

Research Article

Diagnostic Accuracy, Sensitivity, and Specificity of MR Fistulography with Intraoperative Correlation in Anorectal Fistula Management: A Prospective cross-sectional study

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Article History

Received: 13.05.2026

Revised: 26.05.2026

Accepted: 25.06.2026

Published: 30.06.2026

Citations:

Ahlawat R, Kumari S, Ahlawat V. Diagnostic accuracy, sensitivity, and specificity of MR fistulography with intraoperative correlation in anorectal fistula management: a prospective cross-sectional study. *J Surg Radiol*, V5(6) 505-511

Abstract: Introduction: Accurate pre-operative mapping of fistula-in-ano is crucial for complete surgical clearance, sphincter preservation, and prevention of recurrence. MRI is widely used for this purpose, but evidence from local prospective surgical correlation studies remain valuable for assessing its real-world performance. **Methods:** This hospital-based cross-sectional observational study was conducted from April 2024 to September 2025, in 36 clinically suspected or follow-up patients with perianal fistula referred for MR fistulography at a tertiary care center in Gwalior, MP. MRI was performed on a 1.5-T Philips Ingenia system using oblique axial and coronal T1/T2-weighted fast spin-echo sequences, STIR, T1 fat-saturated images, and diffusion-weighted imaging (b = 400 and 900). MRI findings were compared with intraoperative findings, which served as the reference standard. Percent agreement, Cohen's kappa, and diagnostic indices were calculated; 95% confidence intervals (CI) were generated using the Wilson method where applicable. **Results:** The study included 24 men and 12 women, with a mean age of 37.12±12.68 years. Most patients (50.0%) were aged 26-40 years. Single external openings were seen in 30/36 patients (84.1%). Simple intersphincteric fistula was the commonest subtype (36.1%), and 72.2% had no comorbidity. MRI showed substantial agreement with surgery for external opening localization (29/36, 80.6%; $\kappa = 0.692$) and internal opening localization (28/34, 82.4%; $\kappa = 0.712$). Agreement was almost perfect for abscess detection (35/36, 97.2%; $\kappa = 0.945$) and ramification detection (34/36, 94.4%; $\kappa = 0.911$). For abscess detection, MRI showed sensitivity 100.0% (95%CI 75.8-100.0), specificity 95.8% (95%CI 79.8-99.3), PPV 92.3% (95%CI 66.7-98.6), NPV 100.0% (95%CI 85.7-100.0), and accuracy 97.2% (95%CI 85.8-99.5). Ramification detection yielded sensitivity 90.0% (95%CI 59.6-98.2), specificity 96.2% (95%CI 81.1-99.3), PPV 90.0% (95%CI 59.6-98.2), NPV 96.2% (95%CI 81.1-99.3), and accuracy 94.4% (95%CI 81.9-98.5). **Conclusion:** MR fistulography demonstrated strong surgical concordance for localization of openings, detection of abscess and branching. The technique provides a practical preoperative roadmap for surgical planning and should be incorporated routinely in the evaluation of fistula-in-ano, especially when complex disease is suspected.

Keywords: perianal fistula, MR fistulography, diagnostic accuracy, intraoperative correlation, anorectal abscess.

INTRODUCTION

Perianal fistula, or fistula-in-ano, is an epithelialized tract that connects the anal canal or rectum to the perianal skin. It is a common anorectal disorder, disproportionately affecting men and usually presenting in young or middle-aged adults. Beyond pain, discharge, and local irritation, fistula-in-ano creates a substantial surgical burden because recurrence, persistent sepsis, and postoperative continence disturbance are common when the tract anatomy is incompletely defined [1-4].

The pathogenesis is most often cryptoglandular, beginning with obstruction and infection of anal glands located at the dentate line. Once abscess forms, it can decompress to the skin or extend along the intersphincteric plane, through the external sphincter into the ischioanal fossa, or upward across the levator complex in more advanced disease. Crohn-related and other secondary fistulas add further complexity because

they can be multifocal, recurrent, and associated with abscesses or branching tracts [5-9].

Surgery remains the cornerstone of treatment, yet the operative approach must balance eradication of sepsis with preservation of continence. Simple intersphincteric or low transsphincteric fistulas may be managed with fistulotomy or sphincter-sparing techniques, whereas complex transsphincteric, suprasphincteric, and extrasphincteric disease often requires staged or alternative procedures, including seton drainage, LIFT, gluing, or diversion in selected cases [6,7,9]. The common reasons for failure are missed internal openings, unrecognized secondary extensions, and hidden abscesses [10-12].

