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Added Value of Diffusion Weighted Imaging in Evaluation of Perianal Fistula in comparison with conventional MRI Fistulogram

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ABSTRACT

Background: Perianal fistulas are common inflammatory conditions of the anal canal and perianal tissues with a high morbidity rate. Magnetic resonance imaging (MRI) is currently considered the ideal imaging modality for detailed preoperative assessment of perianal fistula and its related complications. Post contrast study is considered the ideal sequence for characterizing a perianal fistula. Diffusion weighted imaging (DWI) has been under extensive research to assess its additive value to other MRI sequences in assessment of perianal inflammation. **Objective:** To explore the added value of DWI in evaluation of perianal fistula in comparison to conventional MRI fistulogram and whether it can be used as an alternative to post contrast study. **Patients and Methods:** the current study included 50 cases with perianal fistula who were subjected to full history taking and clinical examination. Radiological examination involved MRI assessment with the following sequences: T1, T2, post-contrast T1 sequences in addition to DWI. Post-surgical data has been used as reference for evaluating the diagnostic efficacy. **Results:** There was a significant statistical difference between the different MRI sequences as regard visibility scores (p= 0.020). Visibility score 2 was reported in 90%, 84%, 94% and 96% in T2, DWI, T2 + DWI and post contrast T1 respectively. The mean ADC value of fistulas was higher than that of the associated abscesses (1.34 ± 0.15 versus 0.95 ± 0.21 x10^{-3} mm^2/s). As regard the diagnostic accuracy of different MRI sequences in detection of primary fistula, the highest accuracy (100%) was reported with the combination of T2+ T1-post contrast and combined T2 +DWI sequences. **Conclusions:** Our study confirmed the significant added value of DWI in comparison to T2WI alone in evaluation of perianal fistulas and its related complications. DWI should be routinely included in the MRI protocol for perianal fistula.

Keywords: Perianal fistula, MRI, DWI.

INTRODUCTION

Perianal fistulas are common inflammatory conditions of the anal canal and perianal tissues with a high morbidity rate. Local pain and discharge are the most frequent symptoms. These fistulas occur most commonly due to idiopathic inflammation of the anal cryptogenic glands, and to less extent due to Crohn's disease, radiotherapy, or secondary malignancy [1,2]. Perianal fistulas result from anal gland obstruction with subsequent infection, abscess formation, and its complications. Although anorectal fistulas can easily be treated surgically through excision of the fistulous tract, recurrence rate is high with foci of infection missed during surgery, necessitating multiple surgical interventions [3,4]. The fundamental objective of surgery is to excise the fistula tract and eliminate all foci of infection, while preserving the anal sphincter. Treatment failure commonly occurs due to undetected secondary extensions and abscesses whereas overly aggressive surgery leads to fecal incontinence. Therefore, preoperative imaging is crucial for proper surgical planning [3,5,6].

Conventional fistulogram through injecting contrast material into the external opening was commonly used before the introduction of MRI. Patient's discomfort during the procedure, high possibility of missing secondary tracts and abscesses with resultant low sensitivity and specificity are the main drawbacks of conventional fistulogram. Similarly, anal ultrasound and preoperative examination under anesthesia can miss an abscess and the relationship of the fistula with the adjacent perianal structures can't be fully evaluated [7-9].

Because of excellent soft-tissue contrast, spatial resolution and multiplanar capability; MRI has essentially replaced the use of conventional fistulogram and is considered the ideal imaging modality for detailed preoperative evaluation of perianal fistula. MRI allows assessment of the primary tract, secondary branches, related abscesses and their relation to the anal sphincter, pelvic floor and ischiorectal fossa [3,9-11].

Among the MRI sequences used for perianal fistulas is T2-weighted imaging (WI) that aids in diagnosing fistula tracts but can be unable to differentiate between abscess and inflammatory tissue. The T1-WI delineates the soft tissue anatomical structures. Post contrast study is considered the gold standard for characterizing perianal fistula in many institutions, it can detect the fistula tract, their extent as well as associated abscess or inflammatory soft tissue [12]. Patients with risk of nephrogenic system fibrosis due to severe renal disease or with contrast related hypersensitivity are unfit for gadolinium injection. Also patients with repeated MRI examinations due to high recurrence rate are exposed to gadolinium deposition particularly in neuronal cell. In such cases, fistula evaluation without post-contrast study becomes difficult [13].

