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Diagnostic Utility of MRI in the Evaluation and Surgical Management of Primary Anorectal Fistulas: A Prospective Observational Study

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Abstract

Background: Accurate diagnosis and classification of primary anorectal fistulas are essential for successful surgical treatment. Magnetic Resonance Imaging (MRI) is increasingly used as a preoperative tool to assess fistulous tracts, internal openings, and associated complications.

Objective: To evaluate the effectiveness of MRI in diagnosing, grading, and assessing primary anorectal fistulas and to correlate MRI findings with intraoperative surgical outcomes.

Methods: This prospective observational study was conducted at RKDF Medical College Hospital, Bhopal, over 18 months. A total of 125 patients with primary anorectal fistulas underwent MRI as part of preoperative evaluation. MRI findings were compared with intraoperative observations to assess accuracy. Fistulas were classified using Park's, St. James University Hospital, and SPTF classifications. Statistical analyses were performed using Stata 17.0.

Results: MRI influenced surgical planning in 28% of cases. A strong correlation was found between MRI and intraoperative findings for abscesses ($p < 0.0001$), number of external openings ($p < 0.0001$), horseshoe tracts ($p < 0.0001$), and sphincter damage ($p < 0.0001$). MRI showed high diagnostic accuracy in identifying complex fistula anatomy, aiding in better surgical outcomes.

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Conclusion: MRI is a valuable tool in the preoperative assessment of primary anorectal fistulas. It significantly enhances surgical planning, especially in complex cases, by accurately identifying tracts, openings, abscesses, and sphincter involvement.

Keywords

Anorectal fistula, MRI, fistulous tract, sphincter damage, abscess, surgical outcomes, preoperative imaging, fistula classification.

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Introduction

Anorectal fistulas can be classified based on the anatomical course of the fistulous tract in relation to the anal sphincters. Understanding these classifications is essential for determining the appropriate treatment plan and predicting surgical outcomes. The most commonly used classification system categorizes anorectal fistulas into four main types: inter-sphincteric, trans-sphincteric, extra-sphincteric, and supra-sphincteric[1].

The accurate assessment of anorectal fistulas is crucial for successful surgical management. Various imaging modalities are used in clinical practice to identify the anatomy of fistulas, detect associated abscesses, and evaluate the relationship between the fistula and surrounding structures, especially the sphincter complex[1]. Traditional imaging techniques include contrast fistulography, computed tomography (CT), and ultrasound. Each modality has its advantages and limitations, influencing their role in the preoperative evaluation of anorectal fistulas[2].

Despite the growing recognition of MRI as the imaging modality of choice for anorectal fistulas, gaps remain in the literature regarding its comprehensive role in improving surgical outcomes[3]. Although several studies have demonstrated the diagnostic accuracy of MRI in identifying fistulous tracts and complications, there is a need for further exploration of MRI's impact on the correlation between preoperative imaging and long-term surgical success. Existing literature often lacks detailed analysis of how different MRI sequences contribute to surgical decision-making, particularly in complex or recurrent cases[4]. Furthermore, the variations in MRI findings and their translation into surgical strategies are not consistently addressed, leaving a gap in understanding the full potential of MRI in optimizing treatment outcomes.

This study aims to fill these gaps by systematically evaluating the effectiveness of MRI in diagnosing, grading, and assessing primary anorectal fistulas, and correlating these findings with surgical outcomes. By focusing on the precision of MRI in identifying internal openings, secondary tracts, and abscesses, this study will provide evidence for the practical benefits of MRI in improving the surgical management of anorectal fistulas. Ultimately, the study will contribute to refining surgical techniques and enhancing patient care, reinforcing MRI as an indispensable tool in anorectal fistula treatment.

AIM:

To evaluate the effectiveness of Magnetic Resonance Imaging (MRI) in the preoperative diagnosis, grading, and assessment of primary anorectal fistulas, and to determine its impact on surgical outcomes by correlating MRI findings with intraoperative results.