Historically, fistulography and clinical examination were used to plan surgery. Conventional fistulography has limited soft-tissue contrast and poor sensitivity for branching tracts and internal openings; endoanal

ultrasonography provides useful anatomic detail in selected low tracts but remains operator dependent and limited in field of view [13-15].

MRI overcomes these limitations by providing multiplanar, high-contrast soft-tissue visualization of the anal sphincter complex, intersphincteric space, ischioanal fossa, levator plate, and associated inflammatory changes. Structured MRI reporting has been shown to improve completeness and communication with surgeons, and current guidelines and reviews continue to endorse MRI as the best preoperative imaging test for complex perianal fistulizing disease [2,3,9,15-18].

Despite the growing literature, the diagnostic performance of MRI in routine surgical practice still needs local validation, particularly in terms of exact concordance with operative findings for openings, abscesses, and secondary tracts/ramifications. A prospective cross-sectional study with surgical correlation therefore remains clinically relevant. The present study was designed to assess the diagnostic accuracy, sensitivity, and specificity of MR fistulography with intraoperative correlation in anorectal fistula management.

Aim and Objectives

To evaluate the diagnostic performance of MR fistulography in the preoperative assessment and anatomical mapping of anorectal fistulae, including the identification of fistula openings, ramifications, and associated abscesses, using intraoperative findings as the reference standard.

MATERIALS AND METHODS

Study design and setting: This was a hospital-based cross-sectional observational study conducted jointly by the Departments of Radiodiagnosis and General Surgery at Gajra Raja Medical College and J. A. Hospital, Gwalior, Madhya Pradesh, India.

Study period and sample size: Patients were enrolled from April 2024 to September 2025 (18 months). A target sample size of 36 was derived from a prior sensitivity estimate of 95.56% with 95% confidence, 80% power, 10% precision, and an anticipated drop-out of 20%.

Participants: The study included patients with clinically suspected perianal fistula referred for MRI, those on follow-up after surgery to assess recurrence or residual disease, and patients who underwent MRI followed by surgery. Exclusion criteria were claustrophobia, MRI-incompatible implants or pacemakers, severe comorbidity, refusal of consent, and failure to undergo surgery after MRI.

Study Procedure (MRI technique): MRI was performed on a 1.5-Tesla Philips Ingenia scanner without intravenous contrast. The imaging included coronal, axial, and sagittal STIR; T1-weighted fat-saturated images; diffusion-weighted imaging (b =400 and 900); and T2-weighted coronal, axial, and sagittal sequences. The study also describes oblique axial and coronal T1W/T2W fast spin-echo sequences oriented relative to the anal canal. Images were interpreted in relation to the anal clock, with external and internal openings mapped to quadrants.

Image interpretation and surgical reference standard: MRI was used to assess position of external opening, internal opening, secondary tracts/ramifications, and abscesses. Intraoperative findings at surgery served as the reference standard. Statistical analysis: Descriptive statistics were reported as frequency, percentage, mean, and standard deviation. MRI-operative agreement was assessed with percent agreement and Cohen's kappa. Diagnostic performance indices (sensitivity, specificity, positive predictive value, negative predictive value, and accuracy) were calculated from 2x2 tables where binary comparison was available. 95% confidence intervals were estimated using the Wilson score method where possible.

RESULTS

A total of 36 patients fulfilled the inclusion criteria and underwent MRI followed by surgery.

Table 1. Baseline demographic and clinical characteristics of the study population

Sl. No	Variable	Category	Frequency (%)
1	Age group	<18 years	2 (5.56)
		18-25 years	4 (11.11)
		26-40 years	18 (50.00)
		41-60 years	11 (30.56)
		>60 years	1 (2.78)

2	Mean Age \pm SD (range)	37.12 \pm 12.68 (8-75)	
3	Sex	Female	12 (33.3)
		Male	24 (66.7)
4	No. of external openings	Single	30 (84.1)
		Multiple	6 (15.9)
5	Type of fistula	Simple Inter-sphincteric	13 (36.1)
		Complex Trans-sphincteric	10 (27.8)
		Simple Trans-sphincteric	6 (16.7)
		Complex Inter-sphincteric	4 (11.1)
		Complex Extra-sphincteric	2 (5.6)
		Complex Supra-sphincteric	1 (2.8)
6	Comorbidities	Absent	26 (72.2)
		Present	10 (27.8)

The study cohort showed a clear male predominance. Half of the patients were 26-40 years old, and the mean age recorded is 37.12 \pm 12.68 years. Single external openings were seen in 30/36 patients (84.1%). Simple inter-sphincteric fistula was the commonest subtype (36.1%), and 72.2% had no comorbidity.

