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Original Research Article

Prospective Assessment within a Hospital Setting to Investigate the Utility of Diffusion-Weighted Imaging (DWI) in the Evaluation of Perianal Fistulae

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Abstract:

Aim: The present study was conducted to evaluate the role of diffusion-weighted MRI in the evaluation of perianal fistulae.

Methods: This prospective study was conducted in the Department of Radiology , Lord Buddha koshi medical college and Hospital, Saharsa, Bihar, India and included 80 patients with a total of 100 cryptogenic perianal fistulas and abscesses. These patients presented to the surgery clinic during the time period of 1 year. These patients were then referred for MRI evaluation if a perianal fistula was suspected.

Results: The study included 80 patients, 67 were males and 13 were females. Mean age was 35.5 ± 9.2 years old with a range of 24–60 years of age. The total number of cryptogenic perianal fistulas and abscess was 100. These included 80 fistulas and 20 abscesses. Eight patients had more than 1 fistula or fistula and abscess. In perianal fistulas (n = 80), 30 fistulas were well visualized (score 2) on DWI, in comparison to 50 fistulas well visualized on T2W. In comparison, 20 fistulas were poorly visualized (score 1) on T2W and only 4 was not visualized (score 0). The visibility scores on T2W were not significantly different from that of DWI and both of them were less than the visibility scores of the combined DWI and T2W evaluation, although not significant. All perianal abscesses were well visualized on both sequences, with the same size, location, and extension. The visibility scores of perianal fistulas on DWI were not significantly different between PIA and NIA groups. Similarly, these scores on T2W did not show any significant variation between PIA and NIA groups.

Conclusion: DWI alone is not superior to the T2W regarding the visibility of perianal fistula in our study. However, the best performance was observed for combined DWI-T2W image evaluation, although it was not statistically significant than DWI or T2W alone.

Keywords: Anal fistula, Perianal glands, Diffusion-weighted MRI, Diffusion MRI

Introduction

Perianal fistulas represent a common inflammatory condition of the anal canal and perianal tissues. Most of these fistulas occur due to idiopathic inflammation of the cryptogenic glands in the anal mucosa. Less common causes include Crohn's disease, child birth-related trauma, or radiotherapy. The advent of MRI has offered a major help to these patients as it allowed the direct visualization of the fistulous tract, its site in relation to the anal sphincters, and the extent of the fistula—and its abscess—in relation to the anal sphincters and levator any muscle. This has further improved the surgical outcome for these patients. Diffusion-weighted imaging (DWI) has been studied by several researchers to evaluate whether it adds any value to other MRI sequences in the evaluation of perianal inflammation. Some authors have suggested that DWI is more sensitive than T2W sequence regarding the visibility of the fistula.[1] Others suggested that restricted diffusion indicated activity of the fistula, and some even suggested that it represents a good alternative for post-contrast imaging in case gadolinium cannot be used.[2,3]

Fistula-in-ano is an inflammatory disorder of anorectal region characterized by a tract between the anal canal and the perianal skin.[4,5]

Fistula-in-ano is usually a sequela of a poorly managed perianal abscess. This condition can also be associated with tuberculosis, cancer, and radiotherapy, etc.[5,6] Fistula-in-ano is the second most common anorectal disease after

haemorrhoids.[4] Surgery is considered the treatment of choice aiming to avoid recurrence and preserve anal sphincter function. The risk of recurrence increases to 25% if surgeons fail to recognise and remove radically a fistula and its associated elements during corrective surgery, especially internal openings and secondary tracts.[4,7-9] Accordingly, a precise and comprehensive preoperative assessment of fistula tract is a pivotal diagnostic strategy and contributes significantly to the success rate of surgery. Most of these fistulas occur due to idiopathic inflammation of the cryptogenic glands in the anal mucosa. Less common causes include Crohn's disease, child birth-related trauma, or radiotherapy. The advent of MRI has offered a major help to these patients as it allowed the direct visualization of the fistulous tract, its site in relation to the anal sphincters, and the extent of the fistula—and its abscess—in relation to the anal sphincters and levator any muscle.

The present study was conducted to evaluate the role of diffusion-weighted MRI in the evaluation of perianal fistulae.

Methods

This prospective study was conducted in the Department of Radiology, Lord Buddha koshi medical college and Hospital, Saharsa, Bihar, India and included 80 patients with a total of 100 cryptogenic perianal fistulas and abscesses. These patients presented to the surgery clinic during the time period of 1 year. These patients were then referred for MRI evaluation if a perianal fistula was suspected.

Inclusion criteria: Any patient with suspected perianal fistula or abscess, eGFR ≥ 60 ml/min/ 1.73m2, and no contra-indication to IV gadolinium contrast or to MRI.