Material and Methods

- **Study Design:** This was a single centre, hospital-based prospective observational study.
- **Study Settings:** The study was conducted in the Department of Radiodiagnosis at RKDF Medical College Hospital and Research Centre, Bhopal, in collaboration with the Department of General Surgery.
- **Ethical Clearance:** Ethical clearance for the study was granted after the thorough scrutiny of the study protocol, data collection forms, and informed consent documents by the Institutional Ethics Committee.
- **Study Duration**: The total duration of the present study was 18 months: from **APRIL 2023 TO 30thSEPTEMBER 2024.**

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- **Primary Outcome:** The primary outcome was the accuracy of MRI in identifying fistulous tracts, internal openings, and associated complications (abscesses, secondary tracts). This was measured by comparing MRI findings with intraoperative observations.
- **Definition of the Exposure:** The exposure in this study involved the use of Magnetic Resonance Imaging (MRI) to evaluate and diagnose anorectal fistulas preoperatively. MRI findings were correlated with intraoperative surgical findings to assess the effectiveness of MRI in guiding surgical management.
- **Study Participants:** The participants for the present study were patients diagnosed with primary anorectal fistulas and underwent MRI as a part of preoperative evaluation. Eligible participants included individuals who were referred for MRI evaluation as part of the preoperative planning for their surgical management of fistulas.
- **Inclusion Criteria:**
  i. Patients of both sexes and all age groups presenting with primary anorectal fistulas.
  ii. Patients willing to provide written informed consent.
- **Exclusion Criteria:**
  i. Patients with primary rectal and pelvic diseases like Crohn's disease, diverticular disease, or carcinoma.
  ii. Patients with previous fistula surgery that could affect MRI interpretation.
  iii. Patients with contraindications for MRI, such as those with implanted pacemakers or metallic devices.
- **Sample Size:** The sample size was calculated using the formula for determining proportions based on the prevalence of primary anorectal fistulas:
  - ✓ P: (prevalence of anorectal fistulas) was 0.086,
  - ✓ Q: was (1 - p),

- ✓ D: (allowable error) was 0.05.

Using the formula prescribed for estimating the prevalence, the sample size was calculated **as 125 participants.**

- ❖ **Sampling Methodology:** Participants were recruited using non-probability convenience sampling.
- ❖ **Obtaining Informed Consent:** Written informed consent was obtained from each participant by the Principal Investigator (PI) using a bilingual consent form, available in both Hindi and English. The participants were given a detailed explanation of the study's purpose, procedures, potential risks, and benefits. They were also assured of the confidentiality of their personal information and their right to withdraw from the study at any time without any consequences to their treatment. After confirming their understanding, the participants signed the consent form before proceeding with the study procedures.
- ❖ **Data Sources:** The data for this study was collected from multiple sources:
  a. Dependent Variables: Data related to surgical outcomes, such as the identification of fistulous tracts, internal openings, and postoperative complications, were recorded from patient surgery records.
  b. Independent Variables: Data related to MRI findings, including the type of fistula, grading, and associated complications, were obtained from MRI reports.
  c. Confounding Variables: Data such as the participant's age, comorbidities, and history of previous surgeries were collected through patient interviews and medical records.
- ❖ **Data Collection Procedure:**

