

DIAGNOSTIC ACCURACY AND FEATURE BASED ANALYSIS OF MRI FOR FISTULA-IN-ANO KEEPING SURGICAL FINDINGS AS GOLD STANDARD

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ABSTRACT

Background: Perianal fistulas are a frequent yet difficult anorectal disease needing thorough anatomical examination and customised surgical therapy. Preoperative surgical planning using magnetic resonance imaging (MRI) is becoming more common. The objective of this study is to determine the diagnostic accuracy of magnetic resonance imaging for the diagnosis of anal fistula among clinically suspected patients, taking the surgical finding as gold standard.

Material and Methods: This cross-sectional validation study was conducted from June 2025 to December 2025. We enrolled 264 male and female patients of age between 18-60 years presenting with clinically suspected fistula-in-ano, using non-probability consecutive sampling technique. MRI examination was performed using standardized technique and anal fistula on MRI was labelled as positive if there is T2 hyperintense appearance of the fistula tract, presence of hyperintense cavities, and rectal wall thickening. After that all patients underwent surgical treatment of anal fistula. Collected data was entered and analyzed on computer software SPSS version 25. Diagnostic accuracies were determined using a 2×2 table. Study confounders were controlled by the stratification. Agreement for various features of fistula-in-ano were also determined using kappa statistics.

Results: Overall accuracy of MRI for detecting the fistula -in-ano was 88.6%; while, sensitivity, specificity, NPV and PPV were 90.6%, 82.0%, 72.5% and 94.4% respectively. Agreement analysis showed the highest agreement for horseshoe extension that was 71.2% and lowest for secondary tract that was 56.1%. However, corresponding *k*-values for all the features indicated poor agreement for all the features ranging from (-0.027 to 0.085).

Conclusion: When compared to surgical results, MRI has superior diagnostic accuracy indices for identifying fistula-in-ano in our local population. The performance of MRI was unaffected by any of the study confounders, which is a testament to its reliability and practicality in clinical settings. MRI should be regarded as an essential component of the diagnostic workup for the fistula-in-ano. Integration of the high-quality MRI with surgical expertise has the potential to improve the operative planning, reduce recurrence, and optimize patient outcomes.

KEYWORDS: accuracy, agreement, fistula-in-ano, internal opening, magnetic resonance imaging, sensitivity, specificity, surgery

INTRODUCTION

An anal fistula (AF) or Fistula-in-ano refers to an anomalous connection between the anorectal canal and the skin surrounding the anus. The condition typically arises when the anal glands, located in the intersphincteric plane, become blocked and infected, leading to the formation of a cryptoglandular abscess (1). It is the second most prevalent anorectal condition, following haemorrhoids and one of the leading reasons of proctological surgery, which greatly affects patients' anorectal function and quality of life (2). Fistula-in-ano has a prevalence rate of 5.6 to 12.3 instances per 100,000 population and is more commonly observed in males (3). The two most prevalent causes are cryptoglandular anal fistula (AF) and anorectal Crohn's disease (CD). Additional causes, such as trauma caused by medical treatment, infections, and cancer, have a lower occurrence and prevalence (4).

Accurately identifying the main cause of crypt infection, as well as comprehending the exact path of primary and secondary tracks and abscesses throughout the body, is a crucial diagnostic approach that greatly enhances the effectiveness of surgical procedures (5). Unsuccessful treatments result from inaccurate attempts to identify perianal fistulous tracts following surgery. Performing a surgical procedure that is excessively forceful or too conservative can result in the recurrence of a disease (residual infected areas) or serious problems such as the loss of control over bowel movements (injury to the anal sphincter) (6). Advanced diagnostic techniques such as transrectal ultrasonography and magnetic resonance imaging (MRI) have improved our understanding of the root cause of the illness and treatment.

However, surgical examination under anesthesia remains the most reliable method for diagnosis and evaluation (7,8). MRI is currently regarded as the preferred method for evaluating perianal fistulas because of its reduced reliance on operators, non-invasive nature, exceptional differentiation of soft tissues, superior field of view, and ability to observe multiple planes. Furthermore, MRI can accurately evaluate the fistula tract in connection to the sphincter complex and its associated issues, offering surgeons highly detailed anatomical information (9,10).