Table 2. MRI versus intraoperative findings for external opening localization

Sl. No	Quadrant	MRI n (%)	Operative n (%)	Agreement table
1	Q1: 1-3 o'clock	6 (16.67)	5 (13.9)	3/4 correct
2	Q2: 4-6 o'clock	15 (41.67)	17 (47.2)	14/17 correct
3	Q3: 7-9 o'clock	10 (27.8)	8 (22.2)	10/13 correct
4	Q4: 10-12 o'clock	5 (13.9)	6 (16.67)	2/2 correct

Overall, MRI agreed with the operative quadrant for external opening in 29/36 cases (80.6%; 95% CI 65.0-90.2), with substantial agreement ($\kappa = 0.692$, $p < 0.001$).

Table 3. MRI versus intraoperative findings for internal opening localization

Sl. No	Quadrant	MRI n (%)	Operative n (%)	Agreement table
1	Q1: 1-3 o'clock	8 (22.2)	7 (19.4)	2/3 correct
2	Q2: 4-6 o'clock	17 (47.2)	18 (50.0)	13/16 correct
3	Q3: 7-9 o'clock	7 (19.4)	8 (22.2)	9/13 correct
4	Q4: 10-12 o'clock	4 (11.1)	3 (8.3)	2/2 correct

Internal opening localization showed agreement in 28/34 cases (82.4%; 95% CI 66.5-91.7), with substantial agreement ($\kappa = 0.712$, $p < 0.001$). Two patients with multiple external openings had merged internal openings, explaining the denominator of 34 internal openings.

Table 4. MRI versus intraoperative findings for abscess detection

Sl. No	MRI finding	Intra-op absent	Intra-op present	Total	Interpretation
1	Abscess absent	23	0	23	True negative
2	Abscess present	1	12	13	False positive / true positive
	Total	24	12	36	

MRI detected abscess in 13/36 patients (36.1%), while surgery confirmed abscess in 12/36 (33.3%). There was one false-positive MRI diagnosis and no false negatives. Agreement was 35/36 (97.2%; 95% CI 85.8-99.5), with almost perfect agreement ($\kappa = 0.945$, $p < 0.001$).

Table 5. MRI versus intraoperative findings for ramification/branching

MRI finding	Intra-op absent	Intra-op present	Total	Interpretation
No ramification	25	1	26	True negative / false negative
Ramification	1	9	10	False positive / true positive
Total	26	10	36	

Ramification was detected on MRI in 10/36 patients (27.8%) and surgery identified ramification in 10/36 (27.8%). So yielded 34/36 agreement (94.4%; 95% CI 81.9-98.5), with almost perfect agreement ($\kappa = 0.911$, $p < 0.001$).

Table 6. Diagnostic performance measures calculated

Outcome	Sensitivity	Specificity	PPV	NPV	Accuracy	κ	p value
Abscess	100.0% (75.8-100.0)	95.8% (79.8-99.3)	92.3% (66.7-98.6)	100.0% (85.7-100.0)	97.2% (85.8-99.5)	0.945	<0.001
Ramification	90.0% (59.6-98.2)	96.2% (81.1-99.3)	90.0% (59.6-98.2)	96.2% (81.1-99.3)	94.4% (81.9-98.5)	0.911	<0.001

For binary outcomes, MRI showed very high diagnostic performance, particularly for abscess and ramification.

DISCUSSION

The present study evaluated the diagnostic accuracy and radio-surgical correlation of High-Resolution Computed Tomography (HRCT) temporal bone in 60 patients with cholesteatoma. Cholesteatoma is a locally destructive lesion characterized by progressive accumulation of keratinizing squamous epithelium with a marked tendency for bony erosion involving the ossicular chain, scutum, tegmen tympani, facial nerve canal, lateral semicircular canal, and adjacent intracranial structures. Accurate preoperative assessment is therefore essential for determining disease extent, anticipating complications, and planning the appropriate surgical approach. HRCT temporal bone, owing to its excellent delineation of osseous anatomy, has become the imaging modality of choice in the preoperative evaluation of cholesteatoma.