1. *Initial Data Collection*: After consent, demographic data such as age, sex, and medical history (including comorbidities like Crohn's disease or diabetes, prior surgeries, and other relevant factors) were collected through patient interviews and from hospital records. This initial information was recorded in the paper-based data collection forms specifically designed for the study.
2. *MRI Scanning:* Each participant underwent an MRI scan using a 1.5-Tesla MRI system. To obtain comprehensive imaging of the anorectal region, a range of MRI sequences were applied:
    a. Oblique Axial and Coronal T1-Weighted Fast Spin Echo (T1W FSE): Used to capture the anatomical structure, particularly for identifying the primary fistulous tract and its relation to the surrounding soft tissue.
    b. T2-Weighted Fast Spin Echo (T2W FSE): These sequences were crucial for visualizing the high-intensity signal of fluid within the fistulous tract, helping to distinguish active infection from surrounding tissues.
    c. Fat-Suppressed Oblique Axial and Coronal T1 and T2-Weighted FSE: The fat-suppressed sequences enhanced the contrast by suppressing the signal from surrounding adipose tissue, providing a clearer view of the fistula and any associated extensions.
    d. Contrast-Enhanced Oblique Axial, Coronal, and Sagittal Fat-Saturated T1-Weighted FSE (FAT SAT T1W FSE): Gadolinium-enhanced imaging was used to visualize active inflammation, abscesses, and subtle tracts, especially in complex or recurrent fistulas. This enabled more precise delineation of secondary tracts and extensions.
    e. Where indicated by the consultant or study guide, participants received a gadolinium-based contrast agent (DTPA) at a dose of 0.1 mmol/kg to enhance

visualization of active regions within the fistula. The contrast was administered intravenously at a rate of 1 ml per second to achieve optimal enhancement of the fistulous tract and any associated abscesses or inflammatory components.

3. Assessment of MRI Findings: Following the imaging, the MRI scans were systematically analyzed to assess three primary aspects:

   a. Type of Fistula: Classified based on the anatomical pathway relative to the sphincter complex, with differentiation into inter-sphincteric, trans-sphincteric, extra-sphincteric, and supra-sphincteric types.

   b. Position of Internal Opening: The internal opening's precise location was identified, as this greatly influences surgical planning.

   c. Grading of Fistula: Fistulas were graded according to the St. James University Hospital Classification, allowing a structured assessment of the fistula's complexity and associated complications.

   d. Documentation: Each MRI was reviewed by an experienced radiologist, and all findings—including the type, internal opening position, grading, and any noted abscesses or secondary tracts—were documented in the data collection form.

3. Preoperative Assessment: For each participant, the findings from the MRI were used to plan the surgical procedure. The surgeon and radiologist collaborated to confirm the location of fistulous tracts, internal openings, and any associated complications, which helped guide the surgical approach.

4. Surgical Data Collection: During the surgical procedure, intraoperative findings were meticulously recorded. This included confirmation of the fistula tract location, the internal opening, and any associated abscesses or secondary tracts. Discrepancies

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between the MRI findings and the intraoperative findings were noted. Any complications encountered during surgery were also documented. The immediate postoperative outcomes, such as wound closure and early signs of healing, were recorded.

5. Data Recording: At each step of the data collection process, findings were carefully entered into the paper-based data collection forms designed for the study. These forms were reviewed by the PI at regular intervals to ensure that no data was missing or improperly recorded. Once the data collection for a participant was complete, their records were securely stored for later entry into the electronic database for analysis.

- **Statistical Analysis**: The data from paper-based data collection was initially entered into MS Excel and was imported in Stata 17.0. All the statistical and graphical analysis for this study was undertaken by Stata software version 17.0. Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants, while chi-square tests and t-tests were used to determine associations between MRI findings and surgical outcomes. Statistical significance was set at a p-value of less than 0.05.
- **Funding:** There was no external funding for this study. All expenses were borne by the study institute, and the Principal Investigator covered costs pertaining to data collection. Participants were not paid any compensation to participate in this study.
- **Conflict of Interest:** There were no conflicts of interest in the design, implementation, or interpretation of the findings of this study.

RESULTS

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A total of 125 participants who met the inclusion criteria were enrolled in the study. These participants underwent MRI imaging followed by surgical intervention, and the findings were systematically analyzed to assess the diagnostic accuracy of MRI in identifying fistulous tracts, internal openings, and associated complications.

Among the 125 participants, the majority were in the age group of 41–50 years (32%), followed by 31–40 years (27.2%) and 51–60 years (24%). Only 4.8% of patients were between 21–30 years, and 12% were in the 61–70 years category. Males constituted 68.8% (n=86) of the study population, while females accounted for 31.2% (n=39). Regarding symptom duration, 36.8% had symptoms for 5–6 months, 32.8% for 6–9 months, and 24.8% for 3–4 months. Only 5.6% reported symptoms for 9–12 months (Table 1).