Diffusion-weighted imaging (DWI) is a reliable functional technique that helps in diagnosing perianal fistulas. It detects water mobility changes that result

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from interactions with cell membranes and macromolecules. The DWI shows fistulas as hyperintense signal with restricted diffusion [14,15]. DWI may decrease the need for gadolinium based MRI sequences. This will be useful in patients with renal diseases. DWI can easily be included in MRI protocol for perianal fistulas due to short sequence period with no need for contrast agents [16,17]. DWI has been under extensive research to assess its additive value in the setting of perianal inflammation. Some researchers suggested that DWI is more sensitive than T2WI and can be used as a good alternative for post-contrast study when gadolinium cannot be used [16-19].

The current study was conducted to explore the added value of DWI in evaluation of perianal fistula in comparison to conventional MRI fistulogram and whether it can be used as an alternative for post contrast study.

PATIENTS AND METHODS

This study is a cross sectional observational and analytical study that was conducted along the duration of 1 year at the Diagnostic Radiology Department and Department of General Surgery (Colorectal Surgery Unit). The study included 50 patients with perianal fistulas.

Inclusion criteria:

- Patient with clinically suspected perianal fistula.
- Estimated glomerular filtration rate ≥60ml/m/1.73m^2.

Exclusion criteria:

- Contraindications for MRI: cardiac pacemaker, cochlear implants, metallic foreign bodies, artificial valve and history of claustrophobia.
- Patients with previous surgical intervention for perianal fistula.
- Patients who refused to join the study.

All patients were subjected to the following:

History taking: including personal history and demographic data, history of the present illness (onset, course, and duration), clinical symptoms (pain, presence of external opening, presence of inflamed skin and pus discharge) as well as past medical and surgical history. Also, history of inflammatory conditions, pelvic infection, birth trauma, malignancy, systemic diseases or radiotherapy.

General and local examination: to detect the site of external opening and signs of associated inflammation.

MR imaging:

- All patients were imaged using 1.5-T Philips Achieva machine (Philips Healthcare, Best, the Netherlands).
- For image acquisition, a phased-array coil was utilized with the patient in supine position. Distal rectum and subcutaneous tissue were included in the imaging field. The imaging plane included the supralevator space to exclude any extensions.
- Imaging sequences included T1, T2, DWI as well as fat suppressed post-contrast T1 sequences.
- For T1WI (axial oblique): TR/TE, 600/10 ms; slice thickness = 3 mm; interslice gap = 0.5 mm; matrix size = 320 × 220; and FOV = 380 × 240 mm.
- For T2WI with and without fat suppression (axial oblique, sagittal, coronal oblique): TR/TE = 3800-4900/90 ms; slice thickness = 3 mm; interslice gap = 0.5 mm; matrix size = 320 × 220; and FOV = 380 × 240 mm.
- DWI using single-shot echo-planar imaging in the axial oblique plane: TR/TE = 6500/100 ms; slice thickness = 3 mm; interslice gap = 0.5 mm; number of slices = 24; matrix size = 188 × 192, with reconstruction to 256 × 256; FOV = 380 mm × 380 mm; NEX = 4; and *b* values of 0, 500, and 1000 s/mm^2.
- For pre- and post-contrast fat suppressed T1WI (axial oblique, sagittal, coronal oblique): TR/TE = 580/10 ms; slice thickness = 3 mm; interslice gap = 0.5 mm; matrix size = 320 × 220; FOV = 380 × 380 mm. Gadoterate Meglumine at a dose of 0.2 mL/kg was administrated intravenously at a rate of 2 mL/s.

