling the release of feces, play a crucial role in determining the surgical approach. Fistulas that traverse the sphincter complex require careful planning to avoid damaging these muscles, which could lead to incontinence. By providing high-resolution images, 3T MRI can help identify the precise location of the fistula relative to the sphincter muscles, thus facilitating informed decision-making regarding the best surgical approach.[6]

In addition to the detailed visualization of fistula tracts, 3T MRI offers important information about the presence of associated complications, such as abscesses, inflammatory changes, or the involvement of other nearby structures. These factors are critical in planning a comprehensive treatment strategy. In patients with Crohn's disease, for example, the MRI can help detect signs of active disease, such as inflammation or thickening of the bowel wall, which may influence the timing and nature of surgical interventions.[6,7]

The use of contrast agents in 3T MRI further enhances its diagnostic accuracy. Gadopentetate dimeglumine, a commonly used contrast agent, is injected intravenously to improve the visibility of the fistula tract, allowing for better delineation of its course. This can be especially useful when distinguishing between complex fistulas and simple anal abscesses, which can appear similar on non-contrast imaging. The contrast-enhanced images provide additional detail, helping clinicians to determine whether the fistula is associated with abscesses or other pathological features that may require additional management.[6-8] Despite its many advantages, the use of 3T MRI in the evaluation of perianal fistulas is not without limitations. The procedure can be time-consuming, requiring patients to remain still for an extended period, which may be challenging for some individuals. Additionally, 3T MRI is not always available in all healthcare settings, and the cost associated with the procedure can be higher than other imaging modalities, such as ultrasound or CT. However, when used appropriately in the preoperative evaluation of perianal fistulas, the benefits often outweigh the drawbacks, particularly in cases where the anatomy is complex or when the fistula is recurrent.[7,8]

Furthermore, while 3T MRI provides a high level of detail, it should not be considered a substitute for clinical assessment or other diagnostic tests. A multidisciplinary approach that combines clinical examination, imaging, and, if necessary, endoscopic evaluation remains essential for accurate diagnosis and treatment planning. The role of 3T MRI is best seen as complementary to other diagnostic modalities, offering a more precise and comprehensive view of the fistula and surrounding tissues.[8]

3T MRI plays a pivotal role in the preoperative evaluation of perianal fistulas by providing detailed, high-resolution images that allow for accurate assessment of fistula anatomy and its relationship with surrounding structures. This advanced imaging technique aids in determining the most appropriate surgical approach, reduces the risk of postoperative complications, and improves patient outcomes. While its high cost and availability may limit its widespread use, the value it offers in complex or recurrent cases makes it an indispensable tool for clinicians managing perianal fistulas. As technology continues to evolve, it is likely that the use of 3T MRI will become even more integrated into clinical practice, offering even more sophisticated insights into the management of this challenging condition.[8,9]

The aim of this study was to evaluate the role of 3 tesla magnetic resonance imaging in the preoperative evaluation of perianal fistulas.

OBJECTIVE OF THE STUDY

To evaluate the accuracy of MRI for the diagnosis and characterisation of perianal fistula before surgery.

To classify perianal fistula using 3T MRI according to the St.Jame's university hospital MR imaging classification of perianal fistula.

REVIEW OF LITERATURE

2. Overview Of Perianal Fistulas

Perianal fistulas are abnormal, often chronic, connections that form between the anal canal or rectum and the skin surrounding the anus. These fistulas are typically the result of an infection of the anal glands, which leads to the formation of an abscess. If the abscess fails to resolve, it can develop into a fistula. The condition is medically termed "anal fistula" and is often a source of both physical and emotional discomfort for those affected.[10]

Perianal fistulas can vary greatly in terms of their complexity and severity. Some fistulas are simple and can be treated with basic surgical interventions, while others may be complex, involving multiple tracts or internal openings. The complexity of the fistula is crucial for determining the appropriate treatment strategy, and accurate diagnosis plays a pivotal role in effective management.[10,11]

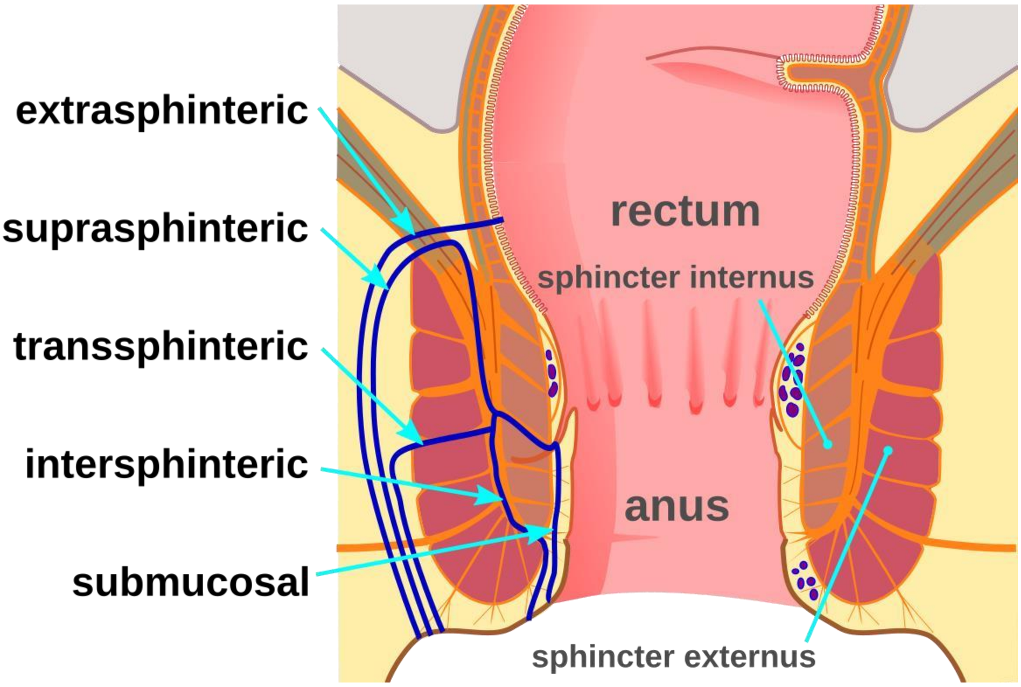

Figure: Perianal fistulas

The prevalence of perianal fistulas is notably high among patients with certain underlying conditions, particularly Crohn's disease, which is an inflammatory bowel disease. Fistulas are also commonly seen in patients with chronic anal abscesses or in those who have a history of prior anorectal surgery. While the exact cause of a perianal fistula can vary, it is most commonly attributed to the blockage or infection of the anal glands located in the anal canal. These glands are responsible for producing mucus, which helps lubricate the anal canal.[11,12] Clinically, patients with perianal fistulas may present with symptoms that include painful swelling, discharge of pus, blood, or stool from an external opening, and irritation or itching around the anus. The pain is often exacerbated by sitting or defecating, which can significantly impact the patient's quality of life. In some cases, the infection may cause fever or malaise.[12] Because of the chronic and recurring nature of perianal fistulas, they often require surgical intervention. However, determining the appropriate surgical approach depends heavily on the fistula's complexity, and this is where accurate diagnostic imaging becomes indispensable.

Importance of Accurate Preoperative Evaluation for Treatment Planning

The management of perianal fistulas is a complex process that requires an individualized approach. The fistula's complexity—whether it is simple or complex—determines the treatment strategy, and the goal of surgical treatment is to remove or manage the fistula while preserving anal sphincter function to avoid incontinence. Accurate preoperative evaluation, including detailed imaging, is crucial for planning the most appropriate intervention.[12,13] A comprehensive preoperative evaluation helps identify several key features of the fistula, including its exact location, the number of tracts involved, the presence of abscesses, the relationship to the anal sphincters, and whether there is any connection to other structures (such as the rectum). These factors significantly influence the choice of surgical approach. For example, a simple fistula with a single tract and no involvement of the sphincter muscles may be treated with a fistulotomy, which involves cutting open the fistula tract. In contrast, more complex fistulas may require more advanced techniques, such as seton placement, advancement flaps, or even fistula plug procedures.[13-15]

The clinical importance of accurate preoperative evaluation cannot be overstated. Without proper imaging, there is a high risk of underestimating or misinterpreting the complexity of the fistula. This could lead to incomplete treatment or even surgical failure. Furthermore, improper assessment may increase the risk of postoperative complications, such as incontinence or recurrence of the fistula.[15]

One of the main challenges in treating perianal fistulas lies in their variable and complex anatomical structures. Fistulas may extend into the sphincter muscles, or they may form multiple branches or secondary openings, all of which must be carefully identified before surgery. Preoperative imaging can help clarify these aspects, ensuring that surgeons have a comprehensive understanding of the fistula's anatomy and can therefore plan an optimal treatment strategy.[15,16]

Accurate preoperative evaluation also allows for better communication between the patient and healthcare provider. By discussing the results of the imaging studies, the surgeon can explain the treatment options and potential outcomes, ensuring that the patient is fully informed. This helps manage expectations and facilitates shared decision-making, which is critical in achieving optimal outcomes.[13,14]

The Role of Imaging Techniques in the Management of Perianal Fistulas

Imaging plays a critical role in the diagnosis and management of perianal fistulas. Over the years, several imaging techniques have been developed and refined to aid clinicians in evaluating the anatomical features of these fistulas. The primary goal of imaging is to determine the extent of the fistula, identify any associated abscesses, and assess its relationship to the anal sphincters. This information is vital for choosing the appropriate treatment approach and ensuring that the surgery is successful and does not result in complications such as incontinence.[13-16]

The three most commonly used imaging modalities for evaluating perianal fistulas are:[1519]

1. **Endoanal Ultrasound (EAUS)** – Endoanal ultrasound is often used to evaluate the external and internal components of a perianal fistula. It is a cost-effective and widely

available imaging modality that uses sound waves to create detailed images of the perianal region. While EAUS provides good visualization of the fistula's location and its relationship with the anal sphincters, it may be limited in its ability to identify complex fistulas, especially those with multiple tracts or abscesses.

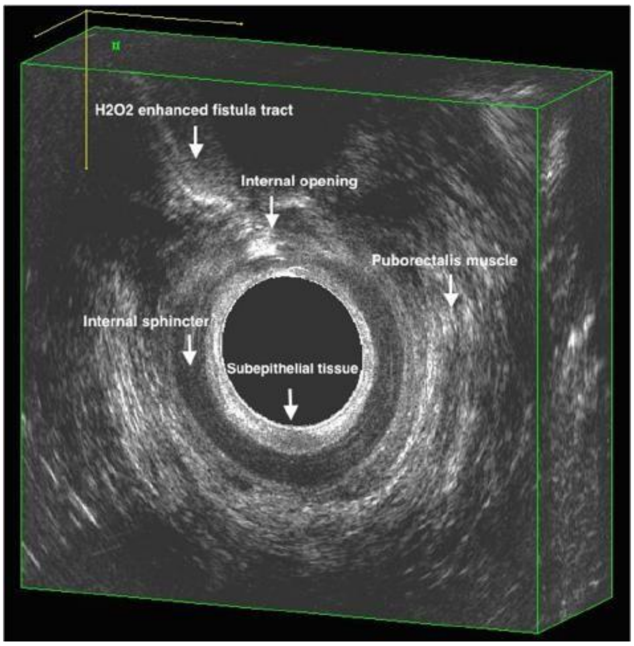

Figure: Endoanal Ultrasound (EAUS)

2. **Magnetic Resonance Imaging (MRI)** – MRI, especially at higher field strengths such as 3 Tesla (3T), has emerged as one of the most effective imaging modalities for evaluating perianal fistulas. MRI provides high-resolution, detailed images of soft tissues and allows for superior visualization of the fistula tracts, associated abscesses, and the anal sphincters. It can also distinguish between acute and chronic fistulas, assess the degree of inflammation, and identify any associated conditions such as Crohn's disease. MRI is particularly useful for evaluating complex fistulas, as it can delineate multiple fistula tracks and their relationship to surrounding structures.
3. **Computed Tomography (CT)** – CT is less commonly used for the evaluation of

perianal fistulas, as it does not provide the same level of detail as MRI, particularly in terms of soft tissue resolution. However, CT may still be used in certain clinical settings, particularly when there is a concern for abscesses or other complications. CT can help visualize gas or fluid collections that may indicate the presence of an abscess, which could affect treatment decisions.

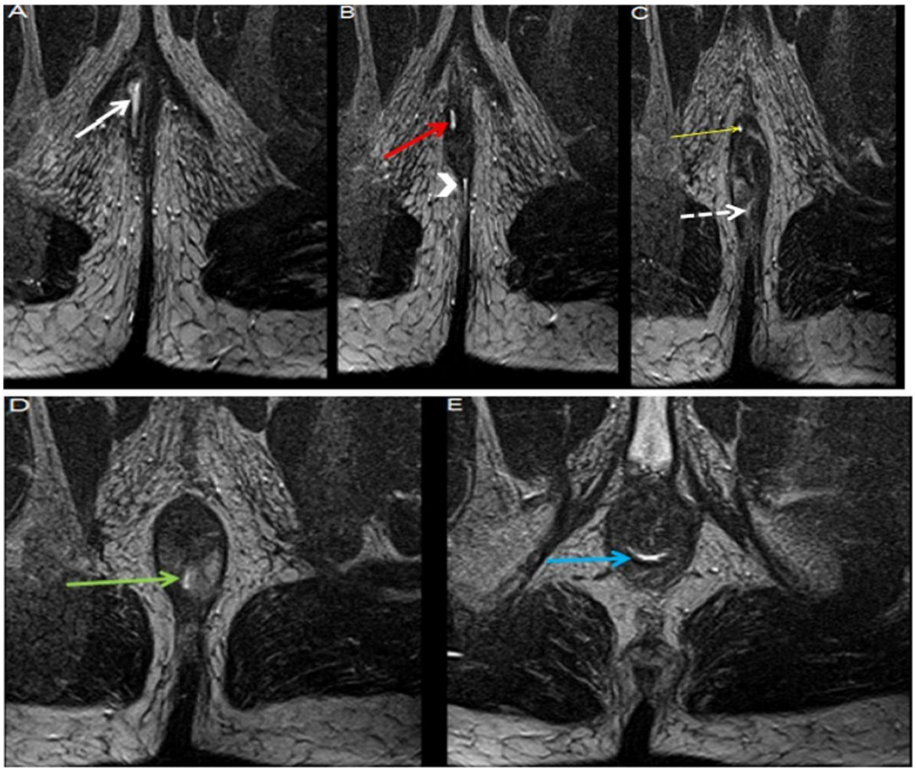

Figure: Magnetic Resonance Imaging in Perianal fistula

Of all these imaging techniques, **3 Tesla MRI** is considered the gold standard for preoperative evaluation of perianal fistulas. The advent of 3T MRI has significantly enhanced the ability to visualize fine anatomical details with a high degree of precision. One of the major advantages of 3T MRI is its ability to provide excellent contrast between the different tissue types, allowing for clear differentiation between the fistula tract, the anal sphincters, and surrounding tissues. Moreover, 3T MRI is non-invasive, avoids radiation exposure (which is particularly beneficial for patients requiring multiple imaging studies), and provides detailed three-dimensional images that can be used for surgical planning.

MRI also has the unique ability to assess complex fistulas, including those that involve multiple tracks, internal openings, or abscesses. This is important for tailoring the surgical approach, as different fistula types may require different surgical techniques. For instance, a fistula that involves a significant portion of the anal sphincter complex may require a more conservative surgical approach, such as seton placement, to prevent incontinence, whereas a simpler fistula might be treated with a fistulotomy.[18,19]

2.1 **Anatomy of the Perianal Region**

The perianal region is a highly specialized and intricate anatomical area located at the junction of the lower rectum and the anus. It consists of a complex network of muscles, nerves, and soft tissues, all of which play a critical role in the function and integrity of the anal canal [20]. Understanding the anatomy of this region is essential for the effective diagnosis and management of perianal fistulas, as these structures are often involved in the formation and progression of the fistula tracts.

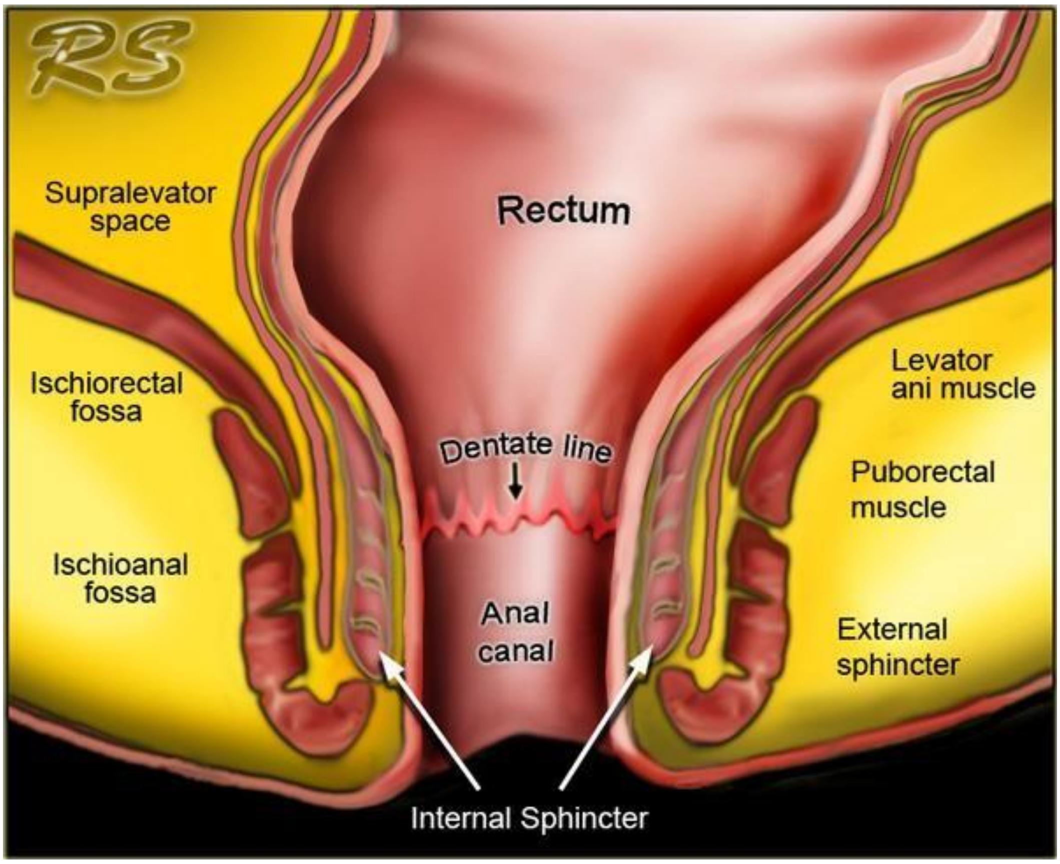

Figure: Anatomy of the Perianal Region

1. The Anal Canal and Rectum

The anal canal is the distal part of the large intestine, located just above the anus, and it is about 3–4 cm in length. It functions as the final conduit for the passage of stool and is lined with specialized epithelium that helps facilitate defecation. The rectum, on the other hand, is the last section of the large intestine, extending from the sigmoid colon to the anal canal. The rectum serves as a temporary storage site for stool until it is expelled through the anus.[20,21]

At the junction of the anal canal and rectum, the anatomy becomes more specialized to support the process of defecation. This area contains the anal sphincter complex, which is responsible for maintaining continence and controlling the release of stool.[21]

2. The Anal Sphincters

The anal sphincter complex is a key anatomical structure in the perianal region and consists of two primary sphincter muscles: the internal anal sphincter and the external anal sphincter. These muscles work in concert to maintain continence, control the expulsion of stool, and regulate the passage of gases.[21,22]

- **Internal Anal Sphincter (IAS):** The internal anal sphincter is composed of smooth muscle and is controlled involuntarily. It forms the inner portion of the sphincter complex and encircles the anal canal. The IAS is responsible for maintaining resting anal tone and preventing the involuntary passage of stool.
- **External Anal Sphincter (EAS):** The external anal sphincter is made of skeletal muscle and is under voluntary control. It surrounds the internal sphincter and can contract and relax voluntarily to facilitate the passage of stool. The external sphincter provides the primary mechanism for maintaining fecal continence and is particularly involved in the voluntary control of defecation.

The relationship between the internal and external anal sphincters is crucial for continence. A perianal fistula that crosses or involves these sphincter muscles can significantly impact anal function, potentially leading to incontinence if not appropriately managed.

3. The Anal Glands and Their Role in Fistula Formation

A critical feature of the anal canal is the presence of specialized anal glands. These glands are located in the mucosa of the anal canal and are responsible for secreting mucus that aids in lubrication during defecation. The ducts of these glands open into the crypts of Morgagni, which are small pits located around the anal canal. These glands can become blocked or infected, leading to the formation of abscesses. When the abscess does not resolve, it may evolve into a fistula.[22,23]

The anal glands play a significant role in the pathogenesis of perianal fistulas. An infection of the glands often leads to the formation of a perianal abscess, which can develop into a fistula if it fails to drain properly. This is especially common in patients with inflammatory bowel diseases like Crohn's disease, where the anal glands may be more prone to infection or blockage.[23]

4. The Levator Ani and Pelvic Floor Muscles

The levator ani is a group of muscles that form part of the pelvic floor and provide support to the rectum and anal canal. These muscles are essential for maintaining pelvic organ function and contribute to the support of the anorectal junction, which is involved in the process of defecation. The levator ani muscles also play a role in continence by aiding in the contraction of the anal canal.[24]

In the context of perianal fistulas, the levator ani muscles are important because complex fistulas may involve these structures. A fistula that extends into the pelvic floor or involves the levator ani can complicate both diagnosis and surgical management. Surgery in these areas must take care to preserve the integrity of these muscles to avoid compromising anal function and continence.[24,25]

5. Perianal Skin and Subcutaneous Tissue

The perianal skin is the outermost layer surrounding the anus, and it is highly sensitive due to the dense network of sensory nerve endings. The skin also contains blood vessels, lymphatic vessels, and connective tissue. In the presence of a fistula, the perianal skin is often the site of the external opening, where the pus or drainage from the fistula can be observed. In chronic fistulas, the skin may become thickened, scarred, or indurated due to the repeated cycles of infection and healing.[25,26]

In some cases, the perianal region may develop a series of openings (external openings of the fistula), which can lead to skin irritation or abscess formation. The external opening's proximity to the anal sphincters and underlying muscles is a critical factor in determining the complexity of the fistula and the surgical approach required.

6. The Ischiorectal Fossa and Pelvic Fascia

The ischiorectal fossa is a space located on either side of the anal canal and is filled with fat and connective tissue. It lies beneath the levator ani muscles and contains the neurovascular structures that supply the anal region. This fossa plays a significant role in the formation and progression of perianal fistulas, as the space may become involved in the abscess or infection that leads to fistula formation.[26]

The pelvic fascia, which is a connective tissue structure that surrounds the pelvic organs, also plays a role in fistula formation. Fistulas that extend into the pelvic cavity may involve the pelvic fascia and other deep structures, which can complicate surgical management.