Exclusion criteria: Patients with other types or perianal fistulas, any contra-indication to gadolinium contrast or MRI

Methodology

The decision of surgery was based solely on clinical and laboratory evaluation, which included the following criteria: severe pain or restriction of daily activity, restriction of sexual activity, reddish edematous skin, pus discharge, and increased serum C-reactive protein (CRP) levels (> 5 mg/L). Fistulas which were confirmed to show pus at surgery were considered to be active, whereas fistulas which did not reveal pus, did not require surgery, or were associated with normal CRP levels were considered non-active. Patients were classified according to the activity of fistulas into Positive Inflammatory Activity (PIA) and Negative Inflammatory Activity (NIA) groups.[10,11]

MR imaging

All patients were imaged on a 1.5-T Philips Achieva machine (Philips Healthcare, Best, the Netherlands). The body coil (dStream Torso coil) was used. Imaging sequences included T1W, T2W, fat suppressed T1W and T2W, STIR as well as post-contrast T1W sequences in 3 orthogonal planes. The axial plane was used for evaluation.

DWI was added to the study with the following criteria: axial, TR/TE = 6400/100 ms; slice thickness = 5 mm; interslice gap = 0.5 mm; number of slices = 24; matrix size = 188 × 192, with reconstruction to 256 × 256; FOV = 385mm × 385 mm; NEX = 4; and b values of 100, 300, and 600 s/mm2. For the T2W sequence, the acquisition parameters were as follows: axial, TR/TE =

3840/90 ms; slice thickness = 5 mm; interslice gap = 0.6 mm; matrix size = 320 × 220; and FOV = 380 × 240 mm. For post-contrast fat suppressed T1W-SPIR, the acquisition parameters were as follows: Axial, TR/TE = 570/8 ms; slice thickness = 5 mm; interslice gap = 0.6 mm; matrix size = 320 × 220; FOV = 380 × 385 mm.

Image analysis

The perianal fistula was evaluated on T2W, DWI and post-contrast fat-suppressed T1W sequences as per its visualization and extent. Both authors (LM, 16 years of experience: NO, 26 years of experience) evaluated all patients in consensus. T2W and DWI images were evaluated separately 2 weeks apart; then, both sequences were simultaneously evaluated after 2 more weeks, to avoid recall bias. Only the DWI images with b value of 600 s/ mm2 were used for visibility comparison. The visibility of fistulas was graded on a 3-point scale from 0 to 2, as follows: 0 = no evident fistula, 1 = probably fistula, and 2 = distinct fistula. Scores of 1 and 2 were indicative of fistula presence. ADC values were recorded from the corresponding ADC maps. A small ROI was placed within the area of abnormality—on the slice where it is best visualized—and the minimum ADC value was recorded. To evaluate the performance of DWI in grading the perianal inflammation, the extent of the perianal fistula/ abscess was determined on DWI, combined T2W and DWI and combined T2W and post-contrast images, separately.[12] The fistula was then graded according to St. James's University Hospital classification using each of the DWI, combined T2W and DWI, and combined T2W and post-contrast images, separately.[13] The combined T2W and post-contrast images were used as the reference for grading the perianal fistula/abscess.[14] In cases of perianal abscess with non-visualization of the related fistula, the same steps were followed; minimum ADC value was recorded from the abscess core, and the grade was determined using DWI, combined T2W and DWI, and combined T2W and post-contrast images.

Statistical analysis

Statistical analyses were performed using SPSS software (version 21.0; SPSS Inc., Chicago, IL, USA). Numerical data, e.g., age and ADC value, is represented as mean ± standard deviation, while non-parametric data is represented as percentage. The visibility scores on each of the DWI and the T2W images were compared to those on the combined T2W and DWI image evaluation using chi-square test. The same visibility scores (DWI images alone, T2W images alone, and combined T2W and DWI image evaluation) were compared between PIA and NIA groups, also using chi-square test. All perianal abscesses belonged to the PIA group and were well visualized on both sequences, so they were excluded from the 2 later analyses. Independent sample T test was used to compare between ADC values of perianal fistulas between PIA and NIA groups. Perianal abscesses were also excluded from this analysis because they all belonged to the PIA group. ADC values were correlated to the CRP level and leucocytic count using Pearson's bivariate correlation test. Finally, the grading of the perianal fistula/abscess (St. James's University Hospital grading system) on DWI and combined DWI and T2W was compared to the combined T2W and post-contrast evaluation and between PIA and NIA groups using Wilcoxon signed rank test. Significance level is considered if $p < 0.05$.