Image interpretation:

- MR image analysis was conducted by two expert radiologists. The perianal fistula was evaluated on T1WI, T2WI, DWI and post-contrast study.
- T2WI, DWI and post contrast images were evaluated separately followed by combined post contrast and T2WI and combined post contrast and DWI each with 2 weeks apart to avoid recall bias.
- DWI was evaluated qualitatively (signal characteristics on DWI and ADC map). Quantitative evaluation by measuring ADC values of fistula, abscess and inflammatory tissue was also performed. A small ROI was placed within the area of abnormality on the slice where it is best visualized in ADC map and the ADC value was recorded.
- The combined T2WI and post-contrast study were considered the reference for grading the perianal fistula.
- Post-surgical data has been considered the reference for assessing the diagnostic accuracy.

The detailed MRI evaluation of perianal fistula included:

- *Primary fistula tract*: we followed the radiological classification of St. James's University Hospital. Grade 1 is a simple linear intersphincteric fistula. Grade 2 is intersphincteric fistula with abscess or secondary tract formation. Grade 3 is transsphincteric fistula while Grade 4 is transsphincteric fistula with abscess or secondary tract formation within

the ischiorectal fossa. Grade 5 includes supralevator and translevator extensions [20].

- *The visibility of a perianal fistula in different sequences:* was assessed on a 3-point scale from 0 to 2. Score 0: no visible fistula, 1: probable fistula, and 2: clearly visible fistula.
- *Site of internal opening*: was determined according to the clock face, in addition to its distance from anal verge. It is defined as any defect of the internal anal sphincter that shows high signal intensity (SI) in T2WI, DWI, or post-contrast enhancement.
- *Site of external opening*: was defined as any defect around the anal verge (right or left gluteal region, scrotum, and vagina) that shows high SI in T2WI, DWI, or post-contrast enhancement.
- *Secondary tracts (*none, single unbranched, single branched or multiple), or extensions of fistula tract (horseshoe, intersphincteric, ischioanal/ischiorectal space, supralevator, or translevator extension).
- *Hyperintensity*: the degree of T2 hyperintensity within a fistula is subjectively graded as absent, mild, or pronounced. It is considered as an indicator of active disease.
- *Enhancement within the tract:* if there is only peripheral enhancement and the tract is of high T2-SI, then the tract is fluid filled and active. When the tract is of high T2-SI, but with internal enhancement, then the tract is healing with granulation tissue. If the tract is of low T2-SI and shows internal enhancement (usually progressive), then the tract is fibrosed.
- *Inflammatory tissue*: area of high T2-SI, no DWI restriction with diffuse post-contrast enhancement.
- *Abscess formation*: a localized distension of tract >5 mm that shows diffusion restriction and peripheral post contrast enhancement with or without air pockets inside [21].

Ethical approval: The study was approved by our institutional review board. A written informed consent was obtained from all patients. The Helsinki Declaration was followed throughout the course of the investigation.

Statistical analysis:

The collected data were analysed using the SPSS (Statistical Package for Social Sciences) version 26 for Windows®. The qualitative data were presented in percentage and number form.Quantitative data were presented as mean ± SD (Standard deviation)/ median (Range). Quantitative data were tested for normality using the Kolmogorov-Smirnov test. The relationship between two or more qualitative variables was examined by Chi-Square test. Monte-Carlo test was used to examine the relationship between two groups with qualitative variables when the expected count is more than 5 in >20% of cells. The performance of each diagnostic test was evaluated including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy. The significance level, denoted by the P value, was used to assess the statistical significance of a result, P values <0.05 are considered significant.

RESULTS

Our study included 50 patients with perianal fistula. They were 41 males (82%) and 9 females (18%) with mean age of 40.78 ± 13.99 years and age range between 18 and 78 years. The age group between 31 and 40 years was the most frequently affected (28%). As regard the site of internal opening, the commonest site was shown at 6 o'clock in 24% of the cases followed by 12 o'clock in 12% of cases. Secondary tracts and extension of the fistula were reported in 19 cases (38%). All the fistulas were active and there were 26 fistulas (52%) active with no extension, 8 (16%) active with extension and 16 fistulas (32%) active with abscess formation. As regard St. James's classification of the fistula, grade II was the commonest in 19 patients (38%) [Table 1].