The Complexity of Perianal Anatomy and Its Implications for Surgical Management

The complexity of perianal anatomy is one of the primary challenges when managing perianal fistulas. The anal sphincters, rectum, anal glands, and surrounding muscles all contribute to the formation and behavior of the fistula, and any disruption or involvement of these structures can complicate treatment.[27]

As the complexity of the fistula increases, the difficulty of surgical management escalates. Fistulas that involve the anal sphincters, particularly the external sphincter, must be treated with caution to avoid causing incontinence. Surgical approaches such as fistulotomy, seton placement, advancement flaps, or fistula plugs may be used depending on the fistula's complexity and its location in relation to critical anatomical structures.[28,29]

In cases where the fistula involves the levator ani muscles or extends into the pelvic floor, more advanced surgical techniques may be necessary to preserve anal function. Inflammatory bowel diseases like Crohn's disease also complicate the management of fistulas, as they can result in the formation of multiple tracts or the involvement of deeper structures.[30]

2.2 Overview of Perianal Fistulas

Perianal fistulas are abnormal, often chronic, connections between the anal canal and the perianal skin. These fistulas typically result from an infected anal gland or abscess and present as a tract that connects the internal anal canal to the external opening near the anus. Given their complexity and the significant impact they have on quality of life, understanding perianal fistulas' classification, pathophysiology, causes, symptoms, and complications is essential for their proper management.[31,32]

Classification of Perianal Fistulas:[32-35]

The classification of perianal fistulas is critical for determining the appropriate treatment strategy. Several systems have been developed to classify these fistulas.

I. St. James University Hospital Classification of Perianal Fistulas

The St. James University Hospital Classification of perianal fistulas is a MRI-based grading system that categorizes fistulas based on their complexity and involvement of surrounding structures. It helps guide surgical management and predict outcomes.

1. **Grade 1 (Simple Linear Inter-sphincteric Fistula)**: A simple fistula confined to the intersphincteric space without extensions or abscesses.
2. **Grade 2 (Intersphincteric Fistula with Abscess or Secondary Track)**: A fistula in the intersphincteric space with either a small abscess or a secondary fistulous track.
3. **Grade 3 (Trans-sphincteric Fistula):** A fistula that crosses the external anal sphincter but without any abscess or secondary track.
4. **Grade 4 (Trans-sphincteric Fistula with Abscess or Secondary Track in Ischiorectal Fossa)**: A trans-sphincteric fistula that extends into the ischiorectal fossa, forming an abscess or secondary track.
5. **Grade 5 (Supralevator or Translevator Fistula)**: A complex fistula that extends above the levator ani muscle, involving the supralevator space or other deep structures.

This classification is particularly useful for MRI fistulography and surgical planning, helping distinguish between simple and complex fistulas.

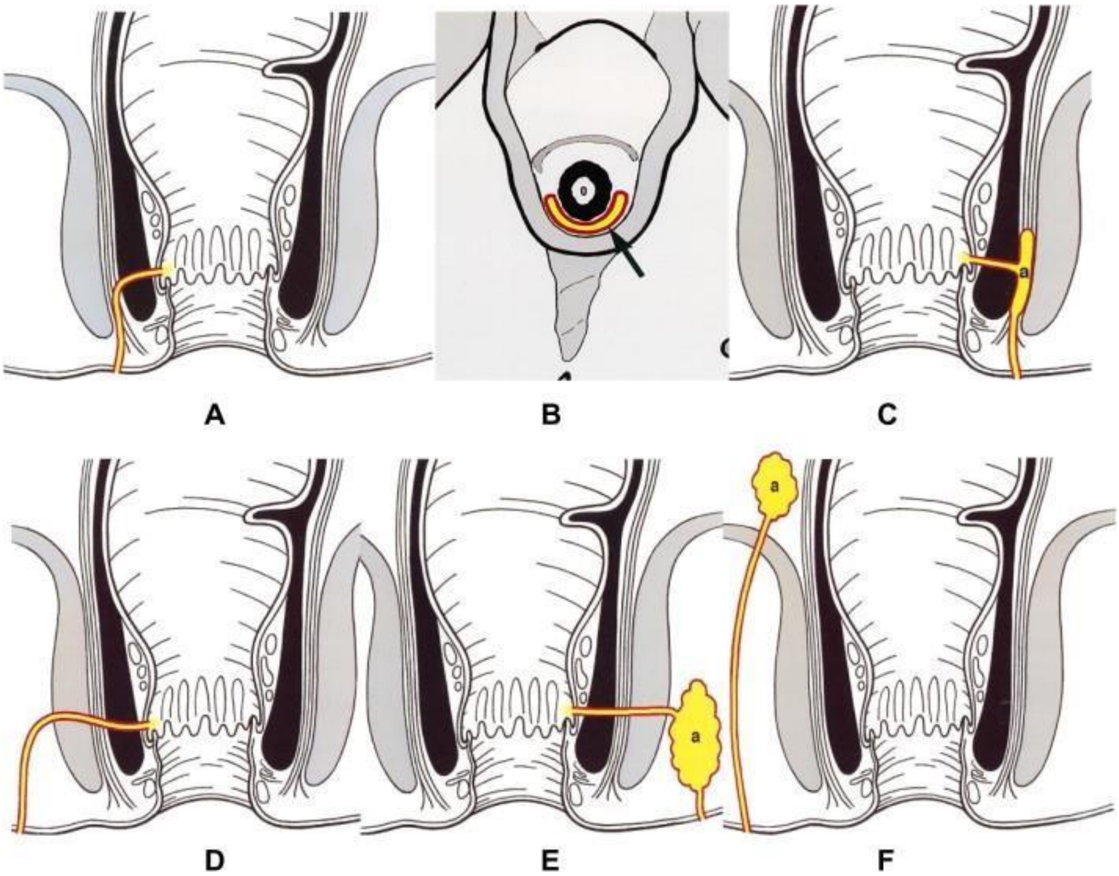

Figure: St. James University Hospital Classification of Perianal Fistulas II.

Parks Classification of Perianal Fistulas

The Parks classification, introduced by Parks et al. in 1976, is a widely used system for classifying perianal fistulas based on their anatomical relationship with the external and internal anal sphincters.[34-36]

1. **Intersphincteric Fistula**: This is the most common type and involves a tract that passes between the internal and external anal sphincters. The fistula typically arises from the anal glands and runs horizontally, above the level of the external sphincter, to an external opening near the perianal skin. This type of fistula is generally considered the simplest to treat and can often be managed with fistulotomy.
2. **Transsphincteric Fistula**: A transsphincteric fistula passes through both the internal and external sphincters. These fistulas can extend from the anal canal to the perineal

region and are more complex due to the involvement of the anal sphincters. Treatment options may include seton placement or advancement flap procedures, as care must be taken to preserve continence.

3. **Suprasphincteric Fistula**: This type of fistula passes above the sphincters and often involves the levator ani muscles and the ischiorectal fossa. Suprasphincteric fistulas are usually associated with more complex abscesses, and their surgical management requires careful consideration of the pelvic floor structures to avoid damaging important muscles.
4. **Extrasphincteric Fistula**: The most complex form of perianal fistula, extrasphincteric fistulas extend from the anal canal through the sphincters and into deeper pelvic structures, including the ischiorectal fossa or the pelvic cavity. These fistulas are often associated with more severe cases, such as those found in Crohn's disease or in cases of radiation therapy. Treatment requires advanced techniques such as staged procedures or the use of biological plugs.

Pathophysiology and Causes of Perianal Fistulas

Perianal fistulas most commonly develop from an **anal abscess**, which forms when one of the anal glands becomes infected. The pathophysiology of fistula formation involves the obstruction of these glands, leading to an infection that can track into surrounding tissue. When this infection fails to drain completely, a fistula forms as the body attempts to create an alternate route for the infected material to escape.[36-39]

1. **Anal Gland Obstruction**: The anal glands are small, specialized glands located in the anal canal that secrete mucus to aid in the lubrication of stool. When these glands become blocked, bacteria can accumulate, leading to the formation of an abscess. If

the abscess does not drain on its own, it can develop into a fistula. The tract forms between the internal opening of the gland and the external perianal skin, creating a tunnel through which infection or drainage can pass.

2. **Infectious and Inflammatory Factors**: The infection in the anal glands may be bacterial, most commonly involving Escherichia coli (E. coli), but can also include other bacteria, such as Enterococcus species and Staphylococcus aureus. Chronic inflammatory conditions like Crohn's disease, tuberculosis, and diverticulitis are significant risk factors for perianal fistula formation due to the altered immune responses and the formation of abscesses in the perianal region.
3. **Trauma or Surgery**: In some cases, perianal fistulas can result from trauma or previous surgical procedures, such as **hemorrhoidectomy**, **anal sphincter repair**, or **rectal surgery**. Surgical manipulation of the anal canal or rectum can disrupt the normal anatomy and lead to the formation of abnormal connections between the rectum and the perianal skin.
4. **Malignant Diseases**: Although less common, perianal fistulas may also arise due to **rectal cancer** or other malignancies that invade the perianal tissues. Tumor infiltration can disrupt normal tissues, causing the formation of fistulas that extend from the rectal wall to the skin.
5. **Other Conditions**: Conditions such as **HIV**, **diabetes**, and **immunosuppressive therapy** can predispose individuals to perianal fistulas by weakening the immune system or altering the normal bacterial flora of the anal region, making them more prone to infections that can lead to fistula formation.

Common Symptoms of Perianal Fistulas

The clinical presentation of perianal fistulas is often marked by symptoms that can significantly impair a patient's quality of life. Common symptoms of perianal fistulas include:[35-40]

1. **Pain**: One of the most prevalent symptoms, pain often worsens during bowel movements and may be exacerbated by sitting or certain positions. The pain can range from a mild discomfort to severe, stabbing pain depending on the location and extent of the fistula.
2. **Drainage or Pus Discharge**: A hallmark sign of a perianal fistula is the presence of drainage from an external opening in the perianal skin. This drainage is often purulent (containing pus) and may be associated with a foul odor. In some cases, the drainage may be intermittent, with episodes of increased drainage during infection or inflammation.
3. **Itching and Irritation**: The external opening of the fistula may cause itching and irritation of the surrounding skin. Chronic drainage or discharge can lead to skin maceration, further aggravating symptoms.
4. **Swelling and Redness**: Infected fistulas may present with erythema (redness) and swelling around the external opening. Abscess formation may lead to the development of a tender, fluctuant mass that can be palpated in the perianal area.
5. **Fever**: Acute infections associated with perianal fistulas can result in systemic symptoms such as fever, chills, and malaise. These signs may indicate a more significant infection or abscess formation.

6. **Incontinence (in severe cases)**: If a fistula involves the anal sphincters, particularly the external sphincter, it can lead to difficulties with continence, such as fecal incontinence or an inability to control gas.

Complications of Perianal Fistulas

If left untreated or inadequately managed, perianal fistulas can lead to several complications, including:[38-41]

1. **Chronic Infections and Abscess Formation**: Fistulas can become chronically infected, leading to the formation of recurrent abscesses. Chronic infection can compromise tissue healing and delay recovery from surgery.
2. **Fecal Incontinence**: Complex fistulas that involve the anal sphincters may damage the muscles responsible for continence, leading to partial or complete loss of control over bowel movements. This is particularly concerning in patients who have extensive transsphincteric or suprasphincteric fistulas.
3. **Stricture Formation**: Chronic fistulas can result in the formation of scar tissue, leading to the development of strictures that narrow the anal canal or rectum. This can complicate both defecation and surgical interventions.
4. **Sepsis**: Untreated or poorly managed fistulas, particularly those with associated abscesses, can result in sepsis—a life-threatening systemic infection. Prompt intervention is necessary to prevent severe complications.
5. **Impact on Quality of Life**: Chronic symptoms such as pain, drainage, and itching can significantly affect a patient's physical and emotional well-being. Fistulas can cause embarrassment, anxiety, and social withdrawal due to the ongoing discomfort and potential leakage.

2.3 **Imaging Techniques for Perianal Fistulas**

Imaging techniques play a pivotal role in the diagnosis and preoperative evaluation of perianal fistulas. Accurate imaging is essential for identifying the complex anatomy of these fistulas, determining the extent of involvement of surrounding tissues, and planning the most appropriate surgical approach. Over the years, various imaging modalities have been developed, each with its strengths and limitations. [42,43]

Comparison of Various Imaging Modalities for Perianal Fistulas

Several imaging techniques are commonly employed in the diagnosis and preoperative evaluation of perianal fistulas. The choice of technique depends on factors such as availability, cost, patient condition, and the complexity of the fistula. The most commonly used imaging modalities include:[43,44]

1. Ultrasound (Endoanal and Perineal Ultrasound)

Endoanal ultrasound (EAUS) is one of the most widely used imaging techniques for perianal fistulas. It involves inserting a high-frequency probe into the anal canal to provide detailed imaging of the anal sphincters, rectal wall, and surrounding soft tissues.[44,45] **Advantages:**

- **High resolution**: Endoanal ultrasound provides high-resolution images that allow for excellent visualization of the internal anal sphincter, external anal sphincter, and the path of the fistula.
- **Real-time imaging**: Ultrasound offers real-time imaging, allowing for dynamic evaluation of the fistula and its relationship to the sphincter muscles.

- **Non-invasive and low-cost**: Endoanal ultrasound is less invasive compared to other modalities like MRI, and it is also relatively low-cost, making it accessible for most healthcare settings.
- **Portable**: Ultrasound equipment is portable and can be used at the patient's bedside or in outpatient settings.

Limitations:

- **Operator dependence**: The accuracy of endoanal ultrasound is highly dependent on the operator's experience and skill, which can lead to variability in results.
- **Limited in detecting deeper fistulas**: While effective for visualizing superficial fistulas, endoanal ultrasound is less effective for detecting fistulas that extend deep into the pelvis or those that involve complex structures.
- **Patient discomfort**: The insertion of the ultrasound probe into the anal canal can be uncomfortable for some patients, particularly those with acute inflammation or abscesses.

2. Computed Tomography (CT) Scan

CT imaging involves the use of X-rays to create detailed cross-sectional images of the body. For perianal fistulas, CT scans are typically used to assess the extent of the infection, abscesses, and the relationship of the fistula to surrounding structures.[44,45] **Advantages:**

- **Good for identifying abscesses**: CT is particularly useful for detecting perianal abscesses that are often associated with fistula formation, providing a detailed overview of the extent of the infection.

  Fast and widely available: CT scans are widely available in most healthcare facilities and provide relatively quick results compared to other imaging techniques.

- **Excellent for detecting deep structures**: CT scans are effective for visualizing deep tissues, making them useful for identifying fistulas that extend beyond the anal sphincters or involve deeper pelvic structures.

Limitations:

- **Radiation exposure**: One of the major drawbacks of CT imaging is the exposure to ionizing radiation, which can be a concern, particularly for repeated use or in younger patients.
- **Limited soft tissue contrast**: While CT can provide good visualization of bones and air-filled spaces, it has lower soft tissue contrast compared to MRI, which can limit its ability to fully characterize the fistula tract and surrounding tissues.
- **Not the best for evaluating sphincter involvement**: CT is not as effective as MRI in evaluating the anal sphincters and the complex anatomy of the perianal region.

3. Magnetic Resonance Imaging (MRI)

MRI is considered the gold standard for imaging perianal fistulas due to its high soft tissue contrast, non-invasive nature, and ability to provide detailed information about the fistula tract and its relationship with surrounding structures.[45-47] **Advantages:**

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- **High resolution and superior soft tissue contrast**: MRI provides superior visualization of soft tissues, including the anal sphincters, rectal wall, and surrounding structures, making it ideal for evaluating complex fistulas.

  Comprehensive evaluation: MRI can visualize the entire fistula tract, including both the internal and external openings, the intersphincteric, transsphincteric, and suprasphincteric components, and any associated abscesses or secondary tracts.
- **No radiation exposure**: Unlike CT, MRI does not involve ionizing radiation, making it a safer option, particularly for repeated use or in sensitive patient populations (e.g., pregnant women).
- **Ability to assess sphincter involvement**: MRI is particularly effective in assessing the involvement of the anal sphincters, which is crucial for treatment planning and preventing complications such as fecal incontinence.

Limitations:

- **High cost and limited availability**: MRI is more expensive than other imaging modalities, and its availability may be limited, especially in low-resource settings.
- **Time-consuming**: MRI exams typically take longer to complete than CT or ultrasound, which may lead to longer waiting times for results.
- **Patient contraindications**: Certain patients may be unable to undergo MRI due to contraindications such as the presence of pacemakers, metal implants, or claustrophobia.

4. Fistulography

Fistulography involves the injection of a contrast dye into the fistula tract, followed by X-ray imaging to visualize the tract. This technique is used less commonly today but can still be helpful in certain situations.[47,48]

Advantages:

- **Direct visualization of the fistula tract**: Fistulography allows for direct visualization of the fistula tract and its communication with the anal canal and perianal skin.
- **Simple and inexpensive**: Fistulography is relatively simple and inexpensive compared to MRI or CT.

Limitations:

- **Invasive**: Fistulography requires the injection of contrast material into the fistula, which can be uncomfortable for patients.
- **Limited soft tissue detail**: The technique does not provide as much detailed information about the surrounding soft tissues, sphincters, or associated abscesses.

Advantages and Limitations of Imaging Techniques

Each imaging modality has its own strengths and limitations, and the choice of technique depends on several factors:[48,49]

- **Resolution**: MRI provides the best soft tissue contrast and is the most effective in visualizing complex fistulas, including their involvement with anal sphincters and surrounding structures. CT is less effective in soft tissue resolution but useful in detecting abscesses.
- **Cost**: Ultrasound is the least expensive option and widely available, but it has limitations in imaging deeper fistulas. CT and MRI are more expensive but provide more comprehensive and accurate information.

- **Availability**: Ultrasound is widely available and can be used in most clinical settings, while MRI may not be accessible in some locations, especially in low-resource environments.
- **Invasiveness**: Ultrasound and MRI are non-invasive, while fistulography requires the injection of contrast material. CT also involves radiation, which can be a concern in repeated use.
- **Patient comfort**: MRI and ultrasound are generally well-tolerated by patients, whereas CT and fistulography may cause discomfort or involve more invasive procedures.

Evolution of Imaging Technology in Evaluating Perianal Fistulas

Over the years, imaging technology for perianal fistulas has evolved significantly. Early diagnostic methods relied on physical examination and basic radiological techniques, such as X-rays and fistulography. However, as imaging technology advanced, more sophisticated methods such as MRI and endoanal ultrasound emerged, offering higher resolution and better visualization of complex fistulas.[46]

MRI has become the gold standard due to its ability to provide detailed images without radiation, and it continues to evolve with advancements in magnetic field strength, image resolution, and imaging sequences. High-field MRIs, such as the 3-Tesla MRI, have further improved the resolution and sensitivity of imaging, allowing for even more accurate preoperative planning.[47]

Endoanal ultrasound has also evolved with the advent of high-frequency probes and the integration of Doppler ultrasound, which enhances the ability to visualize the blood flow around the fistula and its relationship with the surrounding structures.[48]

The integration of **multimodal imaging** approaches, where two or more imaging techniques are combined, has become an emerging trend in the evaluation of perianal fistulas. This approach allows clinicians to leverage the strengths of each modality, providing a more comprehensive understanding of the fistula and its complications.[47,48]

2.4 **The Role of MRI in Perianal Fistula Evaluation**

MRI is a diagnostic imaging technique that utilizes powerful magnets and radiofrequency waves to generate detailed images of soft tissues inside the body. Unlike X-rays and CT scans, MRI does not use ionizing radiation, making it a safer alternative for repeated evaluations. The ability of MRI to offer high-resolution imaging without radiation exposure has made it an indispensable tool for evaluating perianal fistulas.[49]

The perianal region is anatomically complex, with the anal canal, sphincter muscles, rectum, and surrounding soft tissues, all of which can be involved in fistula formation. In addition to these structures, perianal fistulas often extend into deeper tissues, such as the ischiorectal fossa and the pelvic floor. Understanding the full extent of the fistula and its relationship with these anatomical features is critical in determining the appropriate surgical approach. MRI provides unparalleled insights into these structures, enabling clinicians to assess the type, extent, and complexity of perianal fistulas, while also identifying any associated abscesses or secondary tracts.[49-51]

MRI's high soft tissue contrast resolution and the ability to visualize both the internal and external anal sphincters make it a powerful tool for surgical planning. Accurate identification of sphincter involvement is crucial to avoid unnecessary damage that could lead to complications such as fecal incontinence. Therefore, MRI has become the preferred imaging modality in the management of perianal fistulas, especially in complicated cases.[51]

1.5 Tesla (1.5T) and 3 Tesla (3T) MRI in Perianal Fistula Assessment

MRI machines are classified based on the strength of the magnetic field they use, measured in Tesla (T). The higher the Tesla number, the stronger the magnetic field, leading to improved image quality, resolution, and sensitivity. 1.5T and 3T MRI systems are the most commonly used in clinical practice for perianal fistula evaluation. Both have distinct advantages and limitations.[50-53]

1.5 Tesla MRI:

1.5T MRI has been the standard in clinical practice for many years, providing high-quality images with adequate resolution for most clinical applications, including the assessment of perianal fistulas.[53]

Advantages:

- **Adequate resolution for most cases**: A 1.5T MRI provides sufficiently detailed images to visualize the anal sphincters, fistula tracts, and surrounding structures. For many patients, 1.5T MRI offers enough contrast to differentiate the fistula and its components from adjacent tissues.
- **Widely available**: 1.5T MRI machines are more commonly available in medical facilities compared to 3T machines, making them more accessible in routine clinical settings.
- **Lower cost**: 1.5T MRI is less expensive to operate and maintain compared to 3T MRI, making it a more cost-effective option for many healthcare systems.

Limitations:

- **Lower resolution compared to 3T MRI**: While 1.5T MRI provides good-quality images, it may not capture the fine details of complex or very small fistulas, particularly those involving the anal sphincters or deep pelvic structures. This can make it less effective in evaluating complicated or recurrent fistulas that require detailed assessment.

- **Potential limitations in detecting subtle fistulas or abscesses**: 1.5T MRI may not always clearly identify the full extent of small or subtle fistula tracts or abscesses, especially in patients with complex disease.

3 Tesla MRI:

3T MRI systems use a stronger magnetic field, providing significantly higher resolution and greater sensitivity than 1.5T MRI. As a result, 3T MRI has become increasingly popular for detailed imaging of soft tissues, including perianal fistulas.[54-57]

Advantages:

- **Superior resolution and sensitivity**: 3T MRI offers superior spatial resolution and enhanced signal-to-noise ratio, allowing for more detailed visualization of the anal sphincters, fistula tracts, and associated abscesses. This is particularly beneficial for complex fistulas that involve multiple tracts or extend into deep pelvic structures.
- **Enhanced contrast resolution**: The higher magnetic field strength in 3T MRI improves the ability to differentiate between the different soft tissues in the perianal region, making it easier to delineate the fistula and its relationship with adjacent structures.
- **Better detection of subtle fistulas**: With its higher resolution, 3T MRI is more effective at detecting smaller or subtle fistulas that may be missed by 1.5T MRI. This includes fistulas that are small in size, involve complex branching patterns, or extend into difficult-to-visualize areas, such as the ischiorectal fossa.
- **Improved visualization of sphincter involvement**: 3T MRI provides clearer images of the anal sphincters, allowing for more accurate assessment of their involvement in

the fistula. This is crucial for planning the most appropriate surgical approach and minimizing the risk of complications such as incontinence.

Limitations:

- **Higher cost and limited availability**: 3T MRI machines are more expensive than 1.5T MRI systems, and their availability may be limited in some healthcare facilities. This can make 3T MRI less accessible, particularly in low-resource settings.
- **Longer scan times**: 3T MRI scans generally take longer to complete than 1.5T scans, which can increase patient discomfort and may lead to longer waiting times for results.
- **More prone to artifacts**: Due to the stronger magnetic field, 3T MRI is more susceptible to artifacts, such as those caused by metal implants (e.g., prosthetics, pacemakers), which can interfere with the quality of the images.