MRI is a well-recognized modality for diagnosing anal fistulas globally but geo-ethnic variation greatly affects the accuracies of MRI. Limited data on our local population is available that is validating its diagnostic accuracy against surgical findings; however, they reported variation in the accuracy as well (11,12,13). So, this study aims to bridge these gaps by determining the diagnostic accuracy of MRI for anal fistulas in our local population, correlating findings with surgical outcomes. The study findings would not only help to add the further evidence in available data but would also help the clinicians to devise local guidelines based on the reliability of MRI prior to invasive procedures among our local population that would ultimately contribute to improve preoperative assessment and tailored surgical management for anal fistulas.

MATERIAL AND METHODS

For this cross-sectional validation study, we enrolled 264 male and female patients of age between 18-60 years presenting with clinically suspected fistula-in-ano, using non-probability consecutive sampling technique. Patients who presented to the hospital with the complaint of perirectal itching, discomfort, blood or pus discharge and pain with defecation were clinically suspected for anal fistula. Patients were enrolled from June 2025 to December 2025 after getting ethical approval via letter number NO F.1-1/2015/ERB/SZABMU/1441 from Radiology department of Pakistan Institute of Medical Sciences, Islamabad. Sample size was calculated by using sensitivity & specificity sample size calculator taking sensitivity of the test as 87.7% (11), specificity of the test as 70.2% (11), expected prevalence 69.3% (11), confidence level as 95%, and required precision as 10%. Patients with a history of surgical intervention for a fistula and recurrence, patient with chronic renal failure, patients with pelvis or anorectal malignancy or hip implants, patients who were hypersensitive to the IV contrast, patient who were claustrophobic, had pacemaker or MRI incompatible metallic implants and those who lost to follow-up were excluded. MRI examination was performed following maintaining an IV-line, removal of all metal objects and maintaining a partially full urinary bladder before examination to visualize better pelvic anatomy delineation. MRI was performed with 1.5 tesla MRI system using a pelvic phased array multicoil. Patient were positioned supine and iso-centering was ensured. High resolution sequences including T2 weighted imaging (T2WI) followed by fat saturated T2WI; and T1 weighted images (T1WI) were acquired in axial, coronal and sagittal planes. After an IV administration of gadolinium (0.2 ml/kg), T1 contrast enhanced images in axial, coronal and sagittal planes were acquired with repetition time/echo time (TR/TE) of 650/13 ms, section thickness of 3 mm, interslice gap of 0.75 mm, matrix size of 384×216 and field of view (FOV) of 320×320 mm while T2 weighted images would be acquired with TR/TE of 5600/95 ms, section thickness of 3 mm, interslice gap of 0.75 mm, matrix size of 448×336, FOV of 320×320 mm. Images were reported by the consultant radiologist with at least three years of teaching experience. Anal fistula on MRI was diagnosed among all the patients who were clinically suspected for anal fistula and planned for the surgery of the disease. Anal fistula on MRI was labelled as positive if there is T2 hyperintense appearance of the fistula tract, presence of hyperintense cavities, and rectal wall thickening. Chronic fistula is depicted as hypointense areas on both T1 - and T2 - weighted images and do not enhance with intravenous gadolinium contrast. While, a fluid collection larger than 10 mm in diameter with rim enhancement on post-contrast T1W images will be an abscess. After that all patients underwent surgical treatment for anal fistula and surgical findings were recorded along with all the demographic details. Collected data was entered and analyzed on computer software SPSS version 25. Diagnostic accuracies were determined using a 2×2 table. Age, gender, duration of disease, BMI and St. James's University Hospital Grading for anal fistula were controlled by the stratification. Post stratification diagnostic accuracies were determined for all the above-mentioned parameters. Agreement for various features of fistula-in-ano were also determined using kappa statistics.

RESULTS

Analysis of the gathered data reflected the mean age, BMI and duration of disease as 39.42±12.17 years, 26.50±4.92 kg/m², and 26.68±11.39 weeks respectively. Study population was male dominant as 70.5%; n=186 patients were male. More than half of the study participants (52.7%; n=139) belonged to age group 40 or above and the body type was obese or overweight (59.5%; n=157). Grade III (30.3%; n=80) and grade II fistulas (23.9%; n=63) were the most frequently seen grades as per St. James Classification. Detailed analysis of various demographic and clinical variables is illuminated in table 1. Frequency of various features of fistula-in-ano on MRI and surgery are graphically illuminated in figure 1 which is showing that there was considerable difference in the findings of horseshoe extension and associated abscess on MRI and surgery, where, horse shoe was detected in only 49 patients and later on surgery detected 93 patients. Similarly, associated abscess was found in 84 patients on MRI but surgical findings showed that it was present in 195 patients.