Results

Table 1: Demographic features of PIA and NIA groups

	PIA	NIA	Significance level
Age	35.5 ± 9.2 years	37 ± 6.2 years	0.3
Gender	32 males, 8 females	35 males, 5 females	0.36
St. James's University Hospital grade	Grade 1: 12 Grade 2: 8 Grade 3: 2 Grade 4: 10 Grade 5: 8 Extra-sphincteric: 2	Grade 1: 30 Grade 2: 0 Grade 3: 6 Grade 4: 0 Grade 5: 4 Extra-sphincteric: 3	0.014

The study included 80 patients, 67 were males and 13 were females. Mean age was 35.5 ± 9.2 years old with a range of 24–60 years of age. The total number of cryptogenic perianal fistulas and abscess was 100. These included 80 fistulas and 20 abscesses. Eight patients had more than 1 fistula or fistula and abscess.

Table 2: Visibility scores for perianal fistulas between T2W, DWI, and combined T2W and DWI

Visibility score for perianal fistulas	T2W	DWI	Combined T2W and DWI	Significance level
Score 2	50	40	76	0.08–0.26
Score 1	20	30	4	
Score 0	10	10	0	

In perianal fistulas (n = 80), 30 fistulas were well visualized (score 2) on DWI, in comparison to 50 fistulas well visualized on T2W. In comparison, 20 fistulas were poorly visualized (score 1) on T2W and only 4 was not visualized (score 0). The visibility scores on T2W were not significantly different from that of DWI and both of them were less than the visibility scores of the combined DWI and T2W evaluation, although not significant. All perianal abscesses were well visualized on both sequences, with the same size, location, and extension.

Table 3: Visibility scores for each sequence between PIA and NIA groups

		PIA	NIA	p value
DWI visibility scores	Score 2	8	30	0.70
	Score 1	8	20	
	Score 0	4	10	
T2W visibility scores	Score 2	16	10	0.48
	Score 1	4	20	
	Score 0	0	30	
Combined DWI and T2W visibility scores	Score 2	20	60	0.72

The visibility scores of perianal fistulas on DWI were not significantly different between PIA and NIA groups. Similarly, these scores on T2W did not show any significant variation between PIA and NIA groups.

Discussion

Prior to the advent of magnetic resonance imaging (MRI), the medical practise of utilising fistulography was employed for the assessment of fistula-in-ano. Nevertheless, this particular method exhibits a limited diagnostic accuracy of approximately 16%. Additionally, it is unable to effectively visualise secondary tracts, abscesses, and

the sphincter complex due to its suboptimal contrast opacification.[15] Consequently, fistulograms lack the capability to offer insights into the correlation between fistula tracts and anal sphincters. Endoanal ultrasonography is a pioneering imaging modality that offers comprehensive anatomical visualisation of the anal canal.[4] This technique has the potential to be utilised in the diagnosis and treatment of not only abscesses and fistula-in-ano, but also anorectal and prostate tumours.

The research encompassed a sample size of 80 individuals, consisting of 67 males and 13 females. The mean age of the participants was 35.5 years with a standard deviation of 9.2 years. The age range of the participants varied from 24 to 60 years. The cumulative count of cryptogenic perianal fistulas and abscesses was 100. The sample consisted of 80 fistulas and 20 abscesses. A total of eight patients exhibited the presence of multiple fistulas, or a combination of fistulas and abscesses. In a sample of 80 perianal fistulas, it was observed that 30 fistulas had a score of 2 indicating good visualisation on diffusion-weighted imaging (DWI), while 50 fistulas were well visualised on T2-weighted imaging (T2W). In contrast, a total of 20 fistulas exhibited poor visualisation (score 1) on T2-weighted imaging, while only 4 fistulas were not visualised (score 0). The primary surgical intervention for perianal fistulous tracts involves the excision of these tracts and the drainage of any associated abscess, while ensuring the preservation of the anal sphincteric complex.16 Fistula recurrence subsequent to surgical intervention typically arises from the presence of untreated or undetected fistula and abscess during the initial surgical procedure.17 Therefore, it is imperative to conduct preoperative magnetic resonance imaging (MRI) assessment of perianal fistula in order to prevent postoperative treatment failure. Different magnetic resonance imaging (MRI) sequences, particularly when combined with diffusion-weighted imaging (DWI) and T2-weighted (T2W) images, have the ability to detect the fistulous tract in relation to the anal sphincteric complexes. These sequences can also provide information about the path of the tract, its branches, and any abscesses that may be associated with it.