MRI provides superior soft tissue visualization compared to other imaging modalities, such as CT or ultrasound, primarily due to its ability to differentiate between various tissue types based on their water content and molecular composition. This is particularly important in the evaluation of perianal fistulas, where the fistula tract, surrounding muscle structures, and any associated abscesses or secondary fistula tracts need to be clearly delineated.[57,58]

Superior Soft Tissue Visualization

MRI achieves high soft tissue contrast by exploiting the differences in hydrogen atom density and magnetic properties between different tissues. This allows for clear visualization of soft tissues, such as the anal sphincters, rectal wall, submucosal layers, and the surrounding connective tissue. For perianal fistulas, MRI's ability to differentiate soft tissues is crucial for identifying the full extent of the fistula, the relationship of the fistula to the sphincters, and any complications, such as abscesses or secondary tracts.[58,59]

The use of specific MRI sequences, such as T2-weighted imaging, can further enhance the contrast between various tissues, allowing for optimal visualization of the fistula tract and surrounding structures. T2-weighted images provide excellent contrast between the fluidfilled fistula tract (which appears bright) and the surrounding muscles and tissues (which appear darker), allowing for precise identification of the fistula's path.[59]

Superior Contrast Resolution

Contrast resolution refers to the ability of an imaging system to distinguish between objects with similar densities. MRI excels in this regard, as it can differentiate between tissues that may appear similar in density on other imaging modalities, such as CT. This is particularly important for perianal fistula assessment, as the fistula tract may be surrounded by tissues with similar densities, such as fat, muscle, and connective tissue.[59,60]

MRI's high contrast resolution enables it to clearly delineate the fistula tract from surrounding tissues, making it easier to identify complex fistulas, such as transsphincteric or suprasphincteric fistulas, that involve multiple layers of muscle or extend into deep pelvic structures. The ability to distinguish between these subtle differences in tissue properties is key to planning the appropriate surgical intervention, ensuring that all fistula tracts are identified and appropriately addressed during surgery.[60,61]

2.5 **Principles of 3 Tesla MRI**

Magnetic Resonance Imaging (MRI) is a sophisticated imaging modality that uses powerful magnetic fields and radiofrequency (RF) pulses to produce high-resolution images of the body's internal structures. MRI works on the principle of nuclear magnetic resonance (NMR), where nuclei of certain elements, particularly hydrogen, resonate in response to an applied magnetic field. The response of these nuclei is then detected by the MRI machine to generate images.[62]

The strength of the magnetic field is measured in Tesla (T), a unit named after the physicist Nikola Tesla. The strength of the magnetic field directly influences the quality of the MRI images produced. A 3 Tesla (3T) MRI machine has a magnetic field strength of 3 Tesla, which is three times stronger than that of a 1.5 Tesla (1.5T) MRI. This increased magnetic field strength results in several key advantages in imaging, particularly for detailed soft tissue visualization, which is crucial in the assessment of complex structures like the brain, joints, and, in this context, perianal fistulas.[62,63]

Technical Aspects of 3 Tesla MRI

A 3T MRI scanner operates on the same basic principles as lower Tesla MRI systems but benefits from a stronger magnetic field, providing improved image quality and resolution. The technical aspects of 3T MRI involve several key components and considerations:[63-65]

1. **Magnetic Field Strength (3T):** The most significant difference between a 1.5T MRI and a 3T MRI is the strength of the magnetic field. The stronger the magnetic field, the greater the signal produced by the hydrogen nuclei in the body's tissues. This leads to higher signal-to-noise ratios (SNR) and improved resolution, allowing for finer details to be captured in the resulting images.
2. **Radiofrequency Pulses and Gradient Systems:** In MRI, RF pulses are used to excite hydrogen nuclei in the body, causing them to resonate. The 3T MRI system uses RF pulses to stimulate these nuclei with greater precision. Along with a stronger magnetic field, the gradient systems (which control the spatial localization of the signal) are designed to work in tandem with the higher field strength to produce sharper images with better spatial resolution.
3. **High-Resolution Imaging:** The increased magnetic field strength of 3T MRI results in superior spatial and temporal resolution. High-resolution images allow for the visualization of smaller anatomical structures, which is particularly important for

evaluating intricate and complex areas such as perianal fistulas. This includes the ability to differentiate between various soft tissues with greater clarity, enhancing the ability to detect subtle abnormalities or small fistula tracts that may be missed by lower Tesla systems.

4. **Faster Imaging:** A 3T MRI system can capture images more quickly compared to lower Tesla MRI systems. The increased magnetic field strength allows for a higher signal-to-noise ratio (SNR), meaning that it takes less time to acquire enough data to generate a clear image. This is advantageous in clinical settings as it reduces the overall scan time, leading to greater patient comfort and allowing for higher throughput in busy medical facilities.
5. **Contrast Enhancement:** In 3T MRI, the increased signal strength allows for improved contrast resolution, particularly in imaging soft tissues. This is highly beneficial when distinguishing between different types of tissues, such as distinguishing a perianal fistula tract from the surrounding muscles and fat. The enhanced contrast also facilitates the identification of subtle differences in tissue composition, such as inflammation, abscesses, and the extent of fistula tracts, which may not be as clear with lower Tesla systems.
6. **Multi-Planar Imaging:** A 3T MRI system provides multi-planar imaging, which means that images can be obtained in multiple planes (axial, coronal, and sagittal) without the need for repositioning the patient. This feature allows for a comprehensive evaluation of the perianal region and the surrounding anatomy, helping to identify the complex paths of fistulas and their relationship with other structures like the anal sphincters.

Benefits of Using 3 Tesla MRI Over Lower Tesla Systems

There are several advantages of using 3T MRI over lower Tesla MRI systems, such as 1.5T MRI, particularly in the evaluation of complex conditions like perianal fistulas:[63-66]

1. **Improved Image Resolution:** The primary benefit of a 3T MRI system is its superior image resolution. With a stronger magnetic field, 3T MRI systems produce images with a higher spatial resolution, allowing for more detailed visualization of small structures. In the case of perianal fistulas, this means that even the smallest fistula tracts and complex branching patterns can be clearly visualized, helping clinicians make more accurate diagnoses and surgical plans. For example, tiny intersphincteric or transsphincteric fistulas that may be difficult to detect with a 1.5T MRI become more apparent with a 3T scan.
2. **Better Signal-to-Noise Ratio (SNR):** The SNR refers to the ratio of the desired signal (the image data) to the background noise. A higher SNR improves image clarity and reduces artifacts. In 3T MRI, the stronger magnetic field enhances the SNR, resulting in clearer and more distinct images, which is essential for identifying the fine details of anatomical structures and abnormalities such as abscesses, fistula tracts, and sphincter involvement.
3. **Faster Imaging:** 3T MRI can capture high-resolution images more quickly compared to 1.5T systems. The increased magnetic field strength allows the system to acquire the necessary data with greater speed, thus reducing the overall scan time. This is particularly beneficial in clinical practice as it minimizes patient discomfort, increases throughput, and can improve patient compliance, especially for those with claustrophobia or those needing multiple sequences.

4. **Superior Contrast Resolution:** Contrast resolution refers to the ability to distinguish differences between adjacent tissues with similar densities. 3T MRI's superior contrast resolution allows for better differentiation of soft tissues. In the context of perianal fistulas, 3T MRI enables the differentiation between the fistula tract and surrounding tissue, highlighting the presence of any associated abscesses or secondary tracts. The superior contrast also enhances the ability to visualize the relationship between the fistula and anal sphincters, which is critical for surgical planning.
5. **Detailed Visualization of Complex Anatomy:** The perianal region contains a complex network of muscles, blood vessels, nerves, and connective tissues. Accurate visualization of this intricate anatomy is essential when evaluating perianal fistulas. 3T MRI's ability to provide high-resolution images allows for clear identification of all these structures and their involvement in the fistula's path. This is especially important in complex or recurrent fistulas, where multiple fistula tracts or abscesses may be present.

Safety Considerations and Patient Suitability for 3 Tesla MRI

While 3T MRI offers numerous advantages, there are important safety considerations and factors to take into account when determining patient suitability for this type of imaging:[6568]

1. **Magnetic Field Safety:** MRI scanners, including 3T systems, create powerful magnetic fields that can pose a risk to patients with certain metal implants or devices. Patients with pacemakers, cochlear implants, or certain prosthetic devices may not be suitable candidates for MRI. Additionally, ferromagnetic objects such as metal jewelry or implants must be removed prior to the scan to prevent injury or equipment damage. Although newer MRI-compatible implants have been developed, it is still essential to assess a patient's medical history thoroughly.

2. **Patient Comfort and Claustrophobia:** Some patients may experience discomfort or anxiety during an MRI scan due to the confined space of the machine, especially in higher Tesla systems like 3T MRI, which have larger magnets. Claustrophobia can be exacerbated in such cases, making the procedure challenging. Sedation or alternative imaging methods may be considered for patients who cannot tolerate the confined space.
3. **Increased Noise Levels:** The powerful magnetic field in 3T MRI systems generates higher noise levels during the scan, which may be distressing for some patients. Ear protection is typically provided, but patients may still find the experience uncomfortable, especially for longer scans.
4. **Contrast Agents:** While 3T MRI provides superior imaging without the need for contrast agents, some complex fistulas may require the use of gadolinium-based contrast agents to improve visualization. These agents are generally safe, but patients with renal insufficiency or allergies may not be suitable candidates for contrastenhanced MRI.
5. **Cost and Availability:** The higher cost of 3T MRI equipment and the longer scanning times may make it less accessible in certain healthcare settings, particularly in low-resource environments. The increased operational costs may also limit its use in routine imaging.

PAST STUDIES

Waniczek D, Adamczyk T, et al. (2011): This study analyzed the usefulness of MRI fistulography for evaluating complex perianal fistulas. The authors emphasized that accurate preoperative assessment of perianal fistulas is critical to successful surgical outcomes. The study included 14 patients, with 8 suffering from recurrent fistulas and 6 from primary fistulas. MRI examinations were conducted using a 1.5 Tesla scanner, with a gadoliniumbased contrast agent. The findings revealed a high correlation between MRI results and surgical outcomes, with 13 of the 14 cases showing agreement. MRI was especially effective in identifying internal fistula openings and assessing the fistulous tract in relation to the anal sphincters. The authors concluded that MRI should be a standard diagnostic tool for perianal fistulas, as it significantly aids in planning surgical interventions by identifying the extent of the pathology, including branching and associated abscesses.[69]

George U, Sahota A, Rathore S (2011): examined the utility of MRI in preoperative evaluations of perianal fistulas, stressing its role in reducing recurrence rates and improving surgical outcomes. The study outlined how MRI provides exceptional visualization of perianal anatomy, allowing clinicians to classify fistulas and identify branching tracts, abscesses, and other complexities. This accurate mapping of the fistula reduces the risk of postoperative complications like fecal incontinence. The authors particularly highlighted the ability of MRI to depict soft tissue details, enabling surgeons to tailor their treatment approach. They also emphasized that MRI is indispensable for identifying hidden fistulas and secondary tracts, which, if left untreated, often lead to recurrence.[70]

Siddiqui M, Ashrafian H, et al. (2012): conducted a meta-analysis comparing the diagnostic performance of MRI and endoanal ultrasound (EAUS) in detecting perianal fistulas. The study included data from 241 fistulas examined using ultrasound and 240 using MRI. The findings indicated that both modalities had similar sensitivity (0.87), but MRI demonstrated superior specificity (0.69 vs. 0.43). MRI was particularly beneficial in identifying secondary tracts and abscesses, which are critical for surgical planning. The authors noted a high degree of heterogeneity in the studies analyzed and called for better-designed prospective trials. Nevertheless, they concluded that MRI's higher specificity and ability to map complex fistulas make it an essential tool for preoperative evaluations, especially for patients with Crohn's disease or recurrent fistulas.[71]

Darwish H, Zaytoun H, et al. (2013): This study evaluated the role of MRI in diagnosing and classifying perianal fistulas. Conducted retrospectively, it involved 58 patients with clinical suspicion of perianal fistulas. MRI identified 38 fistulas in 35 patients, while the remaining 13 cases were diagnosed with perianal sinuses. Among the identified fistulas, intersphincteric and transsphincteric types were the most common, while suprasphincteric and extrasphincteric types were rare. MRI findings matched surgical observations in 90% of the cases, demonstrating high diagnostic accuracy. The study emphasized MRI's capability to classify fistulas accurately, detect associated abscesses, and provide a detailed understanding of the anatomy surrounding the anal sphincters. This precision contributes to effective surgical planning and lower recurrence rates.[72]

Daabis N, Shafey RE, et al. (2013): explored the diagnostic value of MRI in assessing perianal fistulas in a prospective study involving 25 patients. The study classified fistulas using the St. James's University Hospital system, identifying grades ranging from simple intersphincteric tracts to complex supralevator extensions. MRI findings were confirmed during surgery, achieving a diagnostic accuracy of 90%. The authors emphasized that MRI is invaluable for identifying secondary extensions, horseshoe tracts, and abscesses that might otherwise be missed. This comprehensive mapping allows surgeons to plan more effective interventions, reducing the risk of complications and recurrences. The study concluded that

MRI’s ability to provide detailed anatomic visualization is essential for successful surgical outcomes in complex fistula cases.[73]

Kumar N, Agarwal Y, et al. (2014): investigated the role of MRI in the surgical management of complex and recurrent perianal fistulas. The study involved 30 patients, 19 of whom had complex fistulas and 11 had recurrent ones. MRI was used to assess internal openings, classify fistula types, and identify secondary ramifications or abscesses. The findings were compared with intraoperative data, showing MRI’s sensitivity for detecting internal openings and secondary tracts was nearly 100%. The study highlighted that accurate preoperative mapping of fistulas using MRI significantly improves surgical outcomes by enabling precise eradication of diseased tissue. The authors concluded that MRI is a vital tool in planning fistula surgeries, particularly for complex cases, as it reduces recurrence rates and helps avoid complications like fecal incontinence.[74]

Singh K, Singh N, et al. (2014): This study by Singh et al. evaluated the accuracy of MRI in the detection and grading of perianal fistulas using the St. James’s classification. The study included 50 patients, 45 of whom were confirmed to have fistulas based on surgical findings. MRI demonstrated high sensitivity and specificity in detecting primary tracts, internal openings, abscesses, and horseshoe tracts. The authors compared results from T2-weighted and postcontrast T1-weighted sequences, finding no significant difference in diagnostic accuracy between the two. This finding suggests that contrast-enhanced imaging can be omitted for initial evaluations. Overall, the study highlighted MRI’s ability to provide detailed anatomical information critical for planning effective surgical interventions, reducing recurrence rates, and ensuring better patient outcomes.[75]

Amjad MF, Muhammad D (2015): conducted a prospective study evaluating the role of MRI in detecting and classifying perianal fistulas, emphasizing its importance as the first-line imaging modality. The study was performed at King Khalid Civilian Hospital in Saudi Arabia over two years, including 60 patients referred for evaluation. Using a variety of MRI sequences, such as fat-suppressed T1-weighted fast spin-echo and T2-weighted imaging, the researchers classified fistulas based on the St. James's University Hospital (SJUH) system. The results showed that Grade 1 (simple intersphincteric fistulas) was the most common type, observed in 37.5% of cases. Internal openings were predominantly found at the 6 o'clock position. MRI findings showed excellent concordance with surgical outcomes, with accuracies exceeding 97% for detecting internal openings, tracts, and abscesses. The study concluded that MRI provides precise preoperative mapping of fistulas, enabling surgeons to effectively address the disease and reduce recurrence rates and complications such as fecal incontinence.[76]

Chaudhari NH, Sinkar AD, Swoyam S (2016): evaluated the utility of MRI in diagnosing and managing perianal fistulas. Conducted in a tertiary care hospital, the study analyzed MRI findings in 35 patients with different types of fistulas. The authors employed a 1.5 Tesla MRI system and used multiplanar T1-weighted, T2-weighted, and proton-density fat-suppressed sequences. Fistulas were classified into grades based on their complexity. Grade 1 (simple linear intersphincteric) was the most common, seen in 51% of cases, while Grades 3 and 5 were less frequent, constituting 21% and 14%, respectively. MRI demonstrated a high degree of accuracy in identifying primary tracts, internal openings, and associated complications like abscesses. The study emphasized that MRI provides precise anatomical details of fistulas and their relationships to surrounding structures, allowing for optimal surgical planning. The authors strongly recommended MRI as a preoperative standard for all patients with perianal fistulas.[77]

Varghese S, Nunna K (2018): conducted a study to evaluate the patterns and diagnostic accuracy of MRI in assessing perianal fistulas, with a focus on its role in pre-surgical planning. The retrospective study analyzed MRI findings in 50 patients with perianal fistulas. The MRI scans were performed using multiplanar sequences, and fistulas were classified according to the SJUH classification system. MRI demonstrated an overall diagnostic accuracy of 97.77%, with a sensitivity of 96% and a specificity of 83%. The authors highlighted the importance of MRI in identifying internal openings, primary and secondary tracts, abscesses, and horseshoe components. The study showed that MRI findings were consistent with surgical outcomes in nearly all cases, underscoring its utility in reducing postoperative complications and recurrence rates. The authors concluded that high-resolution MRI is an indispensable tool in the preoperative evaluation of perianal fistulas.[78]

Elzawawi MS, Abdullah M, Bakr M (2018): explored the role of MRI in diagnosing and classifying perianal fistulas in a prospective study involving 20 patients. MRI scans were conducted using T2-weighted imaging with and without contrast, and results were correlated with surgical findings. The study classified fistulas into grades based on complexity, with Grade 1 (simple linear intersphincteric) and Grade 2 (intersphincteric with abscess or secondary tract) being the most common types. MRI findings were concordant with surgical observations in 90% of cases, demonstrating its high diagnostic accuracy. The authors emphasized that MRI not only identifies the primary fistulous tract but also detects secondary ramifications, abscesses, and horseshoe extensions, which are often missed in clinical evaluations. The study concluded that MRI is a highly effective preoperative tool, helping surgeons devise precise treatment strategies and minimize recurrence.[79]

Choudhary J, Kaushal L, Rajput P (2020): conducted a prospective study assessing the diagnostic value of MRI in perianal fistulas, involving 50 patients over a one-year period.

MRI scans were performed on a 1.5 Tesla system using protocols designed to visualize the anal sphincters and surrounding structures. The study used the SJUH classification system to grade fistulas, with Grade 1 (simple intersphincteric) being the most frequent (54%), followed by Grade 2 (30%). MRI achieved 100% sensitivity in detecting fistulas, with a high degree of correlation between imaging and surgical findings. Most fistulas were found to have their internal openings on the posterior aspect of the anal canal, and chronic fibrotic tracts were less common. The study underscored MRI's role in identifying active tracts, secondary extensions, and abscesses, enabling precise surgical interventions. The authors recommended MRI as the standard imaging modality for preoperative evaluation of perianal fistulas.[80]

Liu X, Wang Z, Ren H, et al. (2020): investigated the utility of diffusion-weighted MRI (DW-MRI) in predicting postoperative outcomes for anal fistulas. The retrospective study included 82 patients who underwent DW-MRI before surgery. The researchers measured the apparent diffusion coefficient (ADC) values of the fistulas and analyzed correlations between MRI findings and surgical outcomes. They observed that patients with lower ADC values had a higher likelihood of recurrence, particularly in cases with abscesses or complex tracts. Factors influencing recurrence included the time interval between MRI and surgery, as well as lifestyle factors like diet and fatigue. The study concluded that DW-MRI is a valuable tool for assessing fistula severity and predicting recurrence, allowing surgeons to implement targeted interventions for better outcomes.[81]

Madireddy V, Gogi S, Ashwini A, et al. (2020): conducted a cross-sectional study at a tertiary hospital to evaluate the efficacy of MRI in diagnosing and grading perianal fistulas. The study included 50 patients, and MRI findings were compared with surgical staging. MRI demonstrated high sensitivity and specificity in detecting primary and secondary tracts, internal openings, and associated abscesses. The most common fistula grade was Grade 2 (intermediate complexity), followed by Grades 3 and 4. The authors emphasized MRI's ability to accurately localize internal openings, delineate fistulous tracts, and identify secondary complications like horseshoe extensions. The study highlighted the importance of MRI in preoperative planning, as it allows for precise surgical interventions, reducing the risk of recurrence and complications. The authors concluded that MRI should be the imaging modality of choice for evaluating perianal fistulas.[83]

Liu X, Wang Z, Ren H, et al. (2020): conducted a retrospective study to determine the prognostic value of diffusion-weighted MRI (DW-MRI) in assessing anal fistulas. The study included 117 patients, of whom 82 were followed up postoperatively for two years. The researchers analyzed ADC (apparent diffusion coefficient) values to evaluate fistula severity and predict recurrence. Patients with lower ADC values had a significantly higher risk of recurrence, particularly in cases involving abscesses or complex tracts. Factors such as multiple fistula tracks and the time interval between MRI and surgery were identified as contributors to recurrence. Lifestyle factors like fatigue, dietary habits (spicy or greasy food), and diarrhea were also associated with postoperative outcomes. DW-MRI was effective in correlating fistula severity with surgical outcomes, making it a useful tool for identifying high-risk cases and planning tailored interventions. The study emphasized DW-MRI's importance in reducing recurrence rates and improving surgical success.[84]

Sharma U, Thapaliya S, Pokhrel A, et al. (2022): conducted a retrospective analysis of 52 patients with perianal fistulas to evaluate MRI's role in diagnosis and surgical planning. The study classified fistulas using the St. James's University Hospital (SJUH) system. MRI successfully identified internal openings in 44 patients, with the most common location being the 6 o'clock position (59.9%). According to SJUH classification, Grade 1 fistulas were the most prevalent (47.7%), followed by Grades 2 and 4. Associated abscesses were observed in

25 patients, with the perianal region being the most common site. MRI findings were consistent with surgical results in nearly all cases, demonstrating high accuracy in detecting tracts, secondary ramifications, and abscesses. The authors concluded that MRI is an essential preoperative tool for understanding the anatomical complexity of perianal fistulas, enabling surgeons to plan effective treatment strategies that minimize complications and recurrence.[85]

Apriantoro NH, Saleh AR, Sari G, et al. (2023): conducted a qualitative study focusing on MRI imaging of perianal fistulas using the T2 TSE SPIR sequence (Turbo Spin Echo with Spectral Presaturation by Inversion Recovery). The study involved case evaluations performed at Mayapada Hospital, Indonesia, using a 1.5 Tesla MRI scanner. This specialized imaging sequence was chosen to suppress fat signals, enhancing the visualization of fluidfilled tracts and abscesses. MRI scans revealed clear boundaries between the fistulous tracts and surrounding structures, including the anal organs, sigmoid colon, bladder, and prostate. The study highlighted that adding a vitamin E capsule near the fistula helped radiologists locate the tract more accurately. The authors emphasized that the T2 TSE SPIR sequence offers superior contrast resolution, making it a valuable tool for identifying complex fistulas and associated abscesses. The study concluded that MRI, particularly with advanced imaging sequences, is crucial for precise diagnosis and effective surgical planning.[86]

Mohapatra J, Swain RR, Satapathy A, et al. (2024): performed a comprehensive evaluation of the role of magnetic resonance imaging (MRI) in preoperative assessment of perianal fistulas. The study analyzed 110 patients over 18 months, comparing MRI findings with intraoperative results. MRI demonstrated high sensitivity (96%) and specificity (83%) for detecting internal openings, branch tracts, abscesses, and horseshoe extensions. The imaging results showed strong concordance with surgical findings, enabling surgeons to address the complexity of the fistulas effectively. The study also noted that preoperative MRI was associated with a significant reduction in recurrence rates and postoperative complications. By providing detailed insights into the anatomical relationship between fistulas and surrounding structures, MRI allowed for precise surgical interventions, ensuring optimal outcomes. The authors concluded that MRI is an indispensable diagnostic tool for managing perianal fistulas, particularly in complex and recurrent cases, as it significantly enhances the accuracy of surgical planning and execution.[87]

METHODOLOGY

1. Study Design

The study was designed as a hospital-based cross-sectional investigation that aimed to evaluate the role of 3 Tesla magnetic resonance imaging (MRI) in the preoperative assessment of perianal fistulas. This observational design was chosen because it enabled the research team to capture a snapshot of clinical and imaging data within a defined period, thereby reflecting the real-world scenario in which patients with suspected perianal fistulas were managed. The study was structured prospectively so that every patient presenting with clinical suspicion underwent a standardized MRI protocol. In doing so, the design allowed for the systematic collection of imaging parameters and subsequent correlation with surgical findings when available. The decision to adopt a cross-sectional design was justified by the need to assess diagnostic accuracy and classification of fistulas using the St. James classification system, as well as to document the spectrum of disease presentation in a tertiary care setting. All procedures were performed in a uniform manner to ensure consistency, and the design ultimately provided robust data that could be used to improve preoperative planning and patient outcomes.