Table 1: Distribution of participants based on Age (n= 125)

	n	**%**
Age Group		
21-30	6	4.8
31-40	34	27.2
41-50	40	32
51-60	30	24

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61-70	15	12
Gender		
Female	39	31.2
Male	86	68.8
Duration of Symptoms		
3-4 Months	31	24.8
5-6 Months	46	36.8
6-9 Months	41	32.8
9-12 Months	7	5.6

According to Park's classification, intersphincteric fistulas were the most common (38.4%), followed by transsphincteric (31.2%), extrasphincteric (23.2%), and suprasphincteric types (7.2%). Using the St. James University Hospital classification, Grade 1 fistulas were most frequent (30.4%), followed by Grade 3 (24.8%), Grade 2 (23.2%), Grade 4 (15.2%), and Grade 5 (6.4%). Based on the SPTF classification, 78.4% of fistulas were categorized as simple, while 21.6% were considered complex (Table 2).

Table 2: Distribution of participants based on Type of Fistula (n= 125)

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	n	%
Park's Classification		
Intersphincteric	48	38.4
Transphincteric	39	31.2
Extrasphincteric	29	23.2
Suprasphincteric	9	7.2
St. James University Hospital Classification		
Grade 1	38	30.4
Grade 2	29	23.2
Grade 3	31	24.8
Grade 4	19	15.2
Grade 5	8	6.4
SPTF Classification		
Simple	98	78.4
Complex	27	21.6

MRI findings led to a change in the planned surgical approach in 28% (n=35) of cases, while in the remaining 72% (n=90), the surgical plan remained unchanged (Table 3). This indicates that although clinical evaluation remains essential, MRI played a pivotal role in guiding surgical decision-making in over one-fourth of the patients.

Table 3: Impact of MRI on the Surgery (n= 125)

	N	%
Impact of MRI on the Surgery		
No Change	90	72
Changed Surgery	35	28

Table 4: Association of MRI and Surgical Findings— Abscess

Abscess on MRI	**Surgical Abscess**		
	No	**Yes**	**Total**
No	111	3	114
	100.00	21.43	91.20
Yes	0	11	11
	0.00	78.57	8.80

Total	111	14	125
Pearson Chi2 = 95.63 P-value < 0.0001			

Table 4 highlights the association between MRI-detected abscesses and surgical findings. Among the 114 participants who did not have an abscess on MRI, 97.37% were confirmed to be abscess-free during surgery, while 2.63% were found to have an abscess intraoperatively. Conversely, 78.57% of patients with MRI-detected abscesses had surgical confirmation of an abscess, whereas 21.43% of MRI-positive cases did not have an abscess detected intraoperatively.

A statistically significant association was found (Pearson $Chi^2 = 95.63$, $p < 0.0001$), indicating that MRI demonstrated high accuracy in detecting abscesses.

Table 5: Association of MRI and Surgical Findings— Number of Openings

Number of Opening	**Surgical Number of External Openings**			
	1	**2**	**3**	**Total**
1	89	3	4	96
	100.00	21.43	18.18	76.80

2	0	11	1	12
	0.00	78.57	4.55	9.60
3	0	0	17	17
	0.00	0.00	77.27	13.60
Total	89	14	22	125
Pearson Chi2 = 179.76; P-value < 0.0001				

Table 5 illustrates the association between MRI findings and the number of external openings confirmed during surgery. Among participants whose MRI indicated a single external opening, 89.6% were confirmed intraoperatively to have one opening, while 10.4% were found to have multiple openings. For those with two openings on MRI, 91.7% had the same finding confirmed during surgery, while 8.3% were found to have a different number of openings. In cases where MRI detected three external openings, all (100%) were accurately confirmed intraoperatively. A statistically significant association was found (Pearson Chi^2 = 179.76, $p < 0.0001$), indicating that MRI was highly reliable in determining the number of external openings.

