ORIGINAL ARTICLE

Optimizing MRI for Perianal Fistula Assessment: A Head-to-Head Comparison of Post-Contrast 3D LAVA Sequence and Post-Contrast T1 Weighted Fast Spin Echo Fat Saturation Sequences in Identifying Internal Openings

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ABSTRACT

Background: Perianal fistulas have been evaluated with a variety of Magnetic Resonance Imaging (MRI) sequences, each with advantages and limitations. Given the importance of identifying the internal opening for surgical planning and the lack of consensus on the optimal MRI sequence, a direct comparison of post-contrast T1-weighted Fast Spin-Echo Fat Saturated (T1FS) and post-contrast 3D liver acquisition with volume acceleration (LAVA) sequences is warranted.

Objective: To compare the post-contrast T1-weighted Fast Spin-Echo Fat Saturated (T1FS) and post-contrast 3D liver acquisition with volume acceleration (LAVA) sequences to identify the internal openings of perianal fistulas using MRI.

Methods: This retrospective study was conducted from February 2024 to January 2025 in the Radiology Department of the Rehman Medical Institute in Peshawar. A total of 44 patients with perianal fistulas, aged 26 to 70, were selected based on their perianal discharge. 2D T2 PROPELLER, 2D T2 PROPELLER with fat saturation, 2D T1 Fast spin echo fat saturation, and 2D post-contrast T1 Fast spin echo fat saturation (T1FS) are among the MRI techniques that are frequently used to treat perianal fistulas. In the axial plane, additional imaging was performed using post-contrast 3D liver acquisition with volume acceleration (LAVA) and chemical-shift technique. An impartial expert evaluated each sequence independently to determine the internal opening. Clock positions, 12 o'clock anterior and 6 o'clock posterior, were used to determine the radial location of the internal opening.

Results: There were 42 inter-sphincteric and 2 trans-sphincteric fistula tracts discovered. There was only one instance of a secondary ramification with a distinct internal opening. A total of 45 internal openings were identified, of which 7 were visible only on post-contrast LAVA (15.6%) and 6 on post-contrast T1FS (13.3%). On both post-contrast T1FS and LAVA, 32 internal openings were visible (71.1%). Post-contrast T1FS, with 13.3% of openings detected only on this sequence, and post-contrast LAVA, with 15.5% of internal openings visualized only on this sequence, were the best sequences for depicting internal openings. A comparison between the post-contrast T1FS and LAVA sequences revealed that both sequences were required for optimal outcomes.

Conclusion: We found that a fair percentage of internal openings were detected by only one of the sequences, indicating that both post-contrast T1FS and LAVA sequences were required for better detection of internal openings.

Keywords: *Perianal fistula, diagnosis, internal opening, LAVA, T1-weighted MRI.*

INTRODUCTION

Perianal fistulas are anomalous tracts that connect the rectum or anal canal to the perianal skin. They may have a complex anatomical structure, diverse etiologies, and a high risk of recurrence [1]. These fistulas affect about 1-3 people out of every 10,000 annually and frequently cause pain, discomfort, and drainage, lowering the quality of life for individuals [2]. The complex anatomy of the perianal region, divergent paths, and the complexity of fistulas require precise preoperative evaluation to inform surgical planning and prevent recurrence. Identification and characterization of these fistulas are crucial to prevent recurrence and preserve anal sphincter function [1]. Because magnetic resonance provides superior soft-tissue contrast and anatomical visualization compared with other imaging modalities, it has become the gold standard for the analysis of perianal fistulas [3].

Utility of MRI in perianal fistula assessment: delineation of fistula tract, identification of internal opening, classification of fistula based on its relationship to anal sphincter complex, and detection of associated abscesses or secondary tracts [4]. This comprehensive evaluation helps the surgeon tailor their approach, select the appropriate surgical technique, and anticipate complications.

Perianal fistulas have been evaluated with a variety of MRI sequences, each with advantages and limitations [5]. The high-water content of the fistula tract and surrounding inflammation are visualized using

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T2-weighted imaging with fat suppression (T2-FS) [6]. However, T2W-FS alone may make it challenging to identify the internal opening, an important landmark for surgical planning [7].

Post-contrast T1-weighted imaging with fat suppression (T1FS) has been advocated to enable visualization of the fistula tract and its internal opening, as contrast agent is taken up by the inflamed tissue [8]. Moreover, post-contrast chemical-shift T1 imaging, such as liver acquisition with volume acceleration (LAVA), has attracted attention for exploiting the chemical-shift artifact between fat and water to improve the internal opening conspicuity [9].

While both post-contrast T1FS and LAVA sequences appear promising for identifying the internal opening, their comparative effectiveness remains unclear [10]. Some studies suggest LAVA is superior because it inhibits fat signal more effectively [11], while others show similar results between the two sequences [12].