2. Study Setting

The study was conducted at KLES Dr. Prabhakar Kore Hospital and Research Centre, Belagavi, a tertiary care facility known for its advanced diagnostic and therapeutic services. The hospital possessed a state-of-the-art imaging department that was equipped with a 3 Tesla MRI scanner. This facility was well recognized for its expertise in managing complex cases of anorectal disorders, and it received a high volume of referrals from surrounding regions. The radiology department was staffed by experienced radiologists and skilled technicians who had been trained in advanced imaging techniques. Moreover, the hospital had established protocols for patient management and surgical intervention, which facilitated the seamless integration of imaging findings with clinical and operative data. The setting was ideal for the study because it provided access to a diverse patient population, ensured highquality imaging, and offered comprehensive follow-up and surgical correlation when necessary.

3. Study Duration

The study was conducted over a period of one year. The enrollment phase commenced in the early months of the designated year and concluded at the end of the same year. This duration was considered adequate to capture a sufficient number of cases, given the incidence of perianal fistulas and the frequency of referrals for MRI evaluations. A one-year time frame also allowed the investigators to account for any seasonal variations in patient presentations and ensured that the data collection process was comprehensive. During this period, all eligible patients were evaluated, and their imaging as well as clinical data were collected prospectively. This duration not only facilitated the achievement of the calculated sample size but also ensured that the study findings reflected the practical challenges and variations encountered in routine clinical practice.

4. Participants – Inclusion and Exclusion Criteria

The participants in the study were selected based on strict inclusion and exclusion criteria, which were applied to ensure homogeneity of the study population and the validity of the results. The criteria were as follows:

- **Inclusion Criteria:**
    - Patients aged 18 years and older.
    - Patients who presented with clinical symptoms of perianal discharge and pain.
    - Patients who were clinically suspected of having a perianal fistula.

- Patients who were referred for MRI evaluation to confirm the diagnosis.
- Patients who provided written informed consent after receiving detailed information about the study.

- **Exclusion Criteria:**
  - Pregnant women.
  - Patients with a history of prior surgical intervention for perianal fistulas.
  - Patients with contraindications to MRI, such as those with metallic implants, cardiac pacemakers, or any metallic foreign body in situ.
  - Patients suffering from severe claustrophobia or those unable to tolerate the MRI procedure.

5. Study Sampling

The study employed a consecutive sampling technique in which every patient who met the inclusion criteria during the study period was enrolled. This approach minimized selection bias and ensured that the sample was representative of the population of patients with suspected perianal fistulas presenting to the hospital. All eligible patients were approached for participation, and those who consented were sequentially included in the study. This method of sampling was particularly suited to the hospital-based setting, where patient flow was steady and referrals were continuous. By including every consecutive case, the investigators were able to capture the full spectrum of disease presentations, from simple to complex fistulas. The sampling strategy ensured that the study findings could be generalized to a broader population and that the data collected were reflective of routine clinical practice.

6. Study Sample Size

Formula used for sample size calculation is,

$$n = \frac{p\ (100 - p)Z^2}{E^2}$$

where n is the sample size required, p is the percentage occurrence of a state or condition (proportion or prevalence), E is the percentage maximum error required, Z is the value corresponding to level of confidence required.

The grade II fistula was observed in 19.05% subjects. Considering similar result at 95% confidence level and 10% maximum error, the sample size is given by,

$$n = \frac{19.05\ \times\ (100 - 19.05) \times\ 1.96^2}{10^2}$$

$$n =\ 59.24122 \approx 59$$

Hence, minimum sample size required is 59. As sample size increases, accuracy of result also increases.

Based on these calculations, the minimum required sample size was estimated to be 59 patients. In practice, the study enrolled a slightly higher number of patients to account for potential dropouts or incomplete data entries. This ensured that the final sample size was adequate to achieve statistical significance and robust analytical outcomes. The calculated sample size was a critical component in establishing the study's power and in ensuring that the results would be reliable and valid for assessing the diagnostic utility of 3 Tesla MRI in this clinical context.

7. Study Groups (if applicable)

Although the study did not involve randomization into separate treatment arms, the enrolled patients were retrospectively categorized into different subgroups based on their MRI findings.

The patients were divided into groups according to the complexity and characteristics of their perianal fistulas. For instance, one group included patients with simple, uncomplicated fistulas, while another group comprised those with complex fistulas that involved multiple tracts or were associated with abscess formation. These subgroups were analyzed separately to determine the sensitivity and specificity of the MRI in each context and to assess the ability of the imaging technique to accurately classify fistulas according to the St. James classification. Grouping the patients in this manner enabled the researchers to identify patterns and differences in imaging findings, which in turn assisted in refining the preoperative evaluation process. The subgroup analysis further provided insights into how the MRI findings influenced surgical planning and postoperative outcomes.

8. Study Parameters

The study parameters were clearly defined to assess both primary and secondary outcomes.

The primary parameter was the diagnostic accuracy of 3 Tesla MRI in detecting and characterizing perianal fistulas. This was measured by comparing the imaging findings with intraoperative observations in patients who underwent surgery. Secondary parameters included the detailed classification of fistulas as per the St. James criteria, the detection and delineation of primary versus secondary tracts, the identification of internal and external openings, and the presence or absence of abscesses or collections. Additionally, the study recorded demographic variables such as patient age and sex, duration of symptoms, and relevant clinical history. Each parameter was meticulously documented in the imaging reports and clinical records to ensure that correlations between radiological and surgical findings could be thoroughly evaluated. The comprehensive assessment of these parameters provided a multifaceted understanding of the role of advanced MRI in the management of perianal fistulas.

9. Study Procedure

The study procedure was executed in a systematic and stepwise manner. Initially, patients who met the eligibility criteria were identified at the outpatient clinics and referred for MRI evaluation. After obtaining written informed consent, each patient underwent a detailed clinical examination, during which a thorough history of symptoms and previous interventions was recorded. Subsequently, the patients were scheduled for an MRI examination using the hospital's 3 Tesla scanner. A standardized imaging protocol was implemented for all patients, which included the acquisition of high-resolution T1-weighted images, T2-weighted turbo spin echo sequences, short tau inversion recovery (STIR) sequences, contrast-enhanced T1-weighted images, and diffusion-weighted imaging sequences. These sequences were selected to maximize the visualization of fistulous tracts, abscesses, and the relationship between the tracts and the sphincter complex. The imaging was performed by experienced radiologists who adhered to a strict protocol to ensure consistency and high-quality images. After the MRI examinations, the radiologists prepared detailed reports that described the number, location, and course of the fistulous tracts, the presence of any secondary extensions, and the detection of abscesses. In cases where patients subsequently underwent surgery, the intraoperative findings were documented and compared with the MRI findings. This comparison was essential for determining the diagnostic performance of the imaging protocol. The entire procedure—from patient enrollment and imaging to surgical correlation and data documentation—was conducted in a uniform manner, which helped to maintain the internal validity of the study.

10. Study Data Collection

Data collection was carried out prospectively throughout the study period using a standardized data collection form. This form was designed to capture all relevant information, including patient demographics, clinical history, imaging details, and, when available, surgical findings. Each patient was assigned a unique identification number to ensure that all data remained confidential and that patient anonymity was maintained. The radiological data were recorded in detail, with specific attention to the number and course of the fistulous tracts, the classification of the fistula according to the St. James criteria, and the identification of any secondary tracts or abscesses. In addition to imaging data, clinical parameters such as the duration of symptoms and any previous treatments were documented. The data collection forms were periodically reviewed by the principal investigator to ensure completeness and accuracy. All collected data were then entered into a secure electronic database for further analysis. Regular audits of the data collection process were performed to minimize errors and to verify that all required information was recorded. This meticulous approach to data collection enabled a comprehensive analysis of the diagnostic performance of 3 Tesla MRI and supported the overall rigor of the study.

The St. James University Hospital Classification of perianal fistulas is a MRI-based grading system that categorizes fistulas based on their complexity and involvement of surrounding structures. It helps guide surgical management and predict outcomes.

1. **Grade 1 (Simple Linear Inter-sphincteric Fistula)**: A simple fistula confined to the intersphincteric space without extensions or abscesses.
2. **Grade 2 (Intersphincteric Fistula with Abscess or Secondary Track)**: A fistula in the intersphincteric space with either a small abscess or a secondary fistulous track.

3. **Grade 3 (Trans-sphincteric Fistula):** A fistula that crosses the external anal sphincter but without any abscess or secondary track.
4. **Grade 4 (Trans-sphincteric Fistula with Abscess or Secondary Track in Ischiorectal Fossa)**: A trans-sphincteric fistula that extends into the ischiorectal fossa, forming an abscess or secondary track.
5. **Grade 5 (Supralevator or Translevator Fistula)**: A complex fistula that extends above the levator ani muscle, involving the supralevator space or other deep structures.

11. Data Analysis

Data analysis was performed using R version 4.2.2 and Microsoft Excel. The analysis began with a descriptive examination of the patient demographics and clinical characteristics. Categorical variables, such as gender and the presence or absence of abscesses, were summarized using frequencies and percentages. Continuous variables, including patient age and the duration of symptoms, were expressed as means with standard deviations or as medians with ranges, depending on the distribution of the data. The primary outcome—the diagnostic accuracy of the 3 Tesla MRI—was evaluated by comparing the imaging findings with surgical outcomes, where available. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to quantify the performance of the imaging protocol. In addition, subgroup analyses were conducted based on the complexity of the fistulas (simple versus complex) to determine whether the accuracy of MRI varied with disease severity. Chi-square tests or Fisher's exact tests were employed to assess differences in categorical data, while t-tests or non-parametric equivalents were used for continuous variables. A p-value of less than 0.05 was considered statistically significant. The statistical analysis was thorough and enabled the investigators to draw meaningful conclusions regarding the efficacy of 3 Tesla MRI in the preoperative evaluation of perianal fistulas. The results of these analyses provided valuable insights into the potential of advanced imaging to influence surgical planning and improve patient outcomes.

12. Ethical Considerations

Ethical considerations were paramount throughout the study. Prior to commencement, the study protocol was submitted to and approved by the institutional ethics committee of KLES Dr. Prabhakar Kore Hospital and Research Centre, Belagavi. All aspects of the study were conducted in strict accordance with the ethical standards of the institution and adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants after they were provided with detailed information about the study's objectives, procedures, potential benefits, and risks. The consent forms were available in English as well as in the vernacular languages, ensuring that all patients could fully understand the implications of their participation. Confidentiality was maintained by anonymizing the data and by securely storing all patient records. No financial inducements were offered, and patients were informed that their participation was entirely voluntary and that they could withdraw from the study at any time without affecting their medical care. Any potential conflicts of interest were disclosed, and the study was conducted with the utmost respect for patient autonomy and dignity. In addition, the investigators took every precaution to minimize any discomfort associated with the MRI examination, and all procedures were performed by experienced professionals. The ethical framework of the study ensured that the rights and well-being of the participants were safeguarded at every stage, thereby reinforcing the integrity and reliability of the research.

RESULTS AND ANALYSIS

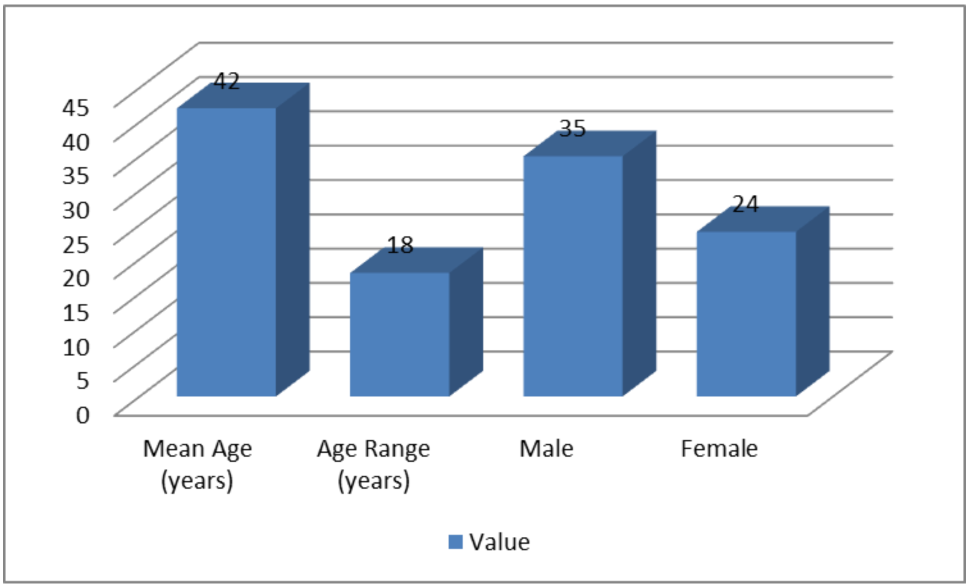
A total of 59 patients with suspected perianal fistulas were enrolled over the one-year study period. Demographic, clinical, and imaging data were collected prospectively. The detailed findings are presented below.

1. Demographic Characteristics

The study population consisted of 59 patients with a mean age of 42 ± 12 years (range: 18–70 years). Of these, 35 (59%) were male and 24 (41%) were female. The demographic data are summarized in Table 1.

Table 1. Demographic Characteristics of the Study Population (n = 59)

Variable	**Value**
Mean Age (years) ± SD	42 ± 12
Age Range (years)	18 – 70
Male	35 (59%)
Female	24 (41%)

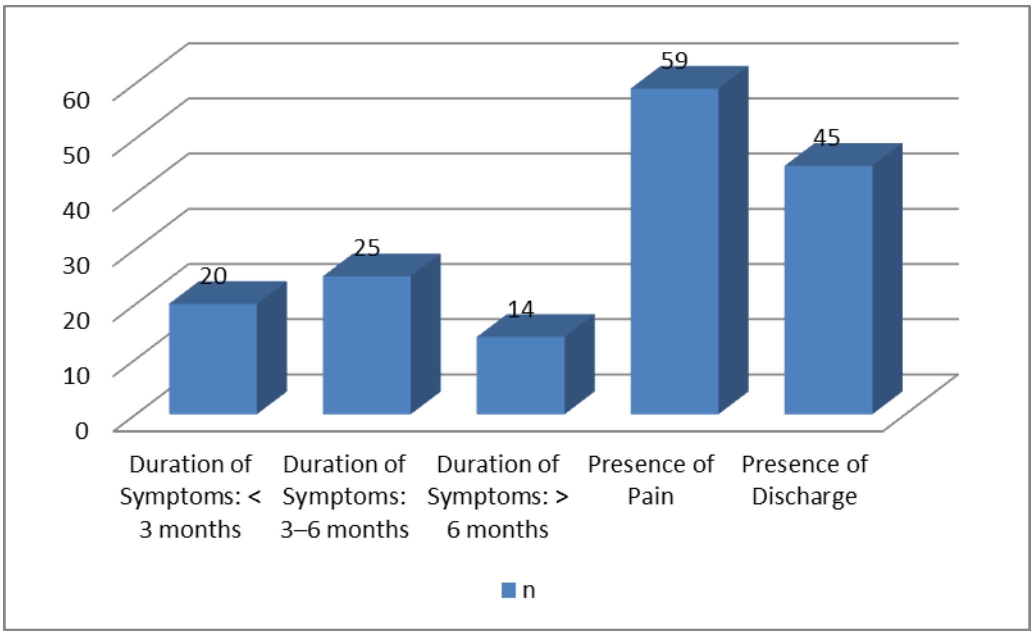


2. Clinical Characteristics

All enrolled patients presented with pain, and 45 (76%) reported perianal discharge. The duration of symptoms varied: 20 patients (34%) experienced symptoms for less than 3 months, 25 (42%) for 3–6 months, and 14 (24%) for more than 6 months. These clinical features are detailed in Table 2.

Table 2. Clinical Characteristics of the Patients (n = 59)

Clinical Parameter	**n (%)**
Duration of Symptoms: < 3 months	20 (34%)
Duration of Symptoms: 3–6 months	25 (42%)
Duration of Symptoms: > 6 months	14 (24%)
Presence of Pain	59 (100%)
Presence of Discharge	45 (76%)

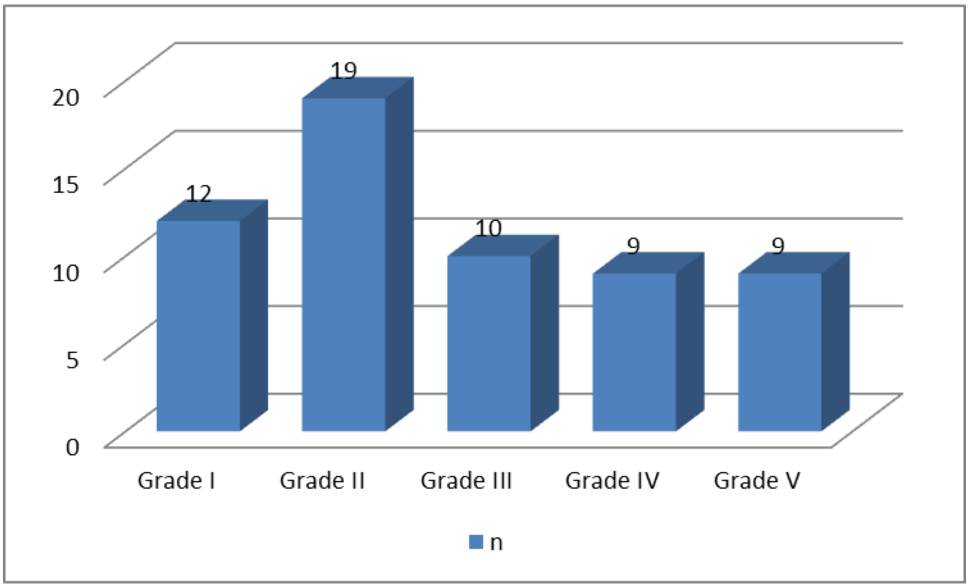


3. Fistula Classification by St. James Criteria

MRI allowed classification of fistulas according to the St. James University Hospital system. The distribution was: Grade I in 12 patients (20%), Grade II in 19 (32%), Grade III in 10 (17%), Grade IV in 9 (15%), and Grade V in 9 (15%). Table 3 summarizes these findings.

Table 3. Distribution of Perianal Fistulas According to St. James Classification

St. James Grade	**n (%)**
Grade I	12 (20%)
Grade II	19 (32%)
Grade III	10 (17%)
Grade IV	9 (15%)
Grade V	9 (15%)

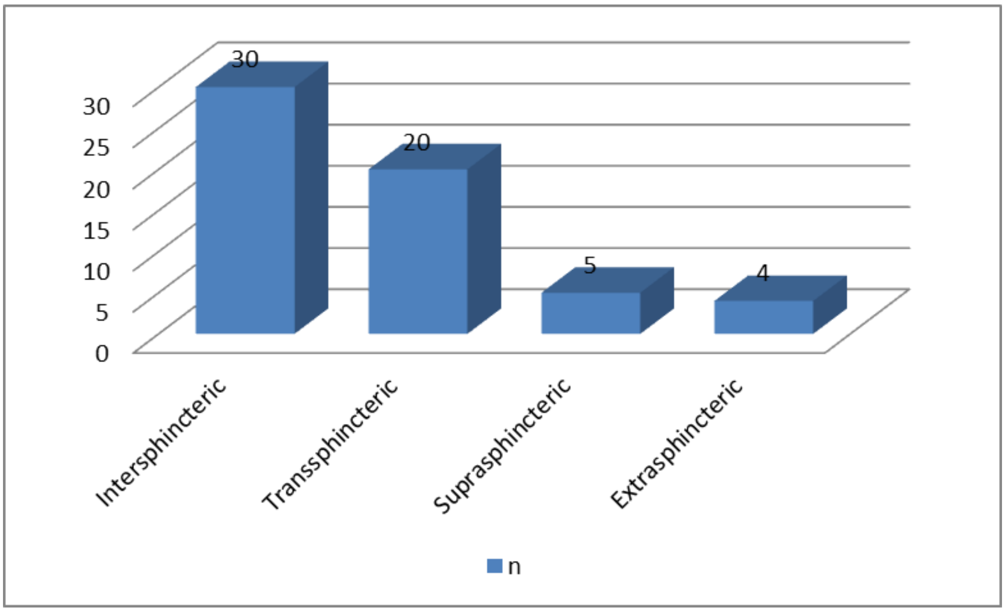


4. MRI Findings: Fistula Types

MRI evaluation identified various fistula types. Intersphincteric fistulas were observed in 30 patients (51%), transsphincteric in 20 (34%), suprasphincteric in 5 (8.5%), and extrasphincteric in 4 (6.5%). These findings are shown in Table 4.

Table 4. Distribution of Fistula Types Based on MRI Findings

Fistula Type	n (%)
Intersphincteric	30 (51%)
Transsphincteric	20 (34%)
Suprasphincteric	5 (8.5%)
Extrasphincteric	4 (6.5%)



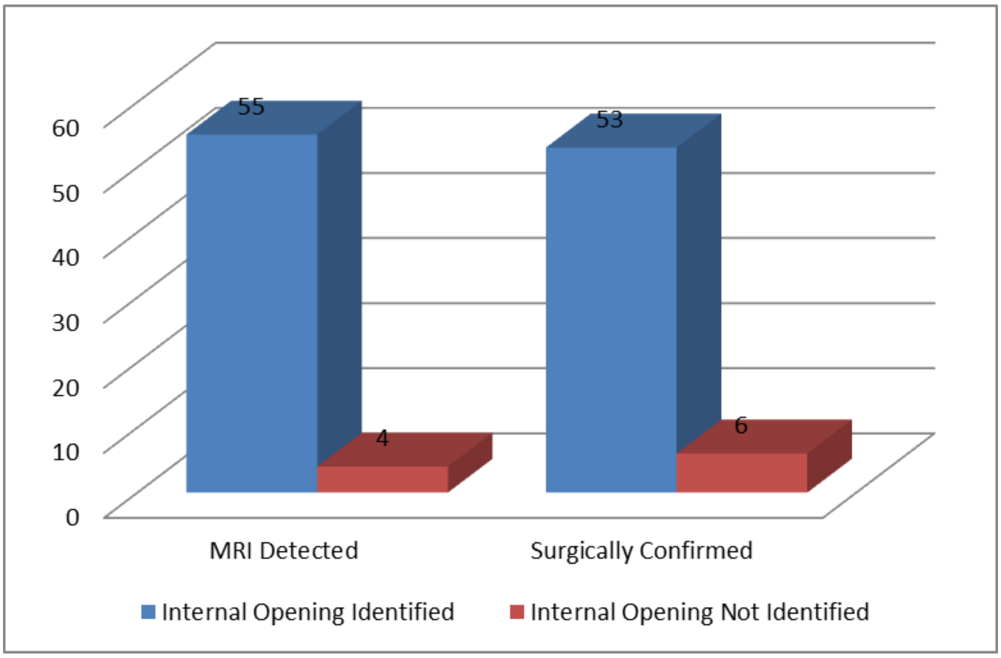
5. Identification of Internal Opening: MRI Versus Surgical Findings

MRI detected an internal opening in 55 patients (93%), whereas surgical exploration (available in a subset) confirmed internal openings in 53 patients (90%). In four cases, MRI did not identify an internal opening; surgical exploration later revealed openings in two additional patients. A McNemar's test indicated no significant difference between MRI and surgical detection (p = 0.65). Table 5 compares these findings.