According to a certain author, there exists a strong correlation between the activity of a disease and the rapid and maximum enhancement observed during dynamic MRI scanning. Nevertheless, the effectiveness of this dynamic imaging technique is constrained by its inadequate spatial coverage, which hampers the ability to assess the full extent of inflammation due to the need for improved temporal resolution. Recently, there has been a growing interest among researchers in studying the application of 18 DWI (diffusion-weighted imaging) for the purpose of visualizing and grading perianal fistulas and abscesses. The most prevalent applications of diffusion-weighted imaging (DWI) in the field of oncology are found outside the cranial region. Nevertheless, the assessment of abscesses holds significant importance in the context of diffusion-weighted imaging (DWI) due to the pronounced contrast observed between the abscess cavity and the adjacent inflammation on the DWI image.[4,19,20]

In the course of our investigation, we encountered difficulties in replicating the previous findings. In our patient cohort, the diagnostic efficacy of diffusion-weighted imaging (DWI) was found to be comparable to that of the T2-weighted (T2W) sequence for the visualisation of perianal fistulas and abscesses. However, it should be noted that DWI detected a lower number of fistulas compared to T2W across all levels of visibility. However, our findings align with the conclusions of Cavusoglu et al. (2014), Hori et al. (2020), and Bakan et al. (2011), which suggest that the utilisation of combined diffusion-weighted imaging (DWI) and T2-weighted (T2W) evaluation resulted in increased visibility of perianal fistulas. In our study, we were able to detect 96.7% of perianal fistulas using this combined approach. A total of two fistulae were not observable on both diffusion-weighted imaging (DWI) and T2-weighted imaging (T2W). However, these fistulae were visible on post-contrast images. The patient in question exhibited a grade 1 perianal fistula with a normal C-reactive protein (CRP) level. Furthermore, the patient belonged to the non-invasive approach (NIA) group and did not necessitate surgical intervention. There was no statistically significant difference observed in the visibility of perianal fistulas on diffusion-weighted imaging (DWI) images between the groups with perianal inflammatory disease (PIA) and those without perianal inflammatory disease (NIA). In contrast, perianal abscesses were observed with equal clarity on both sequences.[14,20,11]

In the present investigation, it was observed that all perianal abscesses were classified under the PIA group. Furthermore, the apparent diffusion coefficient (ADC) of abscesses was found to be significantly lower compared to perianal fistulas that did not exhibit abscesses. This finding is consistent with the findings reported by Bakan et al.[11] There were no significant differences observed in the visibility scores between T2-weighted imaging (T2W) and diffusion-weighted imaging (DWI). Additionally, both T2W and DWI had lower visibility scores compared to the combined evaluation of DWI and T2W, although this difference was not statistically significant. The perianal abscesses were adequately observed on both sequences, exhibiting consistent dimensions, placement, and scope. There was no statistically significant difference observed in the visibility

scores of perianal fistulas on diffusion-weighted imaging (DWI) between the groups with perianal inflammatory activity (PIA) and those without perianal inflammatory activity (NIA). In a similar vein, the scores on T2W exhibited no statistically significant differences between the PIA and NIA groups. According to the classification system employed by St. James's University Hospital, diffusion-weighted imaging (DWI) demonstrated a precise classification rate of 84.4% for perianal fistulas and abscesses. A total of two cases were misclassified solely by DWI. In the case of this patient, a small collection with a high ADC value was observed, resulting in a grade 1 classification on DWI images. However, on post-contrast images, it was classified as grade 2. The diagnostic accuracy of DWI alone was found to be significantly lower than that of postcontrast images in the classification of perianal disease. This difference was particularly evident in the NIA group, but not in the PIA group, which is characterized by a higher likelihood of undergoing surgical interventions. The classification accuracy of perianal fistulas and abscesses using a combined evaluation of DWI and T2W imaging was found to be 97.8%. This accuracy was not significantly different between the groups with primary idiopathic anorectal disease (PIA) and non-idiopathic anorectal disease (NIA). The findings of our study align with those of Cavusoglu et al., who reported that the diagnostic performance of combined diffusion-weighted imaging (DWI) and T2-weighted (T2W) evaluation was comparable to that of combined T2W and post-contrast image evaluation, without any significant differences.[14]

Conclusion

In our study, we found that the use of DWI alone does not exhibit superiority over T2W in terms of the visibility of perianal fistula. Nevertheless, the most optimal results were obtained when evaluating the combined DWI-T2W images, despite the lack of statistical significance compared to DWI or T2W alone. The calculation of the mean apparent diffusion coefficient (ADC) value, in conjunction with the obtained cutoff ADC value, aids in the differentiation between active and inactive perianal fistulas. Further investigation is required to substantiate the detectability of perianal fistulas using diffusion-weighted imaging (DWI), T2-weighted imaging (T2W), contrast-enhanced magnetic resonance imaging (CEMRI), and the combined approach of DWI-T2W.

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