Table (1): Clinical and radiological data in the studied cases

Variable	Study cases (N = 50)	
Sex	Number	Percent
Male	41	82%
Female	9	18%
Age groups (Years)		
≤ 20	3	6%
21-30	10	20%
31-40	14	28%
41-50	11	22%
51-60	6	12%
61-70	5	10%
71-80	1	2%
Secondary tracts/extension	19	38 %
Activity		
Active with no extension	26	52 %
Active with extension	8	16 %
Active with abscess	16	32 %
Type of the fistula		
Inter-sphincteric	34	68 %
Trans-sphincteric	15	30 %
Supralevator and translevator extension	1	2%
Grades of perianal fistula		
Grade I	15	30 %
Grade II	19	38 %
Grade III	13	26 %
Grade IV	2	4 %
Grade V	1	2 %

Categorical data expressed as Number (%)

There was no significant statistical difference between the different MRI sequences in grading of perianal fistulas (p= 0.232) [Table 2].

Table (2): St James's classification according to different MRI sequences

Grades of perianal fistulas	MRI sequence				P Value
	T2W	DWI	Combined T2+ DWI	T1 + C	
Grade I	13 (26%)	12 (24%)	14 (28%)	15 (30%)	0.232
Grade II	18 (36%)	17 (34%)	18 (36%)	19 (38%)	
Grade III	12 (24%)	11 (22%)	12 (24%)	13 (26%)	
Grade IV	2 (4%)	2 (4%)	2 (4%)	2 (4%)	
Grade V	1 (2%)	1 (2%)	1 (2%)	1 (2%)	

Categorical data expressed as Number (%)

There was a significant statistical difference between the different MRI sequences as regards visibility of fistula (p= 0.020). Visibility score 2 was reported in 90%, 84%, 94% and 96% in T2WI, DWI, T2WI + DWI and post contrast T1 respectively [Table 3 & figures 1-3].

Table (3): Visibility score according to different MRI sequences

Sequence	Visibility score	Study cases (N= 50)	P value
T2W	2	45 (90%)	**0.020***
	1	1 (2%)	
	0	4 (8%)	
DWI	2	42 (84%)	
	1	1 (2%)	
	0	7 (14%)	
T2W + DWI	2	47 (94%)	
	1	0 (0%)	
	0	3 (6%)	
T1 + C	2	48 (96%)	
	1	2 (4%)	
	0	0 (0%)	

Categorical data expressed as Number (%)