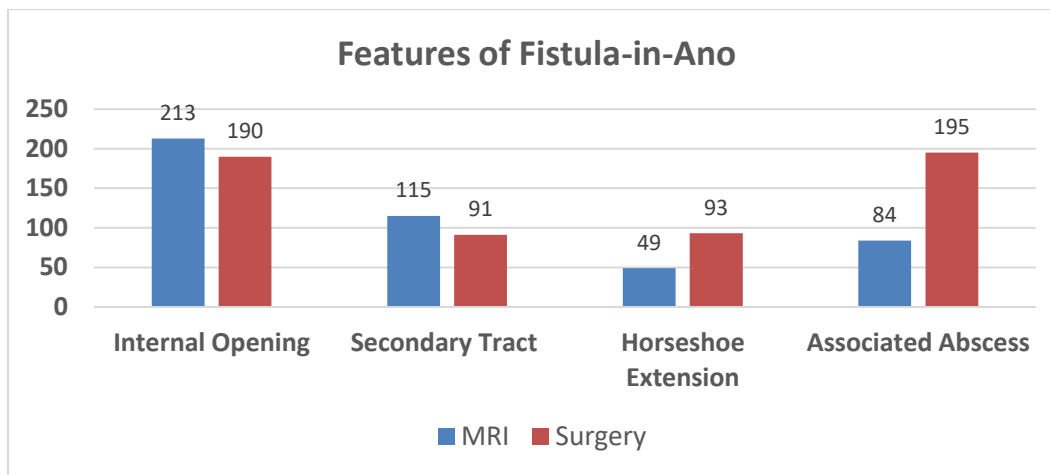


Figure 1: Features of fistula-in-ano on MRI and surgery

Table 1: Qualitative Variables (Frequency Distribution)

Variable	Category	Frequency (%)
Gender	Male	186 (70.5)
	Female	78 (29.5)
Age Groups	< 40 years	125 (47.3)
	≥ 40 years	139 (52.7)
BMI Groups	Underweight	7 (2.7)
	Normal	100 (37.9)
	Overweight/Obese	157 (59.5)
Duration of Disease	≤ 4 weeks	115 (43.6)
	> 4 weeks	149 (56.4)
St. James Grading (MRI)	Grade I	48 (18.2)
	Grade II	63 (23.9)
	Grade III	80 (30.3)
	Grade IV	43 (16.3)
	Grade V	30 (11.4)
Internal Opening (MRI)	Present	213 (80.7)
	Absent	51 (19.3)
Secondary Tract (MRI)	Present	115 (43.6)
	Absent	149 (56.4)
Horseshoe Extension (MRI)	Yes	49 (18.6)
	No	215 (81.4)
Associated Abscess (MRI)	Yes	84 (31.8)
	No	180 (68.2)
Internal Opening (Surgery)	Present	190 (72.0)
	Absent	74 (28.0)
Secondary Tract (Surgery)	Present	91 (34.5)
	Absent	173 (65.5)
Horseshoe Extension (Surgery)	Present	49 (18.6)
	Absent	215 (81.4)
Associated Abscess (Surgery)	Yes	93 (35.2)
	No	171 (64.8)
Overall MRI Findings	Positive	195 (73.9)
	Negative	69 (26.1)
Overall Surgical Findings	Positive	203 (76.9)
	Negative	61 (23.1)

Overall accuracy of MRI for detecting the fistula -in-ano was 88.6%; while, sensitivity, specificity, NPV and PPV were 90.6%, 82.0%, 72.5% and 94.4% respectively (table 2).

Stratification analysis demonstrated that MRI is equally good diagnostic tool for male and female gender with slightly better accuracy among male patients. Specificity was comparatively lower among various age and BMI groups. Detailed stratification analysis is presented in table 3.