In the present study, the ≤ 20 years age group constituted the largest proportion of patients (41.7%), indicating a predominance of cholesteatoma among younger individuals, likely related to early-onset Eustachian tube dysfunction and recurrent middle ear infections. Female patients accounted for 61.7% of the study population, with a female-to-male ratio of 1.6:1. Left-sided disease was most common (41.7%), while bilateral involvement was observed in 26.7% of cases, suggesting advanced or longstanding disease. Delayed healthcare-seeking behaviour was evident, as 46.7% of patients presented after more than five years of symptoms. Ear discharge associated with hearing loss was the most frequent presenting complaint (56.7%), and attic retraction pocket with cholesteatoma was the predominant otoscopic finding (85%), consistent with the acquired pars flaccida subtype commonly described in literature.

Comparable findings have been reported in previous studies. Rajesh Kumar et al.¹⁰ reported a predominance in the 31–40 years age group with female predominance, while Khale A et al.¹¹ observed the highest incidence in the 21–40 years age group. Jain SK et al.¹² similarly demonstrated a high incidence in the second to fourth decades of life, and Aljehani M et al.¹³ reported female predominance in their series. These variations likely

reflect differences in study population, referral patterns, and healthcare accessibility.

The present study demonstrated excellent diagnostic performance of HRCT temporal bone for most evaluated

parameters. HRCT achieved 100% sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy for soft tissue density, aditus ad antrum widening, scutum erosion, ossicular erosion involving the malleus, incus, and stapes, tegmen tympani erosion, mastoid cortex erosion, and intracranial complications. Tympanum erosion showed sensitivity of 98.2% and accuracy of 98.3%, with only one false-negative case. These findings emphasize the high reliability of HRCT in delineating disease extent and identifying bony erosions critical for surgical planning.

Similar observations have been documented in earlier studies. Kapoor AA et al.¹⁴ reported sensitivity exceeding 90% for scutum erosion and mastoid sclerosis with specificity greater than 90% for facial canal and sinus plate erosion. Manik S et al.¹⁵ demonstrated perfect correlation for sigmoid sinus plate erosion, mastoid cortex dehiscence, and scutum erosion, while good correlation was observed for ossicular and tegmen erosion. Dashottar S et al.¹⁶ reported sensitivities ranging from 82–100% for scutum, tegmen, and incus erosion. Aljehani M et al.¹³ observed perfect diagnostic indices for ossicular and sigmoid plate erosion, whereas Uz Zaman S et al.¹⁷ demonstrated an overall HRCT accuracy of 95% in cholesteatoma evaluation.

Despite excellent overall performance, HRCT showed reduced sensitivity for lateral semicircular canal (SCC) fistula and facial canal dehiscence. In the present study, lateral SCC fistula was detected in 6.7% on HRCT compared with 15.0% intraoperatively, yielding a sensitivity of 44.4% and accuracy of 91.7%. Similarly, facial canal dehiscence was identified in 10.0% on HRCT versus 18.3% intraoperatively, with sensitivity of 54.5% and accuracy of 91.7%. However, specificity and PPV remained 100% for both parameters, indicating

absence of false-positive findings. These results suggest that HRCT is highly reliable when positive findings are present but may underestimate subtle bony dehiscences due to the thin osseous covering and adjacent soft tissue masking effects.

These findings are consistent with existing literature. Dashottar S et al.¹⁶ reported only 50% sensitivity for facial canal erosion, while Manik S et al.¹⁵ found moderate correlation for facial canal dehiscence. Ram B et al.¹⁸ similarly described good rather than excellent correlation for labyrinthine fistula and facial canal involvement. Lahel RS et al.¹⁹ reported the lowest agreement for facial canal erosion and attributed discrepancies to partial volume averaging effects. Nevertheless, Rajesh Kumar et al.¹⁰ demonstrated excellent sensitivity for SCC erosion, suggesting that diagnostic performance may vary based on disease severity, imaging protocols, and observer expertise.