Table 6: Association of MRI and Surgical Findings— Horseshoe Fistula

Horseshoe Fistula	**Surgical Horseshoe Fistula**		
	No	**Yes**	**Total**

No	113	2	115
	100.00	16.67	92.00
Yes	0	10	10
	0.00	83.33	8.00
Total	113	12	125
	100.00	100.00	100.00
Pearson Chi2 = 102.36; P-value < 0.0001			

Table 6 depicts the association between MRI findings and the presence of horseshoe fistulas confirmed during surgery. Among patients without horseshoe fistulas on MRI, 98.3% were confirmed as negative intraoperatively, while 1.7% had a horseshoe fistula detected during surgery. Conversely, in cases where MRI identified a horseshoe fistula, 83.3% were confirmed intraoperatively, whereas 16.7% were found to be negative during surgery. A strong statistical association was observed (Pearson $Chi^2 = 102.36$, $p < 0.0001$), suggesting that MRI was highly effective in detecting horseshoe fistulas, though minor discrepancies were noted.

Table 7: Association of MRI and Surgical Findings— Sphincter Damage

Sphincter damage	**Surgical Sphincter Damage**		
	No	**Yes**	**Total**
No	112	1	113
	100.00	7.69	90.40
Yes	0	12	12
	0.00	92.31	9.60
Total	112	13	125
Pearson Chi2 = 114.3; P-value < 0.0001			

Table 7 highlights the association between MRI findings and sphincter damage identified intraoperatively. In cases where MRI did not show sphincter damage, 99.1% were confirmed to have intact sphincters during surgery, while 0.9% were found to have damage intraoperatively. Among those with MRI-detected sphincter damage, 92.3% were confirmed surgically, whereas 7.7% were found to have no actual damage intraoperatively. A statistically significant correlation was observed (Pearson $Chi^2 = 114.3$, $p < 0.0001$), reinforcing the high accuracy of MRI in detecting sphincter involvement, with only a small proportion of cases showing discrepancies.

Discussion

The present study found that MRI findings influenced surgical decision-making in 28% of cases, leading to modifications in the planned surgical approach. In the remaining 72% of cases, MRI did not alter the surgical plan, suggesting that while physical examination and clinical evaluation remain the primary tools for assessing anorectal fistulas, MRI provides additional critical information in a subset of patients. These findings highlight the selective but significant role of MRI in optimizing surgical strategies, particularly in complex cases where anatomical details may not be fully appreciated through clinical assessment alone.

The impact of MRI on surgical decision-making in this study is comparable to the findings of Beets-Tan et al. (2001), who reported that MRI provided additional information in 21% of cases, particularly in patients with Crohn's disease-related and recurrent fistulas[5]. Their study emphasized that MRI findings often revealed secondary tracts and abscesses that were not apparent on clinical examination, leading to more comprehensive surgical management. Similarly, Konan et al. (2018) found that MRI significantly influenced clinical evaluation in 33.8% of cases, especially for complex fistulas and those with external openings more than 2 cm from the anal canal[6].

The present study's results also align with de Miguel Criado et al. (2012), who demonstrated that MRI plays a crucial role in identifying secondary tracts and abscesses, which, if missed, could lead to recurrence[7]. Their study emphasized that MRI findings frequently led to adjustments in surgical planning, thereby reducing the likelihood of persistent or recurrent disease. Kummari et al. (2024) further supported this by reporting high sensitivity and specificity of MRI in detecting complex fistula components, reinforcing its value in surgical decision-making[8].

Additionally, Agha et al. (2013) cautioned that while MRI is highly effective in detecting fistula-related abnormalities, occasional false positives could lead to unnecessary modifications in surgical approaches[9]. This highlights the importance of correlating MRI findings with intraoperative observations to ensure that surgical interventions are justified.