Table 2: Overall Diagnostic Accuracy of MRI for Anal Fistula (Taking Surgical Findings as Gold Standard)

MRI Findings		Surgery Positive n (%)	Surgery Negative n (%)	Total n (%)
Positive		184 (94.4) True Positive	11 (5.6) False Positive	195 (73.9)
Negative		19 (27.5) False Negative	50 (72.5) True Negative	69 (26.1)
Total		203 (76.9)	61 (23.1)	264 (100)
Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
90.6	82.0	94.4	72.5	88.6

Table 3: Stratified Diagnostic Accuracy of MRI According to Confounding Variables

Variable	Category	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Gender	Male	90.4	85.0	95.7	70.8	89.2
	Female	91.2	76.2	91.2	76.2	87.2
Age Group	< 40 years	92.9	73.1	92.9	73.1	88.8
	≥ 40 years	88.5	88.6	95.8	72.1	88.5
BMI	Normal	93.2	80.8	93.2	80.8	90.0
	Overweight/Obese	90.3	81.8	94.9	69.2	88.5
	Underweight	60.0	100.0	100.0	50.0	71.4
Duration of Disease	≤ 4 weeks	86.3	85.0	96.5	56.7	86.1
	> 4 weeks	94.4	80.5	92.7	84.6	90.6

We found a variable concordance among MRI and surgical findings for various features of fistula-in-ano upon agreement analysis that showed the highest agreement for horseshoe extension that was 71.2% and lowest for secondary tract that was 56.1%. However, corresponding *k*-values for all the features indicated poor agreement for all the features that are illustrated in table 4.

Table 4: Agreement Between MRI and Surgical Findings for Specific Fistula Characteristics

Fistula Feature	Observed Agreement (%)	Cohen's Kappa (κ)	<i>p</i> -value
Internal Opening	60.2	−0.089	0.136
Secondary Tract	56.1	0.085	0.162
Horseshoe Extension	71.2	0.048	0.438
Associated Abscess	54.2	−0.027	0.660

DISCUSSION

The demographic profile of our study population revealed a mean age of around 40 years with a marked male predominance and majority of the patients are obese or overweight, which aligns with the existing epidemiological data suggesting that fistula-in-ano is more prevalent among males, potentially due to the androgen-related glandular activity and the anatomical differences in the anal glands (5,14). Similarly, the studies by the Garg et al. and Zhao et al. also reported the male proportions ranging between 65–75% in the fistula cohorts evaluated by the MRI (5,14). The obesity has been involved as a risk factor for the anorectal sepsis due to the impaired immunity, increased perianal skin maceration, and altered wound healing (15). The relatively long mean duration of the disease (26.68 weeks) determined in this cohort reflects delayed presentation and referral, the pattern commonly reported in the low- and middle-income settings most commonly due to the resource deficiency and lack of opportunities (16). In the present study, the St. James grade III and grade II fistulas were the most frequently identified pattern and this predominance of the transsphincteric fistulas mirrors findings reported by the Algazzar et al. and Aly et al., where the transsphincteric variants constituted the most common fistula type on the MRI (16,17). The ability of the MRI to specifically classify fistulas according to the established grading systems (such as St. James Grading System) has the direct clinical relevance, as the fistula complexity strongly influences surgical approach and the recurrence risk.

The MRI detected internal openings in more than 3/4th of the cases, which was higher than the detection rate during surgery, which supports previous evidence that the MRI can determine the occult internal openings that may be

overlooked by the intraoperatively due to the inflammation, fibrosis, or limited exposure (9). The accurate localization of the internal opening is the critical, as failure to address it remains a leading cause of the postoperative recurrence (18).

Diagnostic accuracy and associated parameters evaluated in our study are in line with the present-day regional and local studies as reported by Sharma et al (7), in their review. Similarly, Ali et al (11) reported that validity of MRI was 82.4% for perianal fistula and concluded that it's a beneficial and reliable preoperative examination. They further reported that anal fistula was positive in 69.3% of patients on surgical findings. The specificity and sensitivity of MRI in detecting anal fistula were 70.2%, 87.7 % respectively with surgical findings as gold standard. Minhas S and colleagues in their study reported nearly similar findings as our study but unlike our study, they didn't analyze the accuracy and agreement with features of anal fistula (13). The high positive predictive value found by the analysis of our data indicated that the MRI proved to be highly reliable for the detection of fistula-in-ano, minimizing the risk of the unnecessary surgical exploration. While, the comparatively lower negative predictive value illustrate that we cannot absolutely exclude a disease, if MRI findings are negative, particularly in the early or low-grade fistulas. This limitation has also been highlighted by the Adityan R, et al. (19) and Narsingh NP et al. (20) in their studies, emphasizing cautious interpretation of the negative MRI findings in the symptomatic patients.