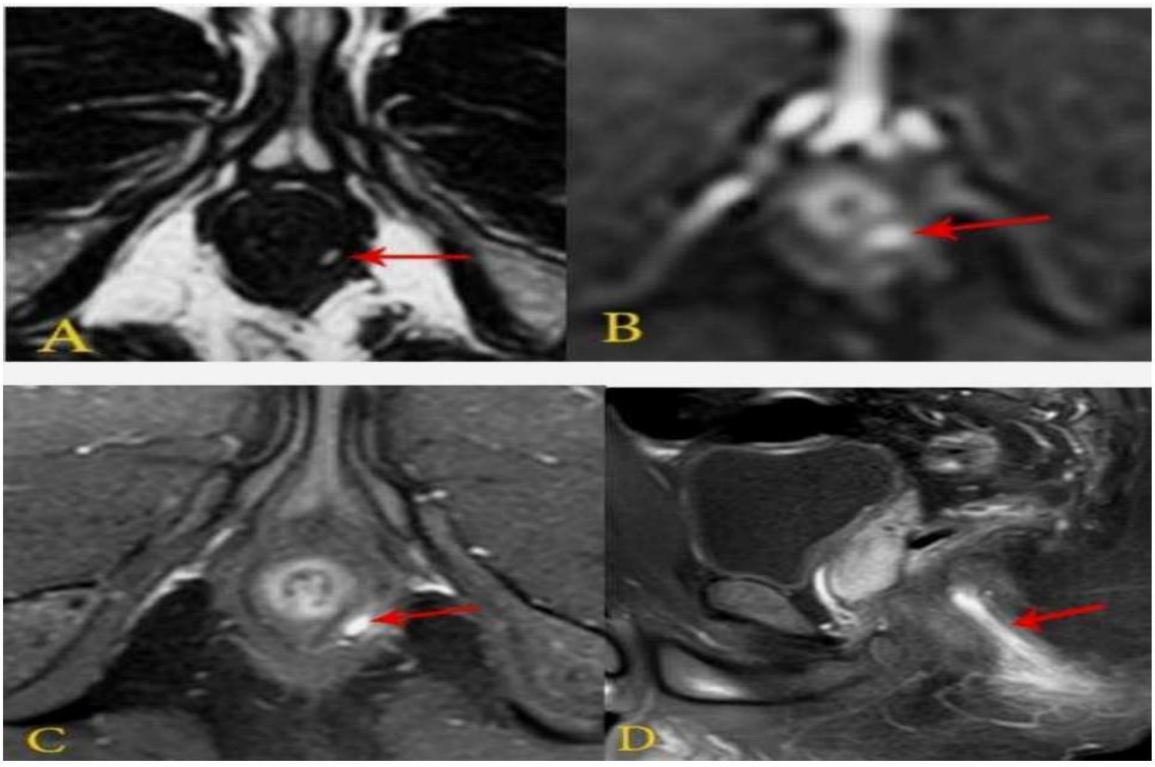

Figure (1): A male patient aged 36 years old with continuous anal pain, and pruritus. (A) Axial T2WI: shows fistula tract (arrow) that exhibits slightly high SI opens at 4 o'clock position.(B) Axial DWI shows restricted diffusion (hyper-intensity) of more pronounced trans-sphincteric fistula (C,D) Axial and sagittal fat-suppressed T1+C: enhanced linear non -branching fistulous tract.Overall MRI finding consistent with trans-sphincteric fistula (Grade III).