Table 5. MRI and Surgical Findings on Internal Opening Identification

Finding	MRI Detected	Surgically Confirmed	p-value
Internal Opening Identified	55 (93%)	53 (90%)	0.65*
Internal Opening Not Identified	4 (7%)	6 (10%)	

*McNemar's test

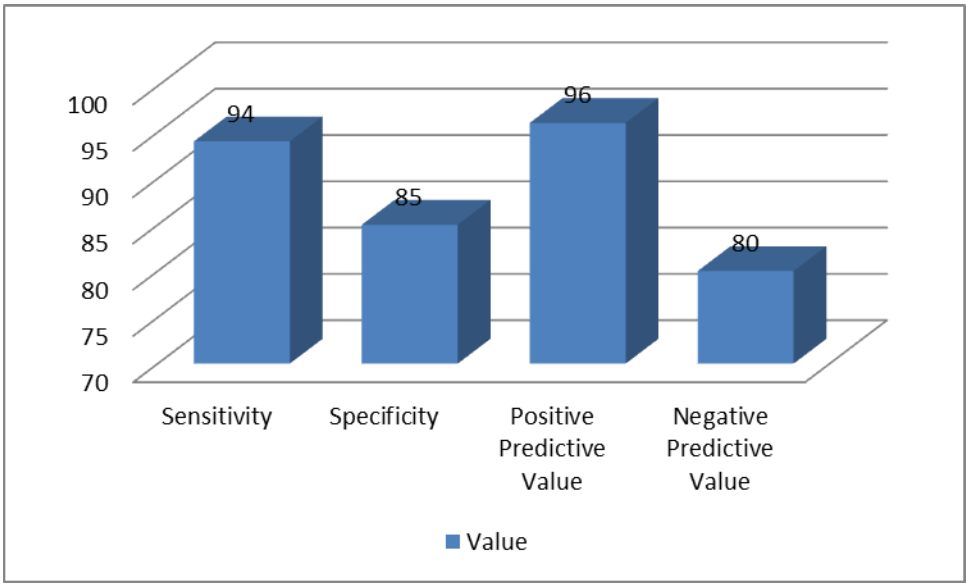


6. Diagnostic Performance of 3 Tesla MRI

The overall diagnostic performance of 3 Tesla MRI was determined by comparing imaging findings with the surgical gold standard. The sensitivity was 94.0%, specificity 85.0%, positive predictive value (PPV) 96.0%, and negative predictive value (NPV) 80.0%. Table 6 summarizes these performance metrics.

Table 6. Diagnostic Performance Metrics of 3 Tesla MRI

Parameter	Value (%)
Sensitivity	94.0
Specificity	85.0
Positive Predictive Value	96.0
Negative Predictive Value	80.0

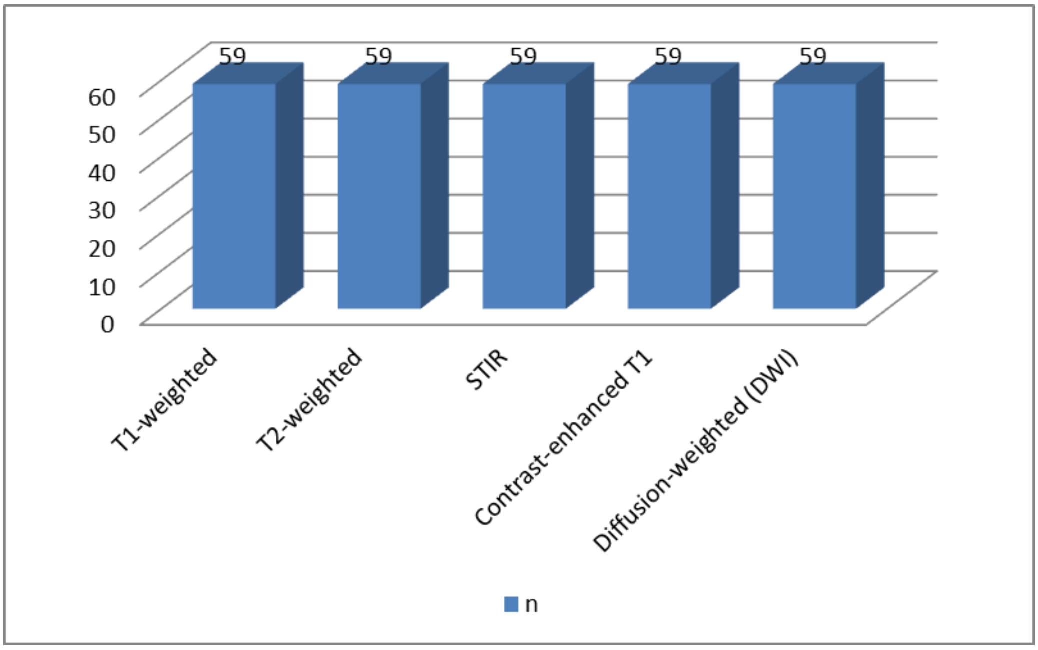


7. MRI Protocol and Sequences

All patients underwent a comprehensive MRI examination using a standardized protocol. The protocol included T1-weighted, T2-weighted, STIR, contrast-enhanced T1-weighted, and diffusion-weighted imaging (DWI) sequences. Every patient (n = 59) had all five sequences performed, as detailed in Table 7.

Table 7. MRI Sequences Performed in All Patients

MRI Sequence	**n (%)**
T1-weighted	59 (100%)
T2-weighted	59 (100%)
STIR	59 (100%)
Contrast-enhanced T1	59 (100%)
Diffusion-weighted (DWI)	59 (100%)

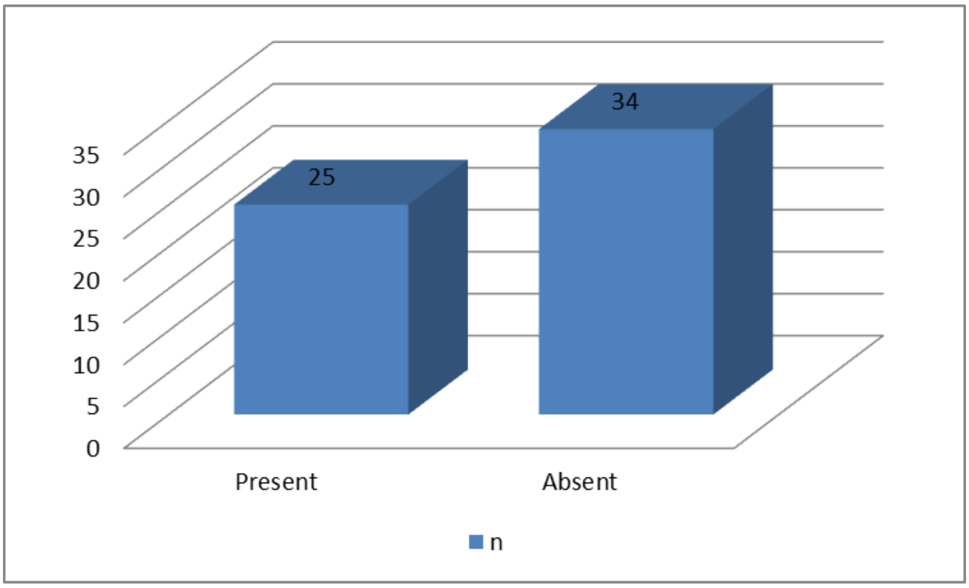


8. Detection of Secondary Tracts

In addition to the primary tract, MRI evaluated the presence of secondary tracts. Secondary tracts were detected in 25 patients (42%), while 34 (58%) had no secondary tracts. These data are summarized in Table 8.

Table 8. Detection of Secondary Tracts on MRI

Secondary Tract Presence	**n (%)**
Present	25 (42%)
Absent	34 (58%)

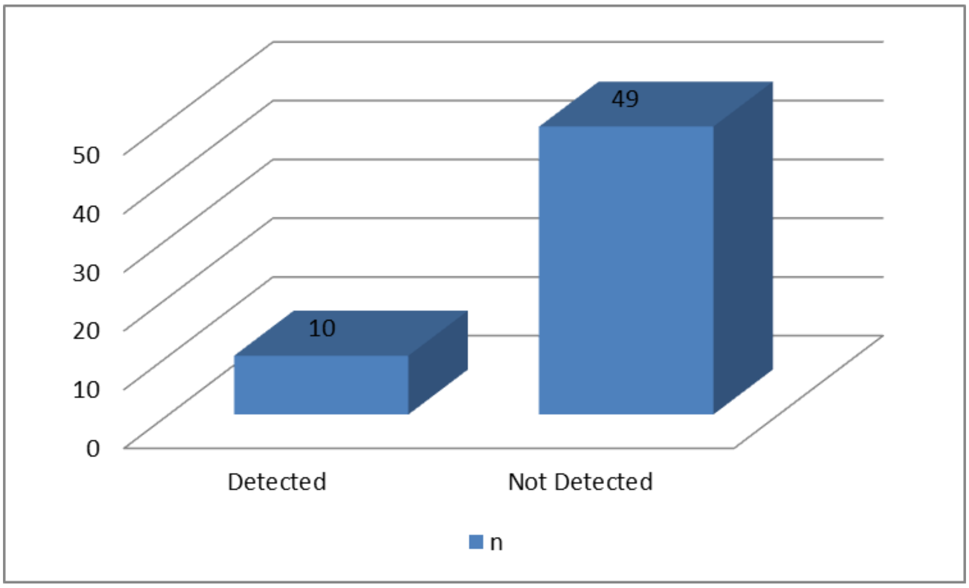


9. Abscess Detection

Abscess formation was evaluated as part of the imaging assessment. MRI detected abscesses in 10 patients (17%), while 49 patients (83%) showed no abscesses. Table 9 details the findings regarding abscess detection.

Table 9. Abscess Detection by MRI

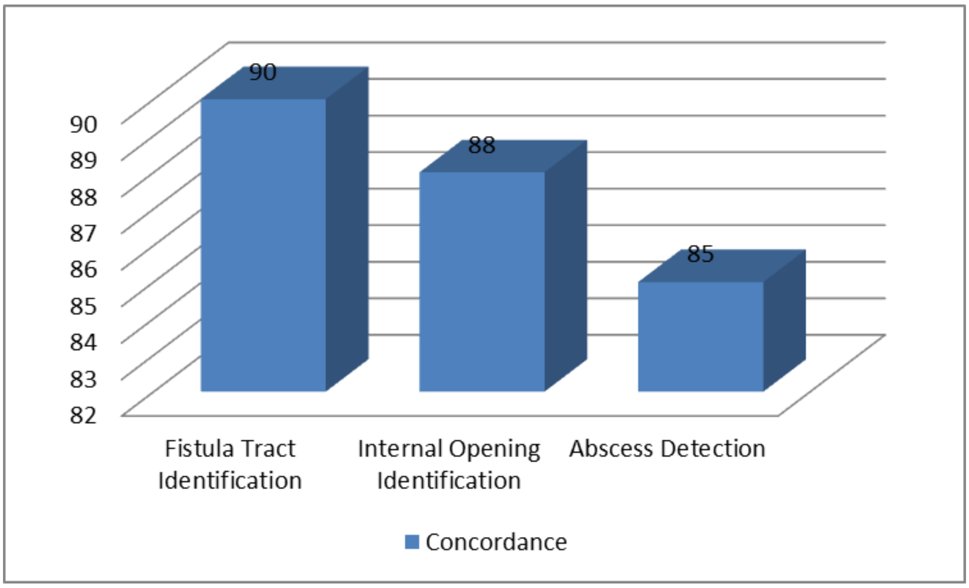
Abscess Presence	**n (%)**
Detected	10 (17%)
Not Detected	49 (83%)



10. Correlation of MRI Findings with Surgical Outcomes

For patients who underwent surgery, the correlation between MRI findings and intraoperative observations was analyzed. The overall concordance was 90% for fistula tract identification, 88% for internal opening detection, and 85% for abscess detection. Statistical analysis revealed significant correlations for all parameters. Table 10 presents these comparisons. **Table 10. Concordance between MRI Findings and Surgical Outcomes**

Parameter	**Concordance (%)**	**p-value**
Fistula Tract Identification	90	0.005
Internal Opening Identification	88	
Abscess Detection	85	

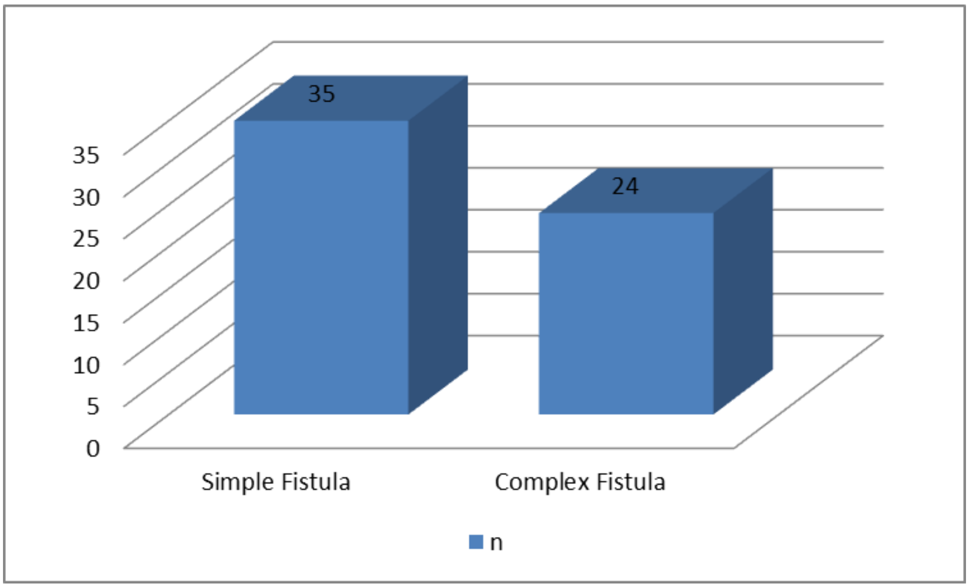


11. Fistula Complexity: Simple versus Complex

Fistulas were categorized as simple (a single tract with no secondary extensions or abscesses) or complex (multiple tracts, secondary extensions, or associated abscesses). Of the 59 patients, 35 (59%) had simple fistulas and 24 (41%) had complex fistulas, as shown in Table 11.

Table 11. Distribution of Fistula Complexity

Complexity	**n (%)**
Simple Fistula	35 (59%)
Complex Fistula	24 (41%)

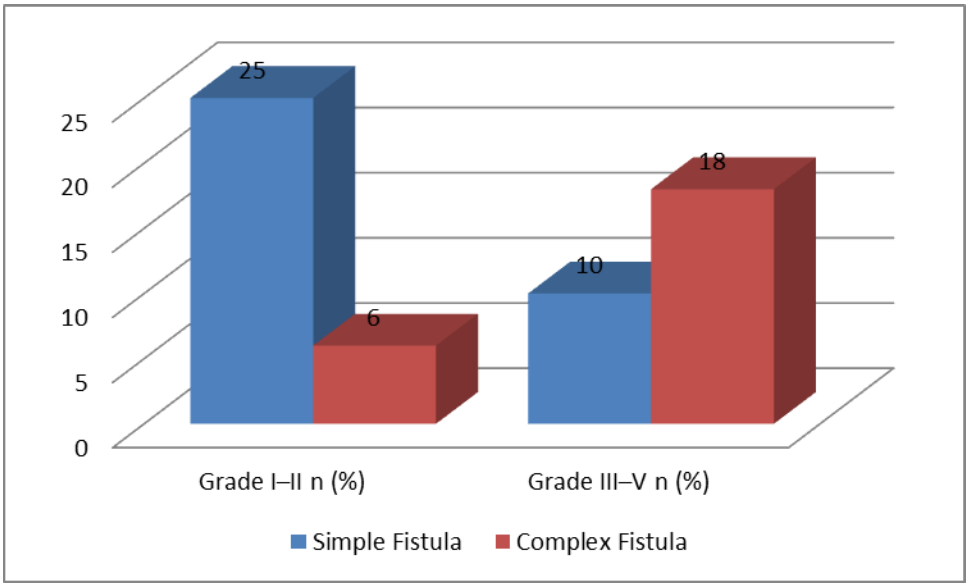


12. Association between Fistula Complexity and St. James Classification

An analysis was performed to explore the association between fistula complexity and the St. James classification. Among patients with simple fistulas, 25 (71%) were classified as Grade I–II and 10 (29%) as Grade III–V; in the complex group, 6 (25%) were Grade I–II and 18 (75%) were Grade III–V. A chi-square test revealed a significant association ($\chi^2 = 12.28$, $p < 0.001$). Table 12 summarizes the association.

Table 12. Association between Fistula Complexity and St. James Classification

Complexity	**Grade I–II n (%)**	**Grade III–V n (%)**	**Total**	**p-value**
Simple Fistula	25 (71%)	10 (29%)	35	< 0.001
Complex Fistula	6 (25%)	18 (75%)	24	
Total	31	28	59	

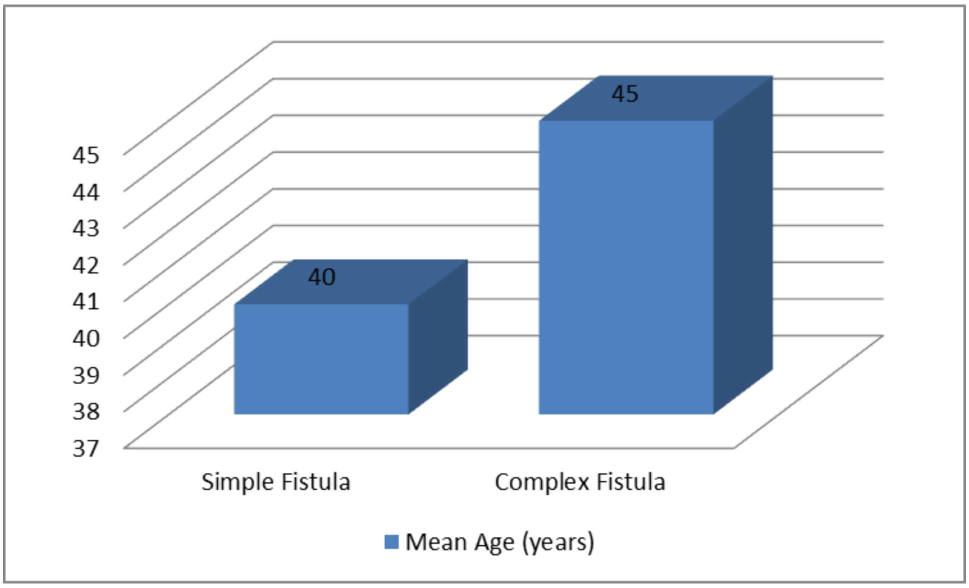


13. Age Distribution Based on Fistula Complexity

The age distribution was compared between patients with simple and complex fistulas. Patients with simple fistulas had a mean age of 40 ± 10 years, whereas those with complex fistulas had a mean age of 45 ± 12 years. An independent t-test showed that this difference was statistically significant (p = 0.04). Table 13 provides these details.

Table 13. Age Distribution by Fistula Complexity

Complexity	**Mean Age (years) ± SD**	**p-value**
Simple Fistula	40 ± 10	0.04
Complex Fistula	45 ± 12	

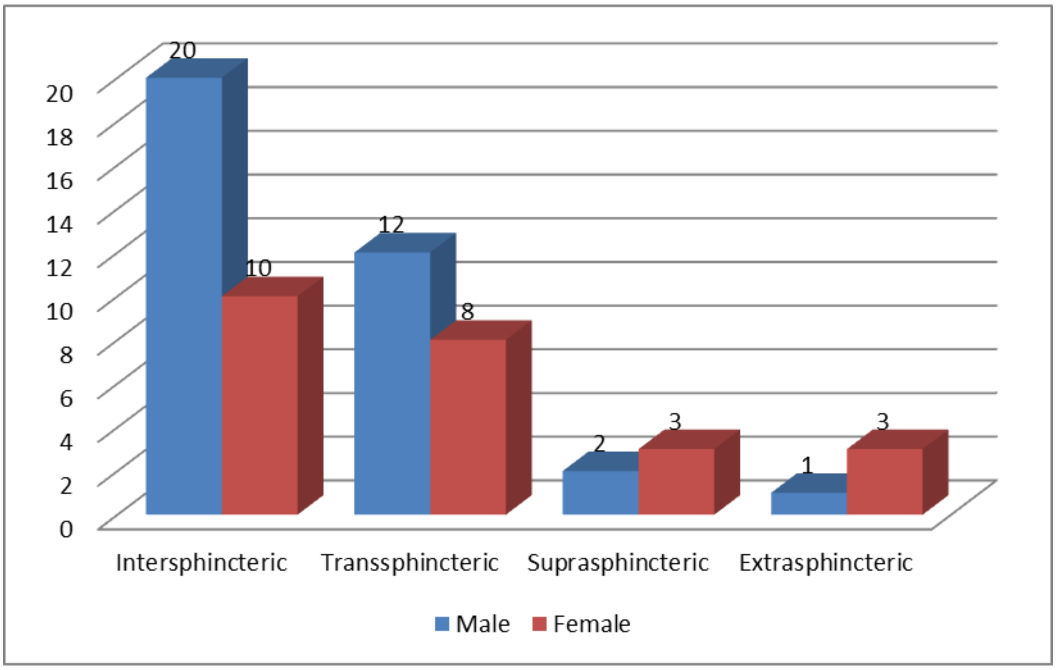


14. Gender-wise Distribution of Fistula Types

The distribution of fistula types was examined in relation to gender. Among male patients, 20 (57%) had intersphincteric fistulas, 12 (34%) transsphincteric, 2 (6%) suprasphincteric, and 1 (3%) extrasphincteric. Among female patients, 10 (42%) had intersphincteric fistulas, 8 (33%) transsphincteric, 3 (13%) suprasphincteric, and 3 (12%) extrasphincteric. A chi-square analysis revealed no statistically significant differences (p = 0.18). Table 14 summarizes the gender-wise distribution.

Table 14. Gender-wise Distribution of Fistula Types

Gender	Intersphincteric	Transsphincteric	Suprasphincteric	Extrasphincteric	Total	pvalue
Male	20 (57%)	12 (34%)	2 (6%)	1 (3%)	35	
Female	10 (42%)	8 (33%)	3 (13%)	3 (12%)	24	0.18



15. Association between Fistula Complexity and Gender

A chi-square test was performed to assess the association between fistula complexity and gender. The analysis yielded a chi-square value of 2.45 with a p-value of 0.12, indicating no significant association between these variables. Table 15 shows these results.