The present study demonstrated a strong correlation between MRI-detected external openings and intraoperative findings, with a statistically significant association (Pearson $Chi^2 = 179.76$, $p < 0.0001$). MRI correctly identified a single external opening in 89.6% of cases, while 78.57% of patients with two external openings and 77.27% of patients with three external openings were accurately diagnosed preoperatively. These findings confirm the high accuracy of MRI in determining the number of external openings, which is essential for precise surgical planning and reducing the risk of incomplete fistula excision.

The findings of this study are consistent with those of Kummari et al. (2024), who reported that MRI demonstrated high sensitivity (93.55%) and specificity (94.12%) in detecting secondary fistulous tracts, which often present with multiple external openings. Their study reinforced the role of MRI in mapping complex fistulas preoperatively, ensuring that all fistulous openings are addressed surgically to prevent recurrence. Similarly, Beets-Tan et al. (2001) observed that MRI had 100% sensitivity in detecting primary fistula tracks and 96% sensitivity for abscesses, further supporting its reliability in preoperative fistula assessment.

The study by de Miguel Criado et al. (2012) also supports these findings, emphasizing that MRI is the most effective imaging modality for identifying multiple external openings, secondary tracts, and associated abscesses[7]. Their research highlighted that accurate preoperative identification of fistula anatomy reduces the likelihood of residual disease and postoperative complications. Likewise, Konan et al. (2018) found that MRI significantly

contributed to surgical planning in cases where physical examination underestimated the complexity of fistulas, particularly when multiple external openings were present.

However, Agha et al. (2013) cautioned that while MRI is highly effective in delineating fistula anatomy, occasional false positives can occur, leading to unnecessary surgical interventions[9]. This underscores the importance of correlating MRI findings with intraoperative observations to minimize overtreatment.

The present study found a statistically significant correlation between MRI-detected sphincter damage and intraoperative findings (Pearson $Chi^2 = 114.3$, $p < 0.0001$). MRI correctly identified intact sphincters in 99.1% of cases and accurately detected sphincter damage in 92.31% of cases. These findings confirm the high diagnostic accuracy of MRI in evaluating sphincter involvement, which is crucial for surgical planning to minimize postoperative complications such as incontinence.

The strong agreement between MRI and intraoperative findings in this study aligns with the results of Beets-Tan et al. (2001), who reported that MRI had a sensitivity of 96% and specificity of 90% for detecting sphincter damage[5]. Their study emphasized that MRI findings played a key role in preventing unnecessary sphincterotomy in cases where sphincter involvement was misdiagnosed clinically. Similarly, de Miguel Criado et al. (2012) highlighted the importance of MRI in accurately delineating the relationship between fistulas and the sphincter complex, reducing the risk of inadvertent sphincter injury during surgery[10]. Kummari et al. (2024) also found that MRI was highly reliable in identifying fistulas with potential sphincter involvement, reinforcing its role in preoperative surgical planning[8]. Their study demonstrated that MRI findings correlated well with intraoperative observations, further supporting its use as a primary imaging modality for complex fistulas. Konan et al.

(2018) reported that preoperative MRI was particularly beneficial in recurrent cases and for fistulas with external openings more than 2 cm from the anal canal, where sphincter involvement was more likely[6]. However, Agha et al. (2013) noted that while MRI is highly effective, occasional false-positive results can occur, leading to unnecessary modifications in surgical approaches. This underscores the need for careful interpretation of MRI findings to avoid overtreatment, particularly in borderline cases[9].

Conclusion

This study demonstrates that Magnetic Resonance Imaging (MRI) is a highly effective tool in the preoperative evaluation of primary anorectal fistulas. MRI showed excellent diagnostic accuracy in identifying fistulous tracts, internal openings, secondary tracts, abscesses, and sphincter involvement. A statistically significant correlation was observed between MRI findings and intraoperative observations, confirming the reliability of MRI in surgical planning. In 28% of cases, MRI findings led to a change in the surgical approach, particularly in complex fistulas where clinical examination alone was insufficient. These results highlight the importance of incorporating MRI into routine preoperative assessment to improve the precision of surgical management, reduce recurrence, and minimize postoperative complications.

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