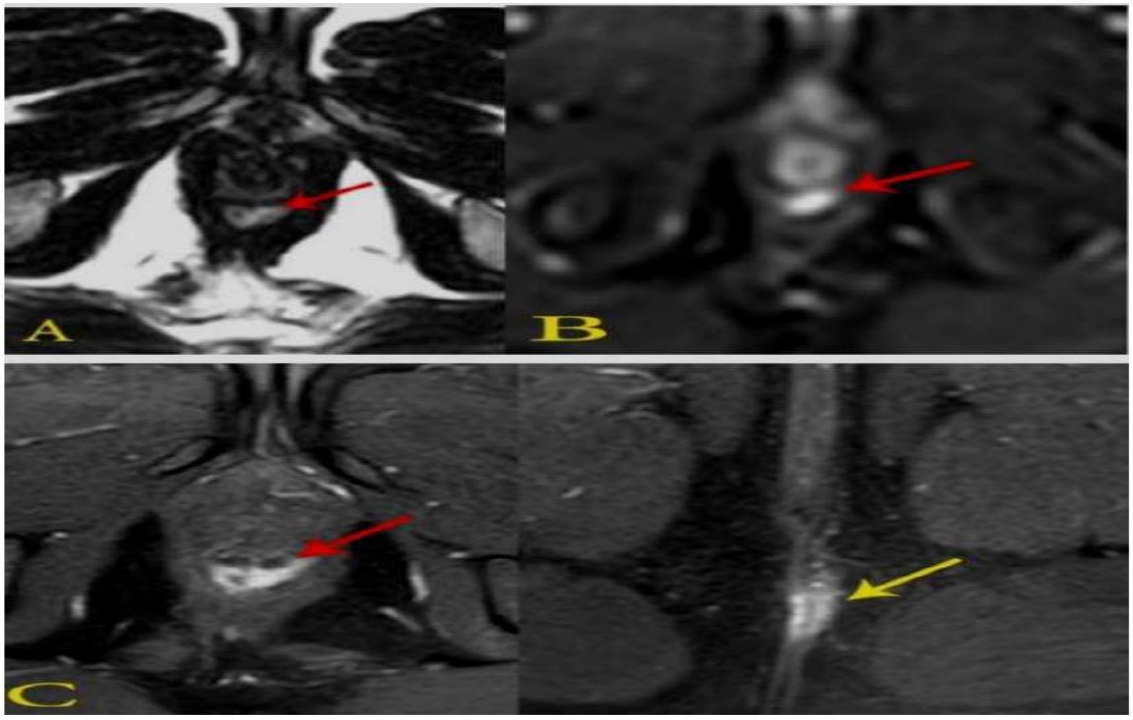

Figure (2): A male patient aged 56 years old with perianal discharge and pruritus. a) Axial T2-WI: shows hyperintense intersphincteric fistula with focal distension forming small abscess with low SI gas foci inside from 5 to 7 o'clock (arrow). b) Axial DWI: shows restricted diffusion (hyper intensity) at the intersphincteric abscess (arrow).c) Axial fat-suppressed T1+C: enhanced fistulous tract from left natal cleft (yellow arrow) with intersphincteric abscess from 5 to 7 o'clock with gas bubbles inside (red arrow). Overall MRI finding consistent with horseshoe intersphincteric fistula with small abscess (Grade II).

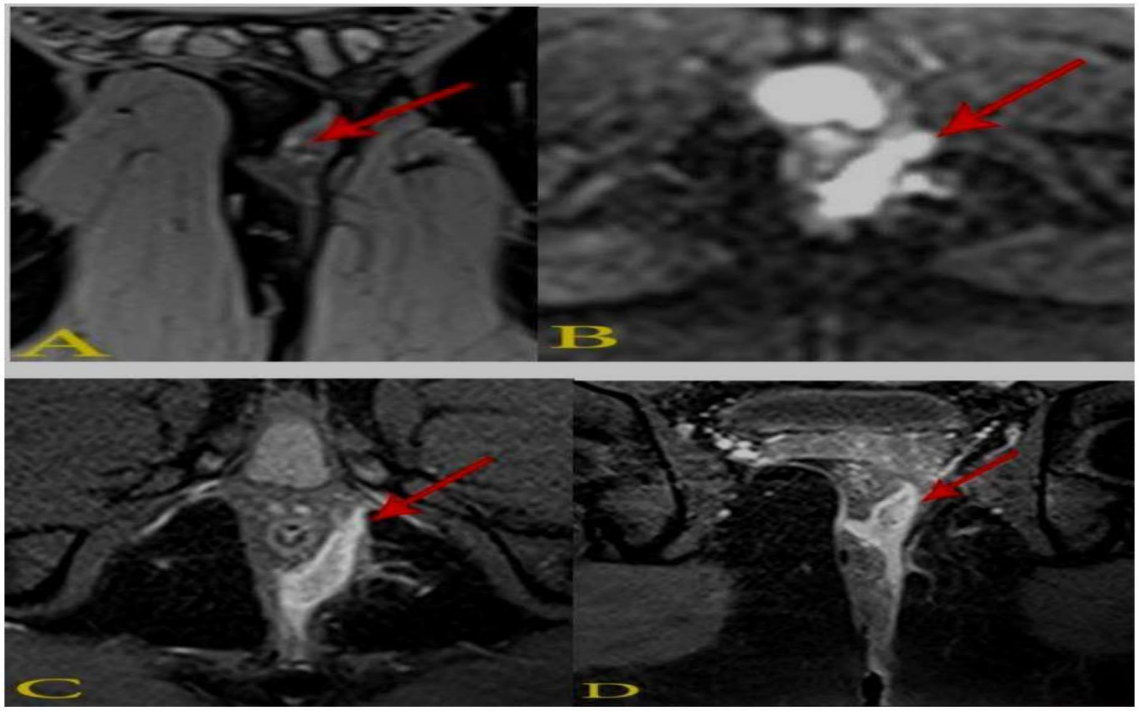

Figure (3): A male patient aged 52 years old complaining of pain, perianal discharge. (A) Coronal T2-WI: shows fistula tract (hyper-intense) from left natal cleft with intersphincteric collection and supralevator extension (arrow).(B) Axial DWI: shows restricted diffusion (hyper-intensity) of the collection (arrow).(C,D) Axial and sagittal fat-suppressed T1+C: enhanced fistulous tract from left natal cleft, tract traverses with large intersphincteric abscess (arrow) with supralevator extension (arrow in D).Overall MRI finding consistent with perianal fistula with supralevator extension (Grade V).