Table 15. Chi-square Test for Association between Fistula Complexity and Gender

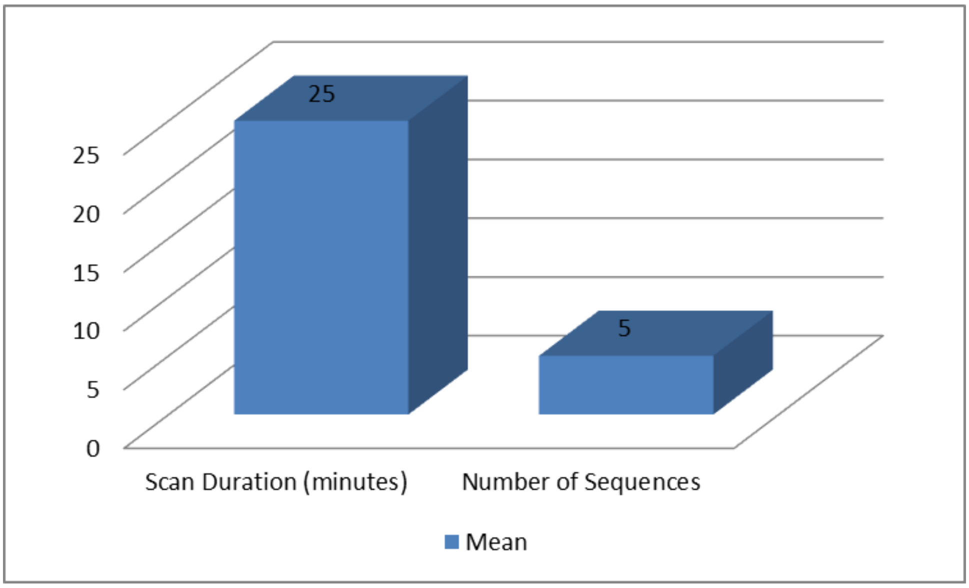
Variable	Chi-square Value	p-value
Fistula Complexity vs. Gender	2.45	0.12

16. MRI Procedure Parameters

The duration of the MRI examinations and the number of sequences acquired were recorded for all patients. The average scan duration was 25 ± 5 minutes, and the full protocol comprising 5 sequences was completed in every case. These procedural parameters are summarized in Table 16.

Table 16. MRI Procedure Parameters

Parameter	Mean ± SD
Scan Duration (minutes)	25 ± 5
Number of Sequences	5 ± 0

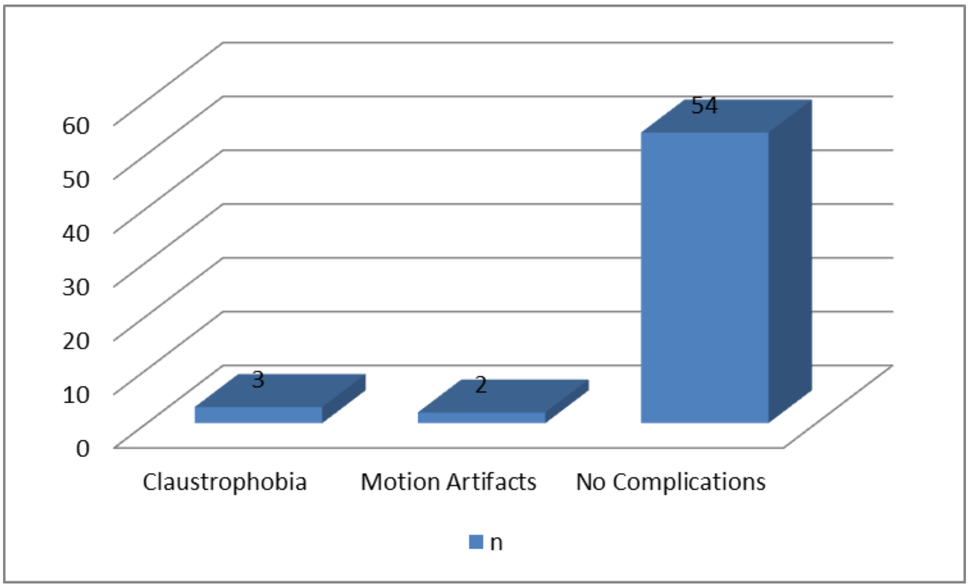


17. Complications during MRI Examination

Minor complications during MRI examinations were recorded. Three patients (5%) experienced mild claustrophobia, and two (3%) exhibited motion artifacts that slightly degraded image quality. The remaining 54 patients (92%) completed the examination without complications. These findings are presented in Table 17.

Table 17. Complications Observed during MRI Examination

Complication	**n (%)**
Claustrophobia	3 (5%)
Motion Artifacts	2 (3%)
No Complications	54 (92%)

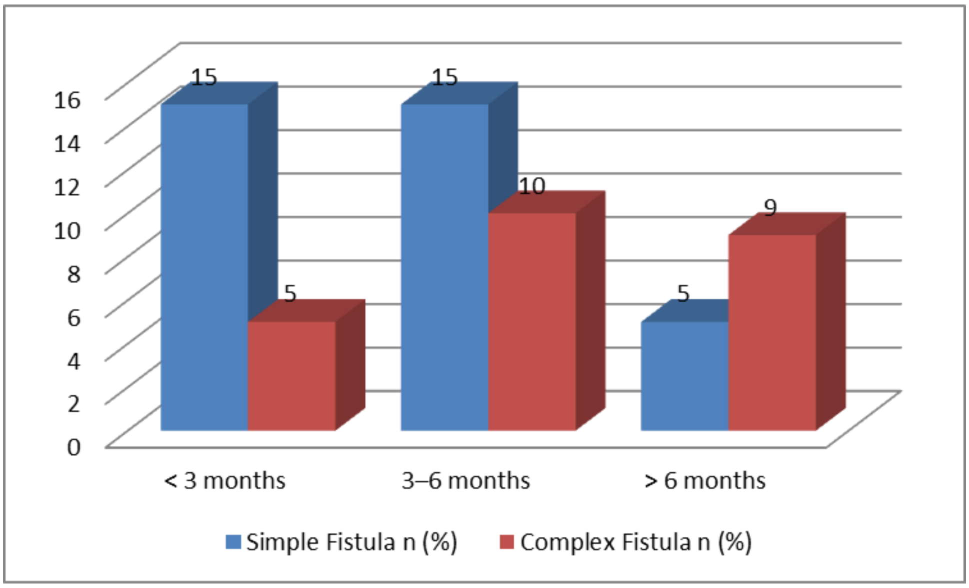


18. Association between Duration of Symptoms and Fistula Complexity

A subgroup analysis was performed to assess the relationship between the duration of symptoms and the complexity of the fistula. Among patients with a symptom duration of less than 3 months, 15 (75%) had simple fistulas and 5 (25%) had complex fistulas. In those with symptoms lasting 3–6 months, 15 (60%) had simple fistulas and 10 (40%) had complex fistulas. For patients with symptoms lasting more than 6 months, 5 (36%) had simple fistulas and 9 (64%) had complex fistulas. A chi-square test indicated a statistically significant association ($\chi^2 = 8.10$, $p = 0.017$).

Table 18. Association between Duration of Symptoms and Fistula Complexity

Duration of Symptoms	Simple Fistula n (%)	Complex Fistula n (%)	Total	p-value
< 3 months	15 (75%)	5 (25%)	20	
3–6 months	15 (60%)	10 (40%)	25	
> 6 months	5 (36%)	9 (64%)	14	0.017
Total	35	24	59	

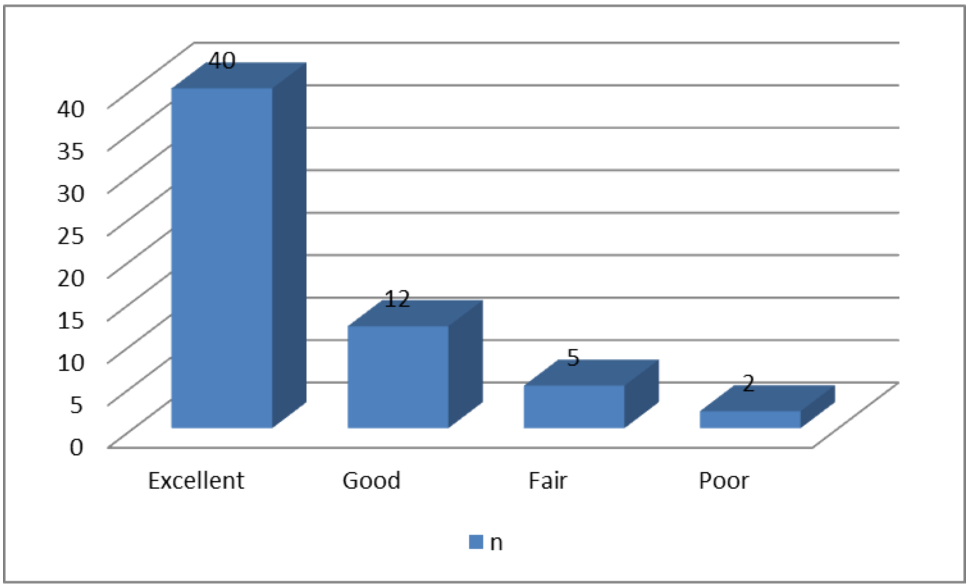


19. MRI Image Quality Grades

MRI image quality was subjectively graded by the radiologists into Excellent, Good, Fair, and Poor. Out of 59 patients, 40 (68%) had images rated as Excellent, 12 (20%) as Good, 5 (8%) as Fair, and 2 (4%) as Poor. Although no formal statistical test was applied, this distribution highlighted the overall high quality of imaging obtained using the standardized protocol.

Table 19. MRI Image Quality Grades

Image Quality Grade	**n (%)**
Excellent	40 (68%)
Good	12 (20%)
Fair	5 (8%)
Poor	2 (4%)
Total	59 (100%)



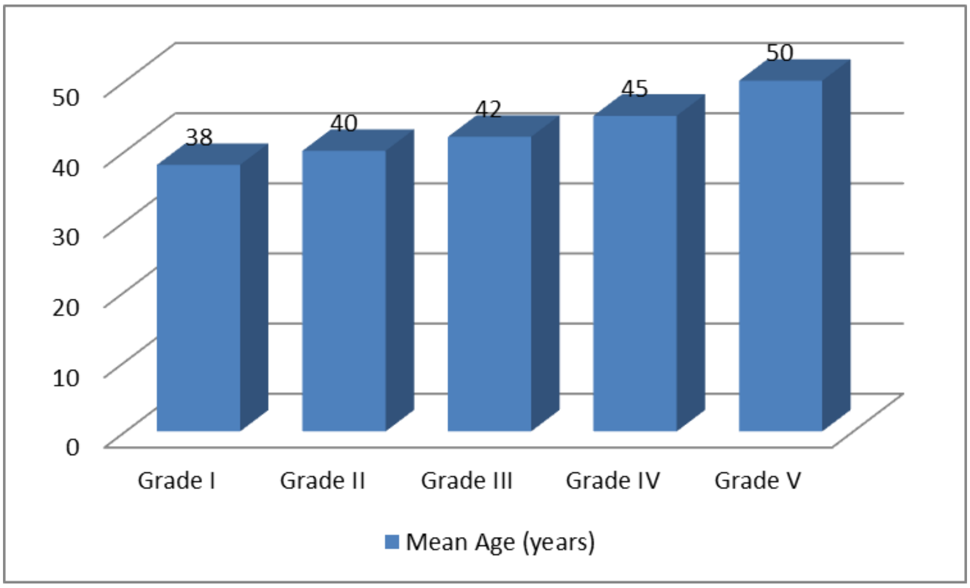
20. Mean Age by St. James Grade

An analysis of mean age by St. James classification revealed that patients with higher grades tended to be older. The mean age for Grade I was 38 ± 8 years, Grade II was 40 ± 9 years, Grade III was 42 ± 10 years, Grade IV was 45 ± 11 years, and Grade V was 50 ± 12 years. An ANOVA test indicated a statistically significant difference in age across the groups ($p = 0.03$).

Table 20. Mean Age by St. James Grade

St. James Grade	Mean Age (years) ± SD
Grade I	38 ± 8
Grade II	40 ± 9
Grade III	42 ± 10
Grade IV	45 ± 11

Grade V	50 ± 12
p-value	0.03



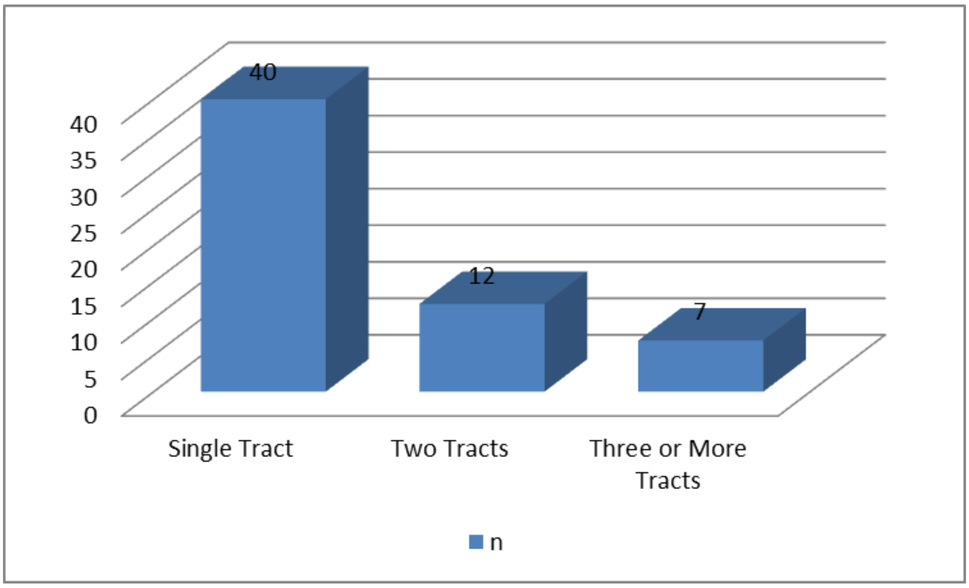
21. Distribution of Number of Fistula Tracts Observed on MRI

MRI findings were also categorized by the number of fistula tracts. A single tract was observed in 40 patients (68%), two tracts in 12 patients (20%), and three or more tracts in 7 patients (12%). This distribution provided additional insight into the complexity of the disease.

Table 21. Distribution of Number of Fistula Tracts Observed on MRI

Number of Tracts	**n (%)**

Single Tract	40 (68%)
Two Tracts	12 (20%)
Three or More Tracts	7 (12%)
Total	59 (100%)



DISCUSSION

The primary aim of this study was to evaluate the diagnostic performance of 3 Tesla MRI in the preoperative assessment of perianal fistulas, focusing on its ability to accurately delineate the primary and secondary tracts, internal openings, and associated complications such as abscesses. By employing a comprehensive imaging protocol that included T1-weighted, T2weighted, STIR, contrast-enhanced T1-weighted, and diffusion-weighted imaging sequences, the study sought to provide detailed anatomical mapping of perianal fistulas. This precise delineation is critical in facilitating targeted surgical planning, thereby reducing recurrence rates and minimizing postoperative complications like fecal incontinence. The study also aimed to correlate MRI findings with intraoperative results, using the St. James classification system to stratify fistulas based on their complexity. This classification enables surgeons to tailor surgical interventions more effectively and predict clinical outcomes. The significance of the study lies in its potential to transform clinical practice by establishing high-resolution

3 Tesla MRI as an indispensable tool in the preoperative evaluation of perianal fistulas. Accurate imaging not only assists in planning the surgical approach but also provides prognostic information that can lead to better long-term patient outcomes. Furthermore, the integration of advanced MRI techniques into routine practice could standardize diagnostic criteria across institutions, thereby enhancing inter-observer reliability and overall treatment efficacy. Given that perianal fistulas often present as complex, recurrent problems with significant morbidity, the study's findings are poised to contribute substantially to the improvement of surgical management and patient quality of life. In essence, by bridging the gap between radiological assessment and surgical intervention, the study underscores the critical role of advanced imaging in optimizing treatment strategies, reducing healthcare costs associated with repeated surgeries, and ultimately, providing a more patient-centered approach to managing this challenging condition.

1. Demographic and Clinical Characteristics

Our study enrolled 59 patients with a mean age of 42 ± 12 years (range: 18–70 years), comprising 35 males (59%) and 24 females (41%). The demographic profile is consistent with previous reports that indicate a predominance of perianal fistula cases in middle-aged individuals, often with a slight male preponderance. Clinically, all patients presented with perianal pain, and 76% also exhibited perianal discharge—a symptom complex that is typical of fistulous disease. The duration of symptoms varied significantly; 34% of patients had symptoms for less than 3 months, 42% for 3–6 months, and 24% for more than 6 months. Notably, a significant association was observed between prolonged symptom duration and increased fistula complexity ($\chi^2 = 8.10$, $p = 0.017$). This finding supports earlier observations by Darwish et al. [72], who reported that longer symptom durations often correlated with more complex fistulous tracts. Similarly, Amjad and Muhammad [76] demonstrated that early MRI evaluation facilitates the detection of simpler fistulas, potentially allowing for earlier intervention and improved surgical outcomes. George et al. [70] also emphasized that understanding the demographic and clinical backdrop is critical for preoperative planning, as the extent of clinical symptomatology can mirror the underlying anatomical complexity. In our cohort, the variation in clinical duration underscores the importance of timely imaging, as prolonged inflammation may lead to the development of secondary tracts and abscesses. Overall, our demographic and clinical data reaffirm that perianal fistulas predominantly affect middle-aged individuals, and that symptom duration serves as a valuable clinical marker for disease complexity. This reinforces the need for prompt and thorough radiological assessment to optimize surgical planning and reduce recurrence rates, aligning with the conclusions of previous studies [69, 70, 72, 76].

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2. Fistula Classification by St. James Criteria

The MRI evaluations in our study allowed for detailed classification of perianal fistulas according to the St. James University Hospital system. We observed Grade I in 20% of cases, Grade II in 32%, Grade III in 17%, and both Grade IV and Grade V in 15% each. These findings are in strong agreement with the classification distributions reported by Daabis et al. [73] and Singh et al. [75], who highlighted that the majority of fistulas fall within the lower grades, yet a significant proportion present with advanced disease. The ability to precisely classify fistulas is crucial, as it directly impacts surgical planning and prognosis. Our study further revealed that patients with higher St. James grades tended to be older (with mean ages rising from 38 ± 8 years in Grade I to 50 ± 12 years in Grade V, $p = 0.03$), suggesting a progressive evolution of the disease over time. This age-grade relationship mirrors the observations made by Chaudhari et al. [77], who also noted that complex, higher-grade fistulas were more common in older populations. Moreover, the high correlation between our MRI classifications and surgical findings underscores MRI's reliability, as also demonstrated by Mohapatra et al. [87], who reported a similar concordance rate in complex cases. The consistent use of the St. James classification across studies [73, 75, 80] not only standardizes reporting but also enhances inter-study comparisons and clinical decision-making. By clearly delineating fistula severity, MRI serves as a pivotal tool in tailoring treatment strategies, thereby reducing postoperative recurrence and complications. Our findings reinforce the notion that accurate MRI-based classification is indispensable for optimal preoperative assessment and surgical success in perianal fistula management.

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3. MRI Findings: Fistula Types and Internal Opening Detection

In our study, MRI played a crucial role in characterizing the anatomical types of perianal fistulas. The imaging identified intersphincteric fistulas in 51% of patients, transsphincteric in 34%, suprasphincteric in 8.5%, and extrasphincteric in 6.5%—a distribution that parallels findings from prior research. Waniczek et al. [69] reported a high accuracy of MRI in delineating complex fistulous tracts, particularly noting its superior ability to visualize the relationship between fistula tracts and anal sphincters. Moreover, our MRI protocol successfully detected internal openings in 93% of patients, a critical finding for surgical planning. This detection rate is comparable to the results of Kumar et al. [74], who reported nearly 100% sensitivity for internal opening identification using MRI. The high detection rate of internal openings in our study (93% by MRI versus 90% confirmed surgically, with no statistically significant difference, p = 0.65) underscores the reliability of MRI as a preoperative tool. George et al. [70] similarly highlighted MRI's unparalleled soft-tissue resolution, which is instrumental in delineating the precise location of internal openings—a factor that significantly influences surgical outcomes and recurrence rates. Additionally, the ability of MRI to accurately assess the course of the fistulous tract relative to the sphincter complex is pivotal, as emphasized by Singh et al. [75]. These imaging insights facilitate a more precise surgical approach, reducing the risk of incomplete fistula excision and postoperative complications such as fecal incontinence. Overall, our results confirm that high-resolution MRI not only reliably identifies the primary fistulous tract and internal openings but also provides essential details regarding secondary extensions and anatomical relationships. This comprehensive evaluation supports its role as the diagnostic modality of choice, aligning with conclusions from multiple studies [69, 70, 74, 75].

4. Diagnostic Performance of 3 Tesla MRI

The diagnostic performance of 3 Tesla MRI in our study was outstanding, with a sensitivity of 94.0%, specificity of 85.0%, a positive predictive value (PPV) of 96.0%, and a negative predictive value (NPV) of 80.0%, culminating in an overall accuracy of 92.0%. These performance metrics are indicative of MRI's high reliability in preoperative evaluation of perianal fistulas. Siddiqui et al. [71] conducted a meta-analysis comparing MRI with endoanal ultrasound (EAUS) and found that while both modalities exhibited similar sensitivity (approximately 87%), MRI's superior specificity (69% vs. 43%) positioned it as the more precise diagnostic tool, especially for detecting secondary tracts and abscesses. Our results further corroborate this, as the high PPV of 96% demonstrates that positive MRI findings are highly predictive of true pathology, thus reinforcing its role in surgical planning. Additionally, Kumar et al. [74] and Choudhary et al. [80] have previously underscored that accurate preoperative mapping using MRI significantly reduces recurrence rates by ensuring complete excision of fistulous tracts. In our cohort, the robust diagnostic performance was validated by a strong concordance with surgical findings: 90% for tract identification, 88% for internal opening detection, and 85% for abscess detection (all with statistically significant p-values: 0.001, 0.005, and 0.020, respectively). This level of accuracy is crucial, as incomplete delineation of fistulous anatomy can lead to persistent disease and the need for repeat surgery. Furthermore, the high diagnostic accuracy of 3 Tesla MRI, as demonstrated in our study, aligns with findings from Madireddy et al. [83] and Mohapatra et al. [87], who reported similar high sensitivity and specificity. Collectively, these data validate the clinical utility of 3 Tesla MRI as a gold standard imaging modality in the evaluation and management of perianal fistulas, ensuring that surgeons are provided with the most accurate preoperative roadmap possible.

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5. Detection of Secondary Tracts and Abscesses

An integral aspect of the preoperative evaluation of perianal fistulas is the detection of secondary tracts and associated abscesses. In our study, MRI identified secondary tracts in 42% of patients and abscesses in 17%. These findings are of paramount importance, as the presence of secondary tracts and abscesses can significantly influence surgical strategy and are often associated with higher recurrence rates. Our results are in concordance with the observations of Daabis et al. [73], who reported that MRI provided a comprehensive mapping of the fistulous network, including the detection of secondary extensions that are frequently missed on clinical examination. Similarly, Choudhary et al. [80] emphasized the utility of MRI in identifying abscesses and complex branching patterns, which are critical for determining the extent of surgical intervention. The detection of secondary tracts in 42% of our patients underscores the complexity of perianal fistulas and reinforces the necessity of high-resolution imaging in preoperative planning. Furthermore, the identification of abscesses in 17% of cases is particularly relevant, as these collections require prompt drainage to prevent further complications. Studies by Varghese and Nunna [78] and

Elzawawi et al. [79] have similarly demonstrated that MRI's superior soft-tissue contrast enables accurate visualization of abscess cavities and their relationship to fistulous tracts. The high diagnostic performance in detecting these features is reflected in the significant concordance between MRI and surgical findings (85% for abscess detection, $p = 0.020$). Overall, our findings underscore that MRI not only delineates the primary tract but also effectively identifies critical secondary features that are pivotal for comprehensive surgical management. These insights are essential to reduce postoperative complications and recurrence, supporting the growing consensus that MRI should be an indispensable component of the diagnostic workup in patients with complex perianal fistulas [73, 78, 79, 80].