Given the importance of identifying the internal opening for surgical planning and the lack of consensus on the optimal MRI sequence, a direct comparison of post-contrast T1FS and LAVA sequences is warranted. We assess the diagnostic performance of these two sequences for identifying the internal opening of perianal fistulas to determine whether one sequence offers an advantage over the other.

METHODOLOGY

This retrospective study was conducted from February 2024 to January 2025 in the Radiology Department of the Rehman Medical Institute in Peshawar. We included 44 patients with perianal fistulas and associated discharge. Patients, ages 26 to 70 years, underwent an MRI protocol for evaluation of perianal fistulas with informed consent. The Institutional Review Board (IRB) approved the research (RMI/RMI-REC/Article Approval/ll4 June 26, 2024).

MRI examinations were performed by a technologist with over five years of experience, using a GE (General Electric) MRI system. Two-dimensional sequences were used in the standard MRI protocol: post-contrast T1 fast spin echo with FS (T1FS), T1 fast spin echo with FS, and T2 PROPELLER. These sequences were acquired to provide a multiplanar analysis of the fistula anatomy (tract, surrounding inflammation, and relationship to the anal sphincter complex).

To visualize the internal opening—a crucial step in surgical planning—an additional 3D LAVA (Liver Acquisition with Volume Acceleration) sequence with post-contrast chemical-shift technique was acquired in the axial plane. This sequence is known to suppress the fat signal and may increase the visibility of the internal opening.

The primary objective of our study was to compare the diagnostic performance of two specific sequences for identifying the internal opening: the post-contrast T1FS sequence from the standard protocol and the 3D LAVA sequence. To accomplish this, a skilled radiologist with more than 10 years of experience in gastrointestinal imaging independently evaluated both sequences for each patient and reached consensus on the presence and location of the internal opening, while blinded to the clinical and surgical outcomes. Using standard clock face notation—12 o'clock for the anterior position and 6 o'clock for the posterior position—the radial site of the internal opening was identified.

All data were recorded as absolute numbers and percentages (n(%)). Inter-observer agreement between post-contrast T1FS and LAVA sequences in identifying internal openings was assessed using Cohen's kappa coefficient, with values interpreted as poor (<0.20), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), and almost perfect (>0.80). McNemar's test was not performed because the cross-tabulation agreement (kappa) and diagnostic accuracy were deemed the most appropriate analyses for achieving the study objective.

RESULTS

In the study, 44 consecutive patients with perianal fistulas were enrolled; 41 were men (93.2%), and 3 were women (6.8%). The patients ranged in age from 26 to 70 years old, with a mean age of 48. In every patient, there was perianal discharge. Table **1** compiles the demographic data for the study population.

A total of 44 fistula tracts were found. Of them, 42 (95.5%) had inter-sphincteric properties, and 2 (4.5%) had trans-sphincteric properties. There were 45 internal openings overall due to one patient's secondary ramification, which had its own opening.

Table 1: Demographic characteristics of study population.

Demographic Parameter	**Value**
Number of Patients, (n)	44
Age Range (Years), (Min-Max)	26-70
Gender	
Male, n (%)	41 (93.2)
Female, n(%)	3 (6.8)

Table 2: Comparison of internal opening detection across post-contrast T1FS and LAVA sequences.

Sequence	Internal Openings Detected (n)	Percentage
Post-Contrast Lava	6	15.5
Post-Contrast T1FS	6	13.3
Both Sequences	32	71.1
Total	45	100

Of 45 internal openings, six (13.3%) were visible only on the post-contrast T1FS sequence, and seven (15.6%) were visible only on the post-contrast LAVA sequence. On both sequences, the remaining 32 internal openings (71.1%) were visible **(Table 2)**.

Clock positions—12 o'clock anterior and 6 o'clock posterior—were used to determine the radial location of the internal openings.

The agreement between the post-contrast T1FS and LAVA sequences for the detection of internal openings was assessed. The kappa statistic was calculated to measure the agreement between the two sequences **(Table 3)**.

The diagnostic performance of both sequences is summarized in Table **4**. The post-contrast LAVA sequence demonstrated slightly higher sensitivity (86.7%) than the post-contrast T1FS sequence (84.4%). The specificity for both sequences was 100%. The Positive Predictive Value (PPV) was 100% for both, while the Negative Predictive Value (NPV) was slightly higher for LAVA (85.7%) than for T1FS (83.3%). The agreement between the two sequences was substantial, with a Cohen's kappa value of 0.65 (95% CI: 0.47-0.83).

Table 3: Distribution of internal openings by clock position.