Tegmen tympani erosion and sigmoid sinus plate erosion demonstrated excellent radio-surgical correlation in the present study. Tegmen erosion showed 100% sensitivity, specificity, and accuracy, while sigmoid sinus plate erosion demonstrated sensitivity of 85.7%, specificity of 100%, and accuracy of 98.3%, with only one false-negative case. Similar excellent correlations have been reported by Ram B et al.¹⁸, Manik S et al.¹⁵, and Aljehani M et al.¹³, reinforcing the utility of HRCT in identifying critical skull base erosions and potential intracranial extension.

Mastoid cortex erosion was identified in 95% of patients with complete agreement between HRCT and intraoperative findings, reflecting the advanced and chronic nature of disease in this cohort. Intracranial complications were present in 5% of patients and demonstrated perfect HRCT correlation. Previous studies by Jain SK et al.¹² and Ram B et al.¹⁸ similarly reported excellent accuracy of HRCT in detecting mastoid involvement and intracranial complications.

The extensive disease burden observed in the present study was reflected in the surgical management pattern. Canal Wall Down (CWD) tympanomastoidectomy was performed in 93.3% of patients, whereas Canal Wall Up (CWU) surgery was feasible in only 6.7% of cases. High rates of mastoid cortex erosion, aditus widening, scutum erosion, and ossicular chain involvement on HRCT strongly influenced the preference for CWD surgery. Similar conclusions regarding the role of HRCT in guiding surgical planning have been emphasized by Jain SK et al.¹², Rajesh Kumar et al.¹⁰, and Pandey N et al.²⁰

Overall radio-surgical agreement in the present study was rated as good in all cases, demonstrating excellent concordance between HRCT findings and intraoperative observations. These findings strongly support the role of HRCT temporal bone as an indispensable preoperative imaging modality in cholesteatoma. Accurate mapping

of disease extent by HRCT not only facilitates appropriate surgical planning and reduces intraoperative surprises but also aids in counselling patients regarding disease severity, surgical risks, and expected outcomes.

This prospective cross-sectional study demonstrates that MR fistulography provides excellent preoperative anatomical mapping of anorectal fistula and correlates closely with surgical findings. The most clinically important findings were the substantial agreement for external and internal opening localization and the almost perfect agreement for abscess and ramification detection. In practical terms, this means that MRI did not merely identify the fistula; it supplied the surgeon with a map of where the tract entered, where it exited, whether there were missed branches, and whether an occult abscess would need drainage.

The demographic profile in the present study is typical of cryptoglandular fistula disease, with a clear male predominance and the highest frequency in the 26–40-year age group. This is consistent with the well-recognized epidemiology of fistula-in-ano, which often affects economically active adults and therefore carries meaningful social and occupational consequences. Similar demographic findings have also been described in contemporary studies of anorectal fistula disease^[1,6,9].

The strongest clinical value of MRI in this series was its accuracy in detecting hidden disease. These findings are consistent with the work of **Savoie-Collet et al.**, who highlighted the utility of MRI in evaluating fistulizing perianal disease and monitoring treatment response through accurate depiction of fistulous tracts and associated inflammatory complications^[19]. Abscesses were identified with excellent agreement and no false negatives, an important result because missed abscesses are a major cause of postoperative sepsis, delayed healing, and recurrence. Similarly, ramification/branching was detected with almost perfect agreement. Even a single missed side branch may render surgery incomplete, particularly in complex transsphincteric disease, horseshoe extension, or recurrent fistula, as highlighted by **Buchanan et al.**, and subsequent studies^[10-12, 16].

When compared with the broader literature, the present findings fall within the higher end of reported MRI performance. Earlier work by **Lunniss et al.** established MRI as a reliable tool for mapping fistula anatomy and predicting surgical outcome^[20,21]. **Buchanan et al.** showed that MRI was more accurate than clinical examination and endosonography for preoperative assessment, and that MRI-guided surgery reduced recurrence in recurrent fistula^[16]. **Spencer et al.** reported high sensitivity and specificity for MR imaging in suspected anal fistula, reinforcing the role of MRI as a problem-solving and planning tool^[22].

More recent studies continue to support this approach. Structured reporting studies (**Poylin VY et al.**, **Thippavong S et al.**, and **Iqbal N et al.**) have shown that a template-based MRI report misses fewer key features than narrative reporting and is more useful for treatment planning [3,23,24]. This is directly relevant to the present study because the value of MRI is not only image acquisition but also the clarity with which the anatomy is communicated to the surgeon. The present study's quadrant-wise correlation for opening position demonstrates how structured interpretation translates into operative usefulness.