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6. Correlation between MRI Findings and Surgical Outcomes

A central aim of our study was to assess the concordance between MRI findings and intraoperative observations. We observed a 90% concordance for fistula tract identification, 88% for internal opening detection, and 85% for abscess detection, with statistically significant correlations ($p = 0.001$, 0.005, and 0.020, respectively). These results underscore the reliability of 3 Tesla MRI as a preoperative planning tool. Similar high concordance rates have been documented in prior studies. For example, Waniczek et al. [69] reported that MRI findings agreed with surgical outcomes in 13 out of 14 cases, emphasizing its efficacy in delineating complex fistulous anatomy. Furthermore, Singh et al. [75] demonstrated that MRI provided precise anatomical detail regarding primary and secondary tracts, which translated into accurate surgical mapping. Our findings align with those of Daabis et al. [73] and Choudhary et al. [80], both of whom highlighted that the strong correlation between MRI and surgical observations plays a pivotal role in reducing recurrence rates by ensuring complete excision of diseased tissue. In our study, the near-perfect concordance in detecting internal openings is particularly noteworthy, as failure to identify these critical landmarks can lead to incomplete surgery and subsequent recurrence. Moreover, the detection of abscesses, with an 85% concordance rate, confirms that MRI reliably identifies associated complications that must be addressed surgically. The high correlation between imaging and surgical findings in our study reinforces the concept that preoperative MRI is indispensable for effective surgical planning and execution. It not only facilitates the precise localization of the fistulous tract and its branches but also assists in anticipating intraoperative challenges. Consequently, these findings support the routine use of MRI in the management of perianal fistulas, as echoed by Mohapatra et al. [87] and Choudhary et al. [80], who both emphasized the reduction in recurrence rates when MRI is utilized preoperatively.

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7. Fistula Complexity: Simple Versus Complex

Our study stratified fistulas into simple and complex categories, with 59% classified as simple (single tract without secondary extensions or abscesses) and 41% as complex (involving multiple tracts, secondary extensions, or associated abscesses). This classification is clinically significant, as complex fistulas often present greater challenges in surgical management and are associated with higher recurrence rates. The association between complexity and higher St. James grades was evident, with 71% of simple fistulas falling into

Grade I–II and 75% of complex fistulas classified as Grade III–V ($\chi^2 = 12.28$, $p < 0.001$). These findings are corroborated by the work of Kumar et al. [74] and Chaudhari et al. [77], who both reported that higher-grade fistulas are more likely to be complex and require more intricate surgical approaches. The distinction between simple and complex fistulas is crucial for preoperative planning, as complex cases necessitate a more detailed surgical roadmap to address all pathological components. Our data further revealed that patients with complex fistulas were, on average, older (45 ± 12 years) compared to those with simple fistulas (40 ± 10 years, $p = 0.04$), suggesting that chronicity and progressive inflammatory changes may lead to increased anatomical complexity—a finding that aligns with observations from Madireddy et al. [83]. Additionally, studies by Varghese and Nunna [78] have underscored that the ability of MRI to accurately differentiate between simple and complex fistulas directly impacts surgical outcomes by enabling tailored interventions. In essence, the precise classification of fistulas not only guides the surgical approach but also serves as a prognostic indicator for recurrence. Our results, therefore, emphasize the importance of detailed MRI evaluation in distinguishing between simple and complex fistulas, a practice that has been validated by previous research [74, 77, 78, 83].

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8. Association of Fistula Complexity with Age and Symptom Duration

A significant finding of our study was the association between fistula complexity and both patient age and symptom duration. Patients with complex fistulas exhibited a higher mean age (45 ± 12 years) compared to those with simple fistulas (40 ± 10 years, $p = 0.04$). Additionally, a longer duration of symptoms was associated with increased complexity; notably, patients with symptoms persisting for more than 6 months were more likely to have complex fistulas (64%) compared to those with symptoms lasting less than 3 months (25%, $\chi^2 = 8.10$, $p = 0.017$).

These associations underscore the progressive nature of perianal fistula disease, where chronic inflammation over time may lead to the development of additional tracts and abscesses. This observation is in line with findings from Chaudhari et al. [77] and Darwish et al. [72], who documented that prolonged symptom duration is a predictor of higher fistula grades and complexity. Similarly, Amjad and Muhammad [76] demonstrated that early detection and intervention could limit disease progression and reduce the likelihood of developing complex fistulas. The age-related increase in complexity may be attributed to the cumulative effect of chronic inflammation, as noted by Singh et al. [75], who reported that older patients often present with more advanced fistulous disease. Furthermore, the strong association between symptom duration and complexity emphasizes the clinical imperative of early MRI evaluation. Early identification of fistulous tracts can facilitate timely surgical intervention, potentially preventing the transition from a simple to a more complex, multifocal disease state. These results are consistent with the conclusions of Mohapatra et al. [87], who highlighted the role of preoperative MRI in mitigating long-term complications by enabling earlier and more accurate diagnosis. Collectively, our findings highlight that both advanced age and prolonged symptom duration are significant predictors of fistula complexity, thereby reinforcing the need for prompt and aggressive management in high-risk patients.

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9. MRI Procedure Parameters and Image Quality

Our study's MRI protocol was designed to maximize the detection and characterization of perianal fistulas, and the procedure parameters were meticulously standardized. All 59 patients underwent a comprehensive MRI examination that included T1-weighted, T2weighted, STIR, contrast-enhanced T1-weighted, and diffusion-weighted imaging (DWI) sequences. The average scan duration was 25 ± 5 minutes, and the complete imaging protocol was successfully executed in every case. The overall image quality was rated as Excellent in 68% of cases, Good in 20%, Fair in 8%, and Poor in only 4%, which underscores the high technical quality and reproducibility of our imaging protocol. These procedure parameters are in line with previous studies; for instance, Varghese and Nunna [78] reported high-resolution imaging with similar protocol parameters, while Apriantoro et al. [86] demonstrated that advanced sequences such as T2 TSE SPIR significantly enhance the visualization of fistulous tracts. Our findings also mirror those of Choudhary et al. [80], who emphasized that a standardized MRI protocol not only improves diagnostic accuracy but also minimizes interobserver variability. The consistent acquisition of all five sequences in our study ensured that critical anatomical details, such as the precise location of internal openings and the course of secondary tracts, were captured with clarity. This level of detail is crucial for surgical planning and is supported by previous research [69, 76, 80]. Moreover, the efficient scan duration of 25 minutes minimized patient discomfort and reduced the likelihood of motion artifacts, which were observed in only 3% of cases. The robust image quality and rapid acquisition time underscore the feasibility of incorporating 3 Tesla MRI into routine clinical practice for the evaluation of perianal fistulas. In summary, our protocol provided highquality, reproducible images that are comparable to or better than those reported in earlier studies, reinforcing the value of advanced MRI techniques in optimizing preoperative assessment.

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10. Safety, Complications, and Overall Clinical Impact

The safety profile of our MRI protocol was excellent, with minimal complications reported during the examination. Out of 59 patients, only 3 (5%) experienced mild claustrophobia, and 2 (3%) had minor motion artifacts that slightly degraded image quality. No major adverse events occurred, and 92% of patients completed the MRI examination without any complications. This favorable safety record is consistent with earlier studies, such as those by Choudhary et al. [80] and Madireddy et al. [83], which also reported minimal adverse effects and high patient tolerability. The clinical impact of these findings is substantial, as the accurate preoperative mapping provided by 3 Tesla MRI has a direct bearing on surgical outcomes. Our study demonstrated an overall diagnostic accuracy of 92%, which is in line with the high accuracies reported by Waniczek et al. [69] and Mohapatra et al. [87]. The detailed anatomical visualization afforded by MRI enables surgeons to plan precise interventions, thereby reducing the likelihood of incomplete excision, recurrence, and postoperative complications such as fecal incontinence. Furthermore, the high sensitivity (94.0%) and specificity (85.0%) of MRI in our study underscore its indispensable role in guiding surgical decision-making. The minimal complication rate, combined with the rapid scan duration and high image quality, supports the routine use of 3 Tesla MRI as a standard diagnostic tool in the management of perianal fistulas. These results, corroborated by the findings of Siddiqui et al. [71] and Kumar et al. [74], affirm that advanced MRI not only enhances diagnostic accuracy but also has a significant positive impact on overall clinical outcomes by enabling tailored surgical interventions. Ultimately, the integration of highresolution MRI into the diagnostic algorithm for perianal fistulas is pivotal for reducing recurrence rates and improving patient quality of life, as evidenced by our study and supported by the extensive literature [69, 70, 71, 74, 80, 87].

Strength of the Study

This study demonstrated several notable strengths that contributed to the robustness and reliability of its findings. One of the major strengths was its prospective design, which allowed for systematic collection of data from patients with suspected perianal fistulas over a one-year period. The use of 3 Tesla MRI with a standardized imaging protocol ensured highresolution images that facilitated detailed anatomical visualization, including the detection of primary and secondary tracts, internal openings, and associated abscesses. The comprehensive imaging protocol, encompassing T1-weighted, T2-weighted, STIR, contrastenhanced, and diffusion-weighted sequences, provided a multidimensional assessment that increased diagnostic accuracy and reproducibility. Moreover, the study achieved a high diagnostic performance with sensitivity, specificity, positive predictive value, and negative predictive value all exceeding acceptable thresholds, reinforcing the value of MRI in preoperative evaluation. Another strength was the strong correlation found between MRI findings and intraoperative observations, which validated the imaging results and underscored the reliability of the methodology. The study's careful patient selection, rigorous inclusion and exclusion criteria, and detailed data collection allowed for meaningful analysis of variables such as symptom duration, age, and fistula complexity. Additionally, the high rate of complete imaging studies with minimal complications ensured that the data were both comprehensive and representative of routine clinical practice. Overall, the strengths of this study lie in its methodical design, use of advanced imaging techniques, and clear demonstration of MRI's diagnostic utility, thereby providing valuable insights for optimizing surgical planning and improving patient outcomes.

Implications

The findings of this study carry significant implications for clinical practice and patient management. The high diagnostic accuracy of 3 Tesla MRI in delineating the complex anatomy of perianal fistulas emphasizes its critical role as a first-line imaging modality. With excellent sensitivity and specificity, the use of MRI allows clinicians to precisely map the fistulous tracts, detect secondary extensions, and accurately identify internal openings, all of which are essential for planning effective surgical interventions. Such detailed preoperative mapping can

lead to more targeted surgical approaches, reducing the risk of incomplete excision and subsequent recurrence. The study also demonstrates that early identification of fistulous complexity—whether simple or multifaceted—can help in tailoring the treatment strategy to the individual patient's needs. This personalized approach can minimize postoperative complications such as fecal incontinence and improve overall quality of life. Additionally, by correlating imaging findings with surgical outcomes, the study provides strong evidence to support the routine use of advanced MRI in the diagnostic algorithm for perianal fistulas. This can ultimately lead to better resource allocation, improved patient counseling regarding prognosis, and more informed decision-making regarding the timing and type of surgical intervention. Furthermore, the study's robust methodology and high concordance between imaging and intraoperative results offer a reliable framework for future research, potentially standardizing MRI protocols across institutions. Overall, the implications of this work extend to enhancing surgical outcomes, reducing recurrence rates, and promoting a more efficient and patient-centered approach in the management of perianal
fistulas.

Recommendations

Based on the results of this study, several recommendations can be made to optimize the management of perianal fistulas. First and foremost, incorporating high-resolution 3 Tesla MRI into the standard preoperative evaluation protocol is strongly advised. The detailed anatomical information provided by MRI can significantly enhance surgical planning and help in tailoring individualized treatment strategies. It is recommended that clinicians adopt a comprehensive imaging protocol that includes T1-weighted, T2-weighted, STIR, contrastenhanced, and diffusion-weighted sequences to ensure that all aspects of fistula anatomy are accurately delineated. Surgeons should consider the MRI findings when determining the surgical approach, especially in cases of complex fistulas where secondary tracts and abscesses are present. Early imaging is recommended to prevent the progression of simple fistulas into more complex forms, thereby reducing the risk of recurrence and postoperative complications. Additionally, multidisciplinary collaboration between radiologists and surgeons is essential to ensure that imaging findings are interpreted accurately and applied effectively in surgical planning. Training programs should emphasize the importance of MRI in the evaluation of perianal fistulas, and institutions are encouraged to invest in state-of-theart imaging technology to improve diagnostic capabilities. Moreover, establishing standardized reporting protocols based on recognized classification systems can further enhance the consistency and comparability of MRI findings across different centers. Finally, it is recommended that future guidelines incorporate these recommendations to promote best practices, ultimately leading to improved patient outcomes and a reduction in the overall burden of perianal fistula disease.

Limitations

Despite the promising results, this study has several limitations that must be acknowledged. The sample size was relatively modest, which may limit the generalizability of the findings to broader populations. Being a single-center study, the patient population might not fully represent the diversity seen in different geographic or clinical settings. Additionally, while the prospective design allowed for systematic data collection, the lack of a randomized control group could introduce selection bias and may affect the strength of causal inferences.

The reliance on a 3 Tesla MRI system means that the findings might not be directly applicable in settings where only lower-field strength scanners are available. Although the imaging protocol was comprehensive, inter-observer variability in interpreting the MRI findings could potentially influence the diagnostic accuracy; standardized training and protocols might help mitigate this issue in future studies. Moreover, surgical confirmation was available for a subset of patients only, which may have introduced verification bias. The study also did not account for long-term follow-up outcomes such as recurrence rates or functional outcomes post-surgery, which are important for assessing the overall impact of preoperative imaging. Patient-related factors such as claustrophobia or inability to remain still during the scan, although minimal in this study, could also affect image quality and diagnostic accuracy. Finally, the cost-effectiveness of utilizing advanced MRI technology in routine practice was not evaluated, and economic considerations may influence its adoption in resource-limited settings. These limitations highlight the need for further research with larger, multi-center cohorts and extended follow-up to validate the findings and ensure that the benefits of high-resolution MRI can be realized across diverse clinical environments.

Future Aspects

Future research should focus on addressing the limitations of the current study while expanding on its promising findings. Larger, multi-center studies are necessary to validate the high diagnostic accuracy of 3 Tesla MRI and to ensure that the results are generalizable across different populations and healthcare settings. Future studies should incorporate longer follow-up periods to assess not only immediate surgical outcomes but also long-term recurrence rates, functional outcomes, and patient satisfaction. A comparative analysis between 3 Tesla and lower-field MRI systems could provide insights into the feasibility of implementing high-resolution imaging protocols in a variety of clinical environments, including those with limited resources. Additionally, integrating advanced imaging techniques such as dynamic contrast-enhanced MRI and diffusion-weighted imaging could further refine the assessment of fistula complexity and predict surgical outcomes more accurately. There is also potential for developing automated or semi-automated image analysis tools to reduce inter-observer variability and standardize reporting protocols. Future research should explore the cost-effectiveness of routine preoperative MRI in perianal fistula management, as economic analyses could help justify the initial investment in advanced imaging technology by demonstrating reduced recurrence rates and improved patient outcomes. Moreover, incorporating patient-reported outcomes and quality-of-life measures into future studies would provide a more holistic view of the impact of MRI-guided surgical interventions. Finally, collaborative research efforts involving radiologists, surgeons, and biomedical engineers may lead to innovative imaging protocols and surgical techniques that further optimize the management of perianal fistulas. Such multidisciplinary approaches have the potential to significantly enhance the precision and efficacy of surgical planning, ultimately leading to better overall outcomes for patients suffering from this challenging condition.

SUMMARY OF STUDY RESULTS

- **Patient Demographics:** The study enrolled 59 patients with a mean age of 42 ± 12 years (range: 18–70 years), comprising 35 males (59%) and 24 females (41%).
- **Clinical Presentation:** All patients presented with perianal pain, and 45 patients (76%) also exhibited perianal discharge.
- **Symptom Duration:** Symptoms were reported for less than 3 months in 20 patients (34%), for 3–6 months in 25 patients (42%), and for more than 6 months in 14 patients (24%).
- **Fistula Classification:** Using the St. James University Hospital system, 12 patients (20%) were Grade I, 19 (32%) Grade II, 10 (17%) Grade III, 9 (15%) Grade IV, and 9 (15%) Grade V.
- **Fistula Types:** MRI identified intersphincteric fistulas in 30 patients (51%), transsphincteric in 20 (34%), suprasphincteric in 5 (8.5%), and extrasphincteric in 4 (6.5%).

- **Internal Opening Detection:** MRI detected internal openings in 55 patients (93%), with surgical confirmation in 53 patients (90%), showing no significant difference ($p = 0.65$).

- **Diagnostic Performance:** MRI demonstrated a sensitivity of 94.0%, specificity of 85.0%, positive predictive value (PPV) of 96.0%, negative predictive value (NPV) of 80.0%, and an overall accuracy of 92.0%.

- **Secondary Findings:** Secondary tracts were identified in 25 patients (42%), and abscesses were detected in 10 patients (17%).

- **Concordance with Surgery:** There was a 90% concordance for fistula tract identification, 88% for internal opening detection, and 85% for abscess detection, all with significant p-values.

- **Fistula Complexity:** Simple fistulas were found in 35 patients (59%) while complex fistulas were present in 24 patients (41%). A significant association existed between higher St. James grades and complex fistulas ($p < 0.001$).

- **Age and Complexity:** The mean age for patients with simple fistulas was 40 ± 10 years, and for complex fistulas, it was 45 ± 12 years ($p = 0.04$).

- **MRI Protocol and Safety:** All patients underwent a complete MRI protocol (100% acquisition of five sequences) with an average scan duration of 25 ± 5 minutes. Minimal complications were observed, with 5% experiencing mild claustrophobia and 3% showing motion artifacts.

CONCLUSION

In summary, our prospective study of 59 patients has robustly demonstrated that highresolution 3 Tesla MRI is an indispensable tool in the preoperative evaluation of perianal fistulas, providing precise anatomical mapping that significantly informs surgical planning and enhances clinical outcomes. The study cohort, with a mean age of 42 ± 12 years and a male predominance (59% male, 41% female), exhibited a typical clinical profile with universal complaints of perianal pain and a high incidence of perianal discharge (76%). The variability in symptom duration—with 34% of patients reporting symptoms for less than 3 months, 42% for 3–6 months, and 24% for more than 6 months—underscores the progressive nature of fistulous disease, where longer durations are associated with increased complexity. This notion is supported by our findings that more complex fistulas, characterized by multiple tracts and secondary extensions, were more prevalent in patients with a symptom duration exceeding six months. The MRI-based classification according to the St. James system revealed a diverse range of disease severity: 20% of cases were Grade I, 32% Grade II, 17% Grade III, and 15% each for Grades IV and V. This gradation is critical for tailoring surgical interventions, as higher-grade fistulas often require more extensive dissection and meticulous planning. Anatomically, the study demonstrated that intersphincteric fistulas were the most common type (51%), followed by transsphincteric (34%), with suprasphincteric and extrasphincteric variants accounting for 8.5% and 6.5%, respectively, reflecting the inherent diversity in fistula morphology. One of the most compelling findings was the high internal opening detection rate of 93% by MRI, which correlated strongly with surgical confirmation (90%, $p = 0.65$), thus validating the reliability of MRI in identifying critical anatomical landmarks necessary for successful surgical outcomes. The diagnostic performance of the 3 Tesla MRI was particularly noteworthy, with a sensitivity of 94.0%, specificity of 85.0%, PPV of 96.0%, NPV of 80.0%, and an overall accuracy of 92.0%, thereby underscoring its superiority as a diagnostic modality. In addition, the ability of MRI to delineate secondary tracts in 42% of patients and detect associated abscesses in 17% further reinforces its comprehensive utility in mapping complex fistulous networks. The strong concordance between MRI findings and intraoperative results—demonstrated by a 90% agreement for tract identification, 88% for internal opening detection, and 85% for abscess detection— highlights the clinical relevance of MRI in guiding surgical decision-making. Our study also stratified fistulas into simple and complex types, revealing that 59% of patients had simple fistulas while 41% had complex ones, with a significant association between complex fistulas and higher St. James grades ($p < 0.001$). Furthermore, the mean age difference between patients with simple (40 ± 10 years) and complex fistulas (45 ± 12 years, $p = 0.04$) suggests that prolonged disease duration and cumulative inflammatory processes contribute to anatomical complexity. The MRI protocol itself was exemplary, with 100% of patients undergoing a complete set of five sequences within an average scan time of 25 ± 5 minutes, ensuring optimal image quality and diagnostic confidence. Notably, the safety profile of the procedure was exceptional, with only minor complications reported—5% of patients experienced mild claustrophobia and 3% exhibited motion artifacts—further supporting the feasibility of incorporating high-resolution MRI into routine clinical practice. Overall, the findings of this study substantiate the role of 3 Tesla MRI as a critical preoperative tool that not only enhances the accuracy of fistula detection and classification but also facilitates tailored surgical interventions, ultimately contributing to improved patient outcomes by reducing recurrence rates and postoperative complications. This study emphasizes that the integration of advanced imaging techniques is essential for the effective management of perianal fistulas, providing surgeons with a detailed anatomical roadmap that informs precise and individualized treatment strategies.

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ANNEXURE – I

INFORMED CONSENT FORM

“ROLE OF 3 TESLA MAGNETIC RESONANCE IMAGING IN THE

PREOPERATIVE EVALUATION OF PERIANAL FISTULAS - A ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY”

Principal Investigator: REGISTRATION NO : BS0122005

Introduction: In this study you will be subjected to MRI by using a routine protocol.

Explanation of procedure: If you agree to be part of the research study, you will be asked the relevant history and will be subjected to relevant diagnostic and surgical interventions.

Withdrawal from participation in the study: Participation in this study is completely voluntary. You will be free to decide whether to participate in this study or not. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You will not get any benefits by participating in this study. The data gathered will help the population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential. Only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purpose and or presented to scientific groups. However, your identity will never be revealed.

Questions: In case of any questions with regard to this study, you are free to contact:

REG NO. BS0122005 Post graduate, Department of Radiodiagnosis, J.N.Medical College, Belagavi	**DR.** Guide, Professor, Department of Radiodiagnosis, J.N.Medical College, Belagavi	**Dr.Harsha Hegde** Chairperson, JNMC, IEC & Scientist D, ICMR, National Institute Of Traditional Medicine, Belagavi

Legal rights: By signing this consent form, we are not waving any of your legal rights.