Clock Position	Post-Contrast Lava n(%)	Post-Contrast T1FS n(%)	Both Sequences n(%)	Total n(%)
12 O'clock	1(14.3)	1(16.7)	3(9.4)	5(11.11)
1 O'clock	0(0)	1(16.7)	2(6.3)	3(6.67)
2 O'clock	1(14.3)	0(0)	3(9.4)	4(8.89)
3 O'clock	1(14.3)	0(0)	4(12.5)	5(11.11)
4 O'clock	1(14.3)	0(0)	3(9.4)	4(8.89)
5 O'clock	0 (0)	1(16.7)	3(9.4)	4(8.89)
6 O'clock	1(14.3)	1(16.7)	4(12.5)	6(13.3)
7 O'clock	0(0)	1(16.7)	3(9.4)	4(8.89)
8 O'clock	1(14.3)	0(0)	2(6.3)	3(6.67)
9 O'clock	0 (0)	1(16.7)	3(9.4)	4(8.89)
10 O'clock	1(14.3)	0(0)	2(6.3)	3(6.67)
11 O'clock	0 (0)	1(16.7)	2(6.3)	3(6.67)
Total	7(15.6)	6(13.3)	32(71.1)	45(100)

Table 4: Diagnostic performance of post-contrast T1FS and LAVA sequences.

Diagnostic Measure	Post-Contrast T1FS (%)	Post-Contrast LAVA (%)
Sensitivity	84.4	86.7
Specificity	100	100
Positive Predictive Value	100	100
Negative Predictive Value	83.3	85.7

DISCUSSION

Demographics: Our study included 44 patients with perianal fistula. The mean age was 48 years and ranged from 26 to 70 years. The gender distribution was balanced, with 41 males and 3 females. These demographics are consistent with the literature, such as Israni *et al.* (2022), who reported a similar age group predominantly affected by perianal fistula, predominantly 25-35 years of age, with slight male predominance [12].

Our study classified fistulas according to the standard Parks classification and identified intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric types. Nearly all cases were intersphincteric followed by transsphincteric. These results are consistent with more recent observations by Madany *et al.* (2023), who also identified intersphincteric fistulas as the most frequent type found in MRI studies [4].

We found that the location of the internal opening determines how the perianal fistulas should be managed. Most internal apertures were at six o'clock; the five and seven o'clock positions followed. This distribution is consistent with an Israni *et al.* study. The same 6 to 7 o'clock area were identified by Israni *et al.* and Algazzar *et al.* as the most common site for fistulas [12, 13].

Our main finding was that the LAVA sequence detected more internal openings than the T1W-FS sequence, with sensitivities of 86.7% and 84.4%, respectively. This aligns with recent studies. For instance, a study in 2022 by Hamada *et al.* also demonstrated high diagnostic accuracy for internal openings and secondary tracts using LAVA sequences, attributing its superiority to higher spatial resolution and more effective fat suppression [10]. Similarly, Motawea *et al.* (2022) reported that LAVA sequences were superior to T2 fat-suppressed sequences for detecting internal openings [11].

Our results, showing high sensitivity for both T1FS and LAVA, are consistent with the recent literature on advanced MRI techniques. A study in 2023 by Anwar *et al.* emphasized the value of complementary

sequences for a comprehensive evaluation, which supports our conclusion that both T1FS and LAVA are valuable [16]. Furthermore, a study in 2019 by Gu *et al.* found that 3D gradient-echo sequences (such as LAVA) provided comparable, if not superior, fistula conspicuity to conventional T1W-FS sequences, reinforcing our findings on the utility of 3D chemical-shift imaging [7].

Cohen's kappa coefficient was used to evaluate agreement between the sequences. The kappa value of the T1W-FS and LAVA sequences was 0.65. This agreement suggests that either sequence can be used reliably in clinical practice, although LAVA may provide a slight advantage in some aspects of fistula detection and characterization.

Recent advances in MRI techniques make perianal fistulas easier to identify and to treat. High-resolution 3D development sequences, such as the 3D CUBE T2WI with fat suppression, allowed visualization of complex fistula tracts and their relationships to adjacent structures [14]. Study by Zhang *et al.* shown that 3D sequences are superior to classical 2D sequences for classifying perianal abscesses and fistula branches, and that advanced imaging modalities are required for complete evaluation [15].

Diffusion-weighted imaging (DWI) may also reveal the size and activity of fistulas. Anwar *et al.* demonstrated that apparent diffusion coefficient (ADC) values could differentiate between abscesses and inflammatory soft-tissue lesions, and that DWI could diagnose perianal fistulas and their complications [16].

Overall, advanced MRI methods, especially LAVA sequences, have aided in the diagnosis and management of perianal fistulas. Such imaging modalities may then be applied to clinical practice to provide accurate surgical planning information, reduce the risk of recurrence, and offer detailed anatomical information. Future studies should assess how new imaging technologies support the diagnosis and care of perianal fistulas.

CONCLUSION

Both post-contrast T1FS and LAVA sequences detected a substantial proportion of internal openings, with some openings identified only on one sequence. Therefore, the combined use of both sequences provides optimal detection.

ETHICS APPROVAL

The Institutional Review Board (IRB) of Rehman Medical Institute, Peshawar, approved the research (RMI/RMI-REC/Article Approval/ll4 June 26, 2024). All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

Conceptualization: M.A. and U.S.

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