The concordance observed here is also comparable with contemporary comparative studies. **Sayed et al.** reported meaningful agreement between endoanal ultrasound and MRI, but MRI remained superior in delineating more complex anatomy [15,25]. **Akhoundi et al.** and other recent comparative studies (**Varsamis N et al.**) similarly showed that MRI performs very well against surgical reference standards, especially for complex fistulas [26,27]. The 2019 Egyptian series by **Algazzar et al.** reported that preoperative MRI predicted disease severity with sensitivity, specificity, and accuracy of 75%, 92%, and 84.6%, respectively, which is directionally consistent with the present findings but somewhat lower than the performance observed in this smaller prospective cohort [28].

The reasons for concordance and discrepancy across studies are likely multifactorial. MRI performance is influenced by scanner strength, use of fat-suppressed and diffusion sequences, radiologist expertise, disease complexity, and whether postoperative or recurrent fistulas are included. **Hori et al.** reported the value of diffusion-weighted imaging as an adjunctive sequence for improving fistula detection and characterization, supporting the role of multiparametric MRI in preoperative assessment [29]. In this study, a 1.5-T scanner with dedicated anal canal sequences was used, and all scans were performed before surgery. This likely improved anatomic clarity. The absence of intravenous contrast may have limited subtle inflammatory delineation in some cases, but the high performance for abscess and branching suggests that the core protocol was adequate for surgical planning. Study by **Aly et al. (2024)**, demonstrated the important role of MRI in the preoperative evaluation of perianal fistulas and emphasized its value in surgical decision-making [30].

Fistula-in-ano is common in general surgery practice, but access to high-quality MRI may be uneven across public and peripheral centers. From an Indian healthcare perspective, the data are particularly relevant. This study supports targeted use of MRI before definitive surgery, especially in complex, recurrent, or ambiguous cases. Even if MRI adds upfront cost, the potential reduction in recurrence, repeat surgery, prolonged wound care, and loss of work capacity may justify the expenditure. This data is consistent with the broader surgical literature emphasizing that missed tracts are a key driver of

recurrence, as discussed by **Buchanan et al.**, **Lunniss et al.** and others [10-12,16,21].

The current findings also have implications for recurrence prevention. The most important determinants of recurrence are unrecognized internal openings, ramifications, and abscesses. MRI directly addresses each of these vulnerabilities. By allowing the surgeon to anticipate a high tract, a transsphincteric extension, or a hidden branch, MRI supports more complete clearance while preserving continence. This is why structured reporting and preoperative imaging are increasingly viewed not as optional extras but as part of definitive management [3,7,9,17,18,23,24].

In summary, this study adds prospective surgical-correlation data from an Indian tertiary center and shows that MRI performs at a very high level for clinically decisive parameters. It is especially useful where the operative strategy depends on an exact understanding of fistula anatomy.

CONCLUSION

MR fistulography demonstrated high diagnostic performance for anorectal fistula characterization in this prospective cross-sectional study. Its concordance with surgical findings was substantial for external and internal opening localization and almost perfect for abscess detection, and branching/ramification detection. The technique provided a reliable preoperative roadmap that is directly relevant to surgical planning, sphincter preservation, and recurrence prevention. Routine preoperative MRI should therefore be strongly considered in the evaluation of patients with suspected complex, recurrent, or surgically ambiguous fistula-in-ano.

Strengths

The prospective study design with preoperative MRI in all patients and direct intraoperative correlation strengthens the validity of the findings. Comprehensive assessment of fistula anatomy, including internal and external openings, abscesses, and secondary tracts, provided clinically relevant information for surgical planning.

Limitations

This study was conducted at a single tertiary-care center with a relatively small sample size, which may limit the generalizability of the findings. Interobserver variability could not be assessed because MRI interpretation was performed within a single reporting setting. Non-contrast MRI was used, potentially reducing the detection of subtle inflammatory activity. Additionally, long-term postoperative outcomes, recurrence rates, and continence assessment were not evaluated.

Ethical Approval: Obtained from institutional ethical committee (IEC) of Gajra Raja Medical College,

Gwalior (M.P.) prior to initiation of the study. Written informed consent was obtained from all participants.

Source of Support: Nil.

Conflict of Interest: None declared.

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