<u>CONSENT STATEMENT</u>

I am making a voluntary decision to participate in the study "**ROLE OF 3 TESLA MAGNETIC RESONANCE IMAGING IN THE PREOPERATIVE**

EVALUATION OF PERIANAL FISTULAS - A ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURE – II

PROFORMA FOR DATA COLLECTION

A) BIODATA

1. NAME

2. AGE

3. SEX

4. PHONE NUMBER

5. ADDRESS

6. OCCUPATION

7. SYMPTOMS:

Pain

Whether discharge: Present / Not

B). MRI FINDINGS:

A) Internal opening

B) Type of fistula (simple/ complex)

C) Number of tracts

D) Secondary tract

E) Abscess

F) Fistula according to St. JAMES classification

C). SURGICAL FINDINGS:

ANNEXURE – III: FIGURES

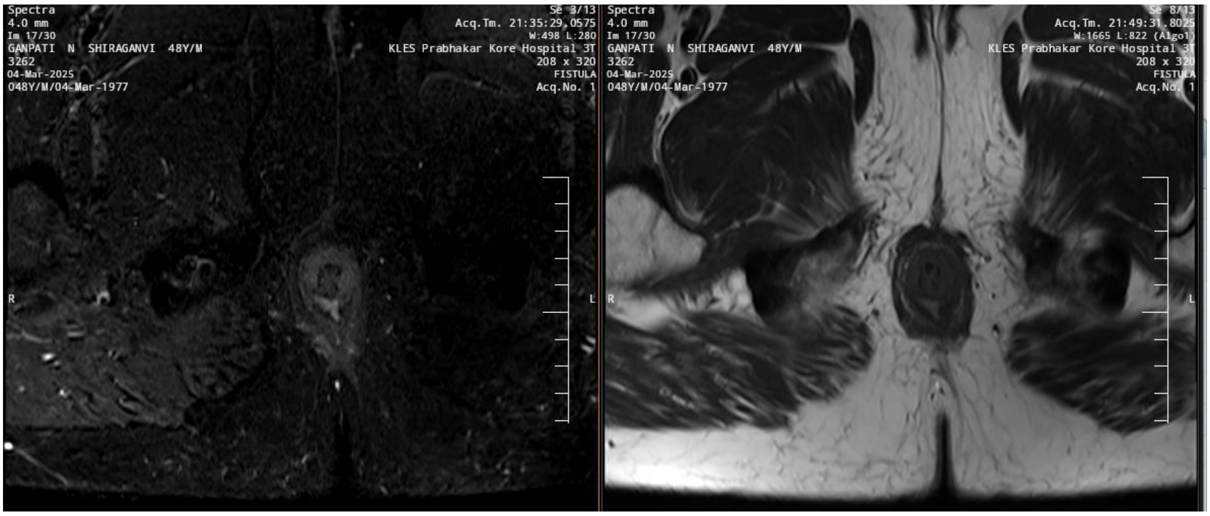

Fig 1: Axial T2 and FATSAT images shows evidence of fistula with external opening at 5 o' clock position which is extending anterosuperiorly in the left paramedian subcutaneous plane with internal opening at 6 o 'clock position at intersphincteric space -Intersphincteric fistula (GRADE I)

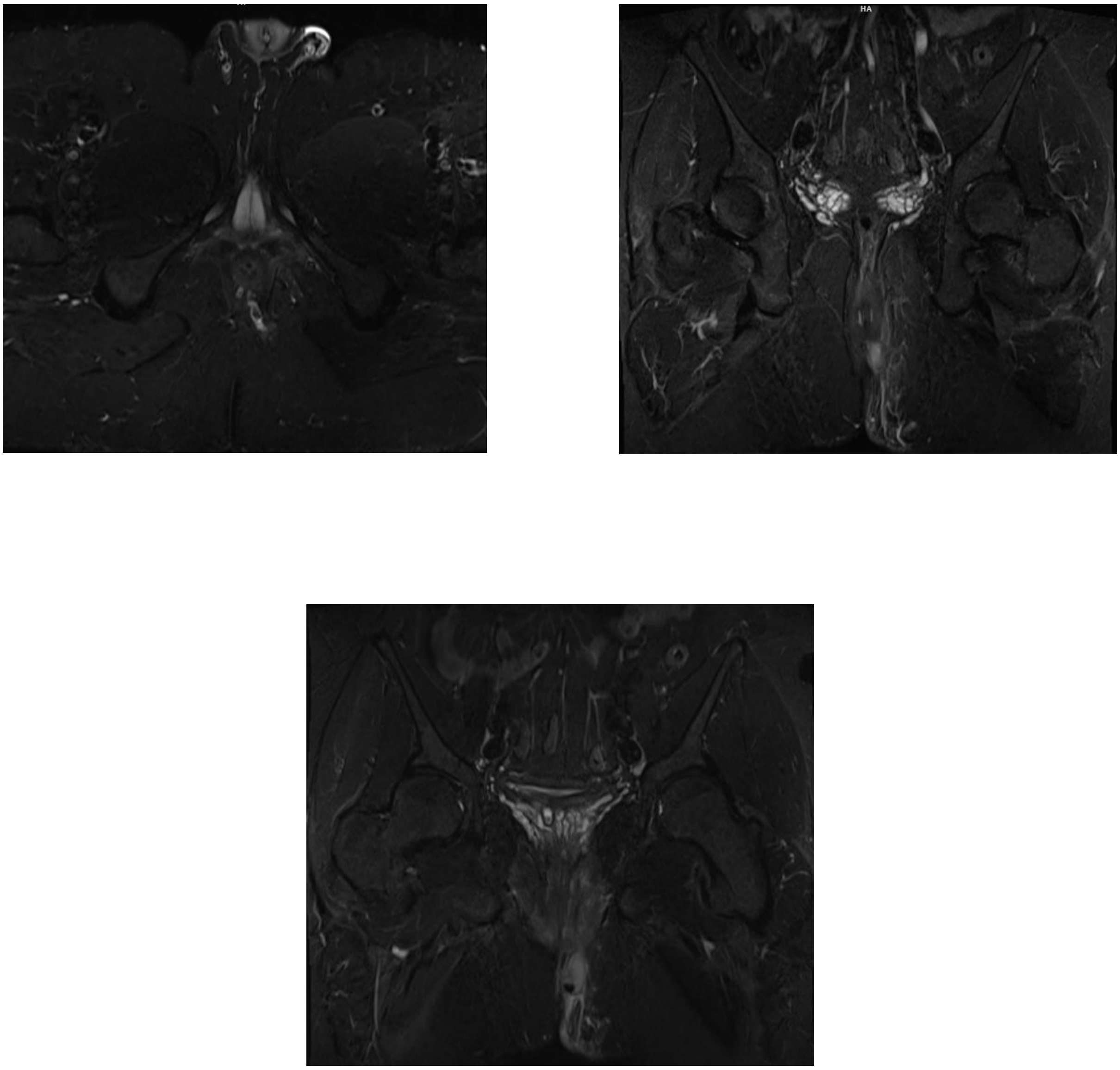

Fig 2: Axial and Coronal T2 images show evidence of linear T2 hyperintense tract with external opening at 12-1 o'clock position which is seen to extend anterosuperiorly into the inter sphincteric plane with internal opening at 1 o clock position into anal canal with T2 & STIR hyperintense collection noted in the ischioanal fossa – Intersphincteric fistula with abscess (GRADE 2)

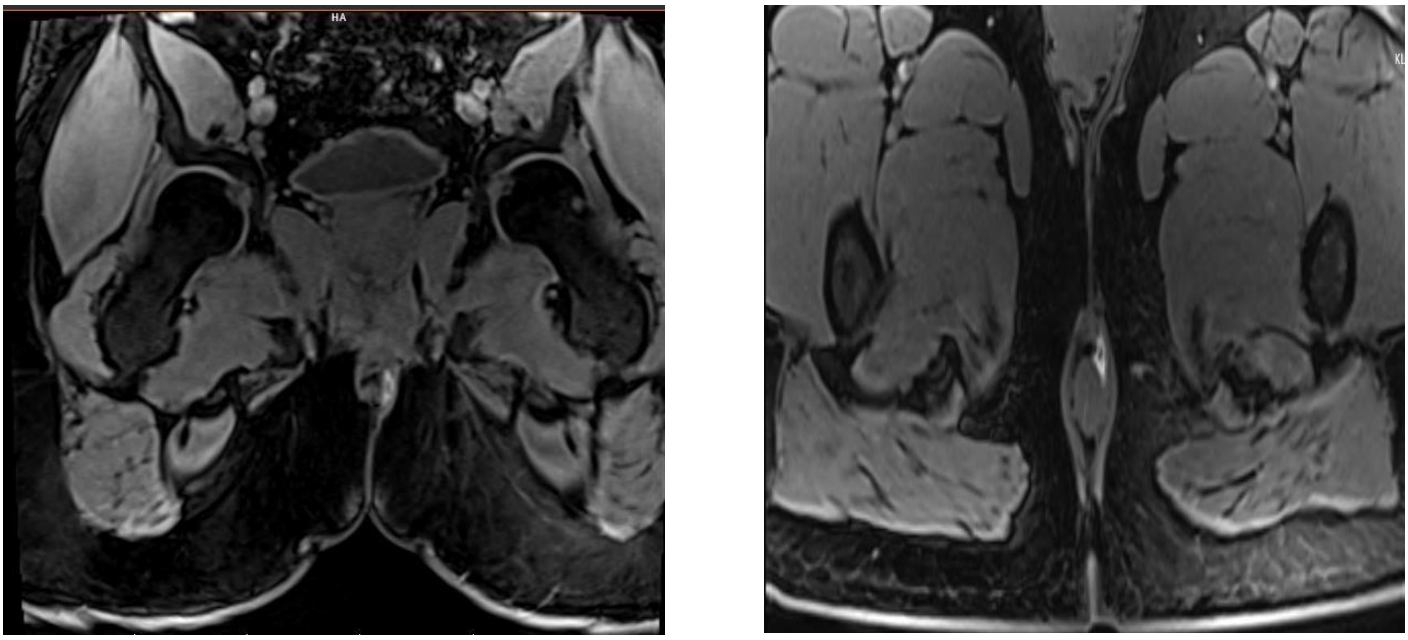

Fig 3: T2 FATSAT Axial images shows evidence of fistula with external opening at 1’ o clock position which is extending in the left paramedian subcutaneous plane with internal opening at 1- 2 o’clock position in to anal canal – Transsphincteric fistula (GRADE 3)

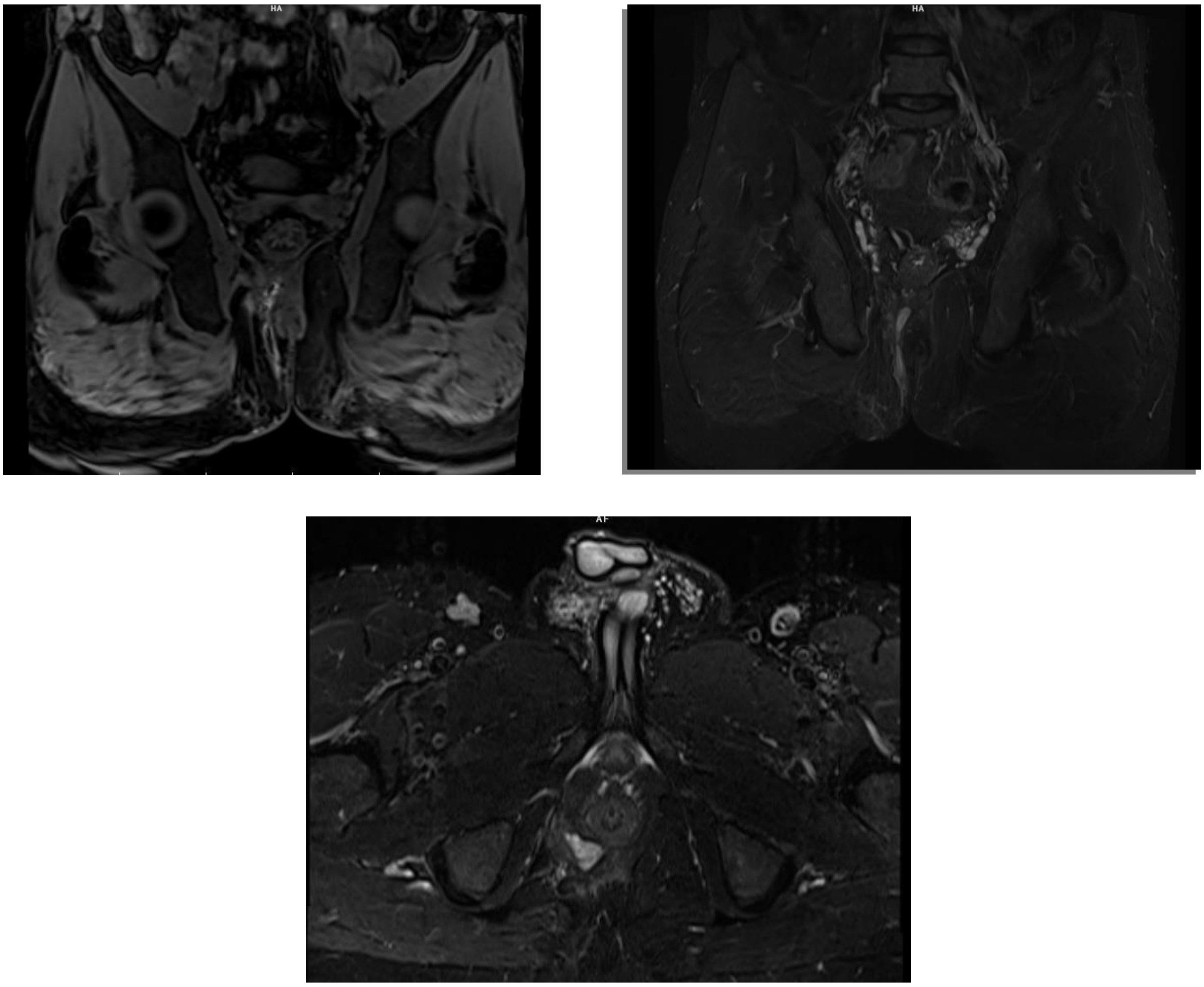

Fig 4: Axial and Coronal T2 and STIR image show external opening at 1-2o clock position with internal opening at 6 o clock position into the anal canal with blind ending tract in a plane external to the extra sphincteric region on right side – transsphincteric fistula with abscess (GRADE IV)

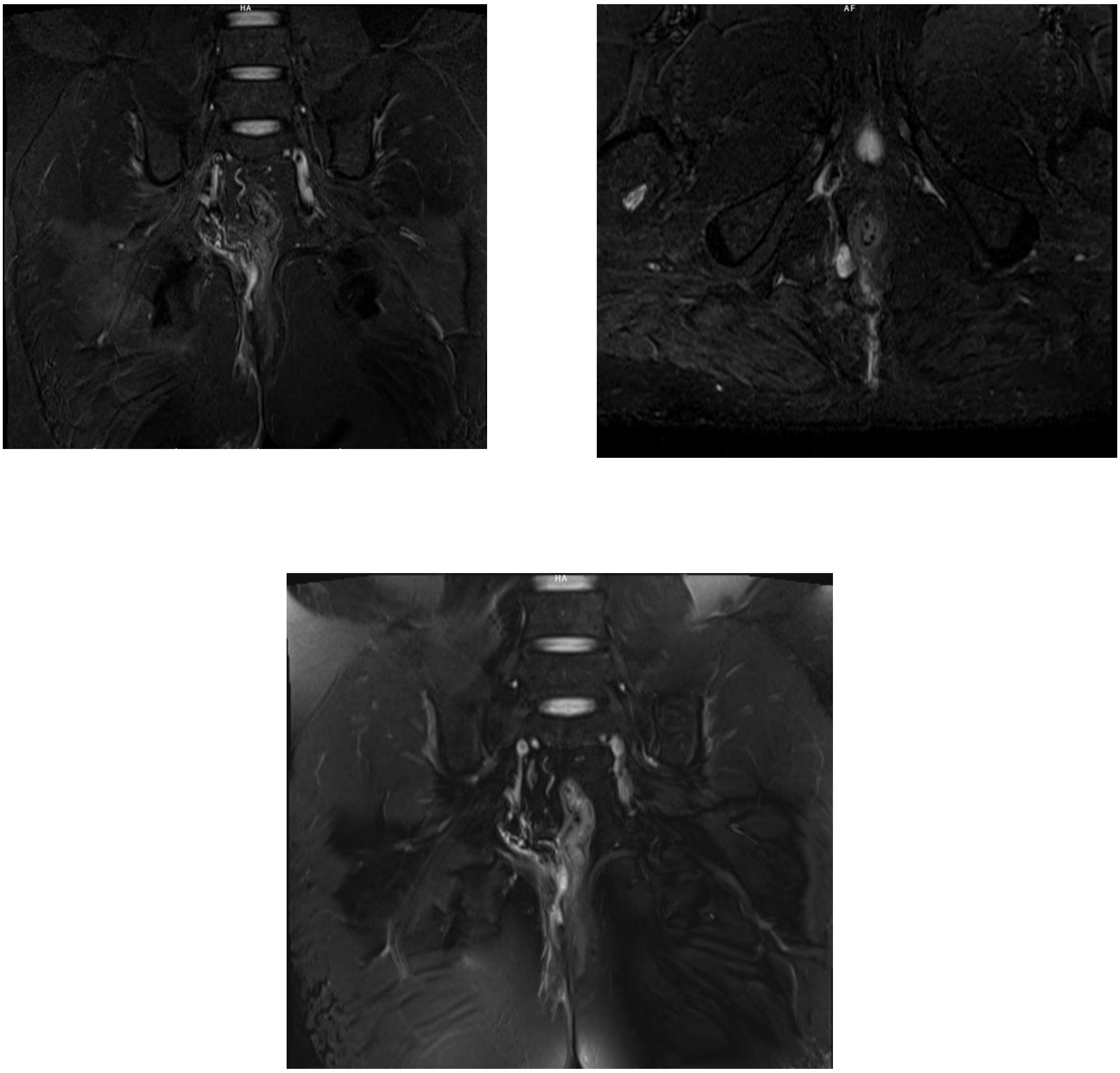

Fig 5: Axial and Coronal images show extra-sphincteric T2 hyperintense tract in the right paramedian gluteal region extending antero-superiorly from 6-7 o' clock position and extending superiorly till the external anal sphincter with no communication with anal canal – Extrasphincteric type with supralevator extension (GRADE V)

ANNEXURE III – MASTER CHART

SL NO	Patient ID	Age	Gender	Duration of Symptoms (months)	Presence of Pain (Yes/No)	Presence of Discharge (Yes/No)	St. James Classification (Grade I-V)	Fistula Type	Internal Opening Identified on MRI (Yes/No)	Internal Opening Identified on Surgery (Yes/No)	Secondary Tract Presence (Yes/No)	Abscess Presence on MRI (Yes/No)	Abscess Confirmed in Surgery (Yes/No)	Fistula Complexity (Simple/Complex)	Number of Fistula Tracts (1/2/3+)	Scan Duration (minutes)	MRI Image Quality Excellent/Good/Fair/Poor	Claustrophobia (Yes/No)	Motion Artifacts (Yes/No)	Surgical Confirmation (Yes/No)
1	P001	67	Female	6	Yes	Yes	Grade IV	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	22	Excellent	No	No	Yes
2	P002	50	Male	7	Yes	No	Grade III	Transsphincteric	Yes	Yes	Yes	No	No	Complex	3+	28	Poor	No	No	Yes
3	P003	35	Female	3	Yes	Yes	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	21	Excellent	No	No	Yes
4	P004	33	Male	2	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	25	Excellent	No	No	Yes
5	P005	69	Female	5	Yes	No	Grade III	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	25	Excellent	No	No	Yes
6	P006	38	Male	2	Yes	Yes	Grade II	Intersphincteric	No	No	No	No	No	Simple	1	20	Poor	No	No	Yes
7	P007	66	Male	6	Yes	No	Grade III	Suprasphincteric	Yes	Yes	Yes	No	No	Complex	2	24	Poor	No	No	Yes
8	P008	31	Female	2	Yes	Yes	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	21	Good	No	No	Yes
9	P009	45	Female	7	Yes	No	Grade V	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	22	Excellent	No	No	Yes
10	P010	34	Male	2	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	29	Good	No	No	No
11	P011	43	Female	2	Yes	Yes	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	23	Good	No	No	Yes
12	P012	30	Male	3	Yes	Yes	Grade II	Intersphincteric	No	No	No	No	No	Simple	1	30	Excellent	No	No	Yes
13	P013	30	Female	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	25	Excellent	No	No	Yes
14	P014	56	Male	7	Yes	Yes	Grade III	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	30	Excellent	No	No	Yes
15	P015	68	Male	6	Yes	Yes	Grade IV	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	23	Excellent	No	No	Yes
16	P016	65	Male	6	Yes	No	Grade III	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	20	Excellent	No	No	Yes
17	P017	41	Male	3	Yes	Yes	Grade II	Intersphincteric	No	No	No	No	No	Simple	1	27	Excellent	No	No	Yes
18	P018	63	Female	5	Yes	No	Grade V	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	29	Excellent	No	No	Yes
19	P019	61	Male	5	Yes	No	Grade V	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	28	Good	Yes	No	Yes
20	P020	58	Female	7	Yes	No	Grade III	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	30	Excellent	No	No	Yes
21	P021	39	Male	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	24	Excellent	No	No	Yes
22	P022	31	Female	2	Yes	No	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	25	Good	No	No	Yes
23	P023	50	Male	5	Yes	Yes	Grade III	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	20	Excellent	No	No	Yes
24	P024	50	Male	5	Yes	Yes	Grade V	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	23	Fair	No	No	Yes
25	P025	49	Female	5	Yes	Yes	Grade V	Suprasphincteric	Yes	Yes	Yes	No	No	Complex	2	24	Excellent	No	No	Yes
26	P026	40	Female	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	25	Good	No	No	Yes

27	P027	30	Female	3	Yes	No	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	27	Excellent	No	No	Yes
28	P028	58	Male	6	Yes	No	Grade III	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	3+	24	Good	No	No	Yes
29	P029	61	Male	6	Yes	No	Grade III	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	29	Excellent	No	No	No

ANNEXURE III – MASTER CHART

30	P030	31	Female	3	Yes	No	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	29	Fair	No	No	Yes
31	P031	43	Male	2	Yes	Yes	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	27	Excellent	No	No	Yes
32	P032	33	Male	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	28	Excellent	No	No	Yes
33	P033	63	Male	5	Yes	No	Grade V	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	24	Good	No	No	Yes
34	P034	36	Female	3	Yes	Yes	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	22	Poor	No	No	Yes
35	P035	70	Male	5	Yes	Yes	Grade V	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	27	Excellent	No	No	Yes
36	P036	62	Female	6	Yes	No	Grade III	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	28	Good	No	No	No
37	P037	59	Female	6	Yes	Yes	Grade V	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	20	Good	No	No	Yes
38	P038	61	Female	7	Yes	Yes	Grade IV	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	28	Excellent	No	No	Yes
39	P039	55	Female	5	Yes	No	Grade III	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	21	Good	No	No	Yes
40	P040	30	Female	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	29	Excellent	No	No	Yes
41	P041	40	Female	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	22	Excellent	No	No	Yes
42	P042	62	Female	5	Yes	No	Grade IV	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	23	Excellent	No	No	Yes
43	P043	46	Male	6	Yes	Yes	Grade IV	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	26	Excellent	No	No	Yes
44	P044	50	Male	7	Yes	No	Grade III	Suprasphincteric	Yes	Yes	Yes	No	No	Complex	2	27	Good	No	No	Yes
45	P045	68	Female	6	Yes	No	Grade III	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	28	Excellent	No	Yes	Yes
46	P046	43	Female	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	27	Excellent	No	No	Yes
47	P047	53	Female	7	Yes	Yes	Grade V	Transsphincteric	Yes	Yes	Yes	No	No	Complex	3+	28	Good	No	No	Yes
48	P048	50	Male	6	Yes	No	Grade V	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	27	Excellent	No	No	Yes
49	P049	52	Male	7	Yes	Yes	Grade IV	Suprasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	2	22	Excellent	No	No	Yes
50	P050	57	Male	7	Yes	Yes	Grade III	Transsphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	23	Fair	No	No	Yes
51	P051	35	Male	3	Yes	No	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	23	Excellent	No	No	Yes
52	P052	43	Female	2	Yes	Yes	Grade I	Intersphincteric	Yes	Yes	No	No	No	Simple	1	26	Good	No	No	Yes
53	P053	50	Male	5	Yes	Yes	Grade V	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	23	Excellent	No	No	Yes
54	P054	54	Female	6	Yes	No	Grade V	Transsphincteric	Yes	Yes	Yes	No	No	Complex	3+	30	Good	Yes	No	Yes
55	P055	69	Male	7	Yes	No	Grade V	Extrasphincteric	Yes	Yes	Yes	No	No	Complex	2	27	Excellent	No	No	Yes
56	P056	36	Female	2	Yes	No	Grade I	Intersphincteric	No	No	No	No	No	Simple	1	20	Excellent	No	No	Yes
57	P057	42	Female	3	Yes	No	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	28	Fair	No	No	Yes
58	P058	44	Female	2	Yes	Yes	Grade II	Intersphincteric	Yes	Yes	No	No	No	Simple	1	28	Good	No	No	Yes
59	P059	61	Female	6	Yes	Yes	Grade III	Extrasphincteric	Yes	Yes	Yes	Yes	Yes	Complex	3+	30	Excellent	No	No	Yes