A major strength of this study is the stratified analysis of the MRI performance across the key confounding variables. The MRI demonstrated the consistently high sensitivity across the gender, age groups, BMI categories, and the disease duration. The absence of the significant sex- or age-based variation in the diagnostic accuracy reinforces the MRI's reliability across the diverse patient populations, as the likewise reported by the Vo et al. and Iqbal et al. (9,21) The MRI performance was marginally reduced in the underweight; however, this finding is likely attributable to the small sample size in this subgroup rather than a true limitation of the MRI. The previous studies have not demonstrated a consistent association between the BMI extremes and reduced the MRI accuracy (7,11,13). The chronic fistulous tracts are more likely to develop well-defined walls, secondary extensions, and the abscesses, making them more conspicuous on the MRI, and our study findings of high accuracy in chronic patient reinforce this fact and supports the concept that the MRI is more particularly valuable in the chronic and recurrent disease.

Despite the higher overall diagnostic accuracy, the agreement between the MRI and surgical findings for the individual fistula features was limited, as reflected by the low Cohen's kappa values. This is the apparent paradox of the high diagnostic accuracy with the low feature-level agreement that has been reported previously and it can be attributed to the several factors. Firstly, surgical exploration itself is an imperfect gold standard, as intraoperative identification of the secondary tracts and abscesses may be limited by the restricted visibility or surgeon experience (15). Secondly, the temporal differences between the MRI and surgery may allow interval resolution or progression of the inflammatory changes (9). Thirdly, the MRI may detect the subclinical extensions that are not surgically apparent but are clinically very relevant for the long-term outcomes. The recent literature has increasingly acknowledged that the MRI may surpass surgery in depicting the full extent of the disease, particularly in the complex and recurrent fistulas (7). Therefore, low kappa values should not be interpreted as a failure of the MRI but rather as evidence of the complementary diagnostic perspectives.

The findings of this study reinforce the role of the MRI as a cornerstone in the preoperative evaluation of the fistula-in-ano. The high sensitivity and diagnostic accuracy across patient subgroups support routine MRI use, particularly in complex, recurrent, or the chronic disease. The MRI-based mapping enables tailored surgical planning, potentially reducing recurrence rates and preserving the sphincter function. Moreover, the discrepancy between the MRI and surgical findings for the individual features highlights the need for the multidisciplinary collaboration. The radiologists and surgeons should engage in the joint image review and standardized reporting, as recommended by the recent consensus guidelines.

Despite of its strengths, this study has the limitations. The cross-sectional design precludes the assessment of the long-term outcomes such as recurrence and the continence. The histopathology, while included as a reference, was not uniformly available for all the anatomical components. In addition to, interobserver variability in the MRI interpretation was not being assessed. Future prospective studies should incorporate the standardized MRI protocols, blinded interpretation, and also the long-term follow-up.

CONCLUSION

Findings of this study established that MRI is highly reliable imaging modality for diagnosing the fistula-in-ano among our local population with excellent diagnostic accuracy indices in comparison with surgical findings. Performance of the MRI remained robust across all the study confounders that reflects the significance of its reproducibility and clinical utility. Although agreement between the MRI and surgical findings for individual fistula features was limited, this likely reflects intrinsic limitations of the surgical exploration and temporal disease variability rather than shortcomings of the MRI. The MRI frequently identifies clinically relevant extensions and the internal openings that may be underestimated intraoperatively, reinforcing its value in more comprehensive disease mapping. In conclusion, the MRI should be regarded as an essential component of the diagnostic workup for the fistula-in-ano, particularly in complex and chronic cases. Integration of the high-quality MRI with surgical expertise has the potential to improve the operative planning, reduce recurrence, and also optimize patient outcomes.

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