The mean ADC value of fistulas was 1.34 ± 0.15 $x10^{-3}$ mm^2/s (range 0.99-1.66) while lower mean ADC value was detected for the associated abscesses 0.95 ± 0.21 $x10^{-3}$ mm^2/s (range 0.68-1.33).

Table [4] shows the diagnostic performance of different MRI sequences and their combinations in detection of primary fistula, internal opening, secondary extension and associated abscess. For detection of primary fistulas, the highest accuracy (100%) was reported with the combined T2+ T1-post contrast (T1+C) and combined T2 +DWI sequences.

Table (4): Diagnostic performance of different MRI sequences in evaluation of each characteristic feature of perianal fistula:

	Study cases (n=50)				
	(T1+C)	T2	DWI	Combination of T2+(T1+C)	Combination of T2+DWI
Primary fistulas tract	49/50	45/50	47/50	50/50	48/50
Sensitivity	98%	90%	94%	100%	96%
Specificity	100%	100%	100%	100%	100%
PPV	100%	100%	100%	100%	100%
NPV	98%	94%	96%	100%	97%
Accuracy	99%	96%	96%	100%	100%
Internal opening	48/50	43/50	45/50	48/50	47/50
Sensitivity	96%	86%	90%	96%	94%
Specificity	100%	100%	100%	100%	100%
PPV	100%	100%	100%	100%	100%
NPV	98%	88%	92%	98%	96%
Accuracy	97%	90%	94%	96%	96%
Secondary extension	19/19	14/19	19/19	19/19	17/19
Sensitivity	100%	73%	100%	100%	89%
Specificity	100%	100%	100%	100%	100%
PPV	100%	100%	100%	100%	100%
NPV	100%	75%	100%	100%	92%
Accuracy	100%	79%	100%	100%	94%
Abscess	16/16	12/16	16/16	16/16	16/16
Sensitivity	100%	75%	100%	100%	100%
Specificity	100%	100%	100%	100%	100%
PPV	100%	100%	100%	100%	100%
NPV	100%	78%	100%	100%	100%
Accuracy	100%	84%	100%	100%	100%

Categorical data expressed as Number (%)

DISCUSSION

Preoperative MRI is of great importance in complete evaluation of the fistulous tract, secondary ramification, associated abscess, hidden areas of sepsis as well as grading of fistula with a high concordance rate between MRI and surgical findings. It has several advantages for example, no exposure to ionizing radiation, no special patient preparation and it is well tolerated with no discomfort to the patient. Accurate preoperative MRI assessment of perianal fistula can impact surgical planning, improve its outcomes and decrease the recurrence rate [3,8,10].

DWI has gained importance in evaluation of perianal fistula and its complications. DWI enhance the capabilities of MRI by offering additional functional information [22]. Inflammation and infection restrict the normal random movement of water molecules due to increased cell content and necrotic components that generates excellent signal contrast between inflammatory foci and the surrounding tissue [4,14,15]. Several recent studies have shown the significant role of DWI in the identification of primary perianal fistula, associated abscesses as well as assessment of fistula activity with high sensitivity and specificity. There is an increasing interest in assessing the effectiveness of DWI when utilized alongside T2WI. The researchers asserted that the addition of supplemental diffusion can enhance the diagnosis with increasing both confidence and sensitivity [4,23-26].

The current study showed that perianal fistulas were more common in males (82%) than females (18%). The mean age was 40.78 ± 13.99 years with age range between 18 and 78 years. The age group between 31 and 40 years represented the highest frequency in the included cases with percentage of 28%. Near similar results were found in the study conducted by **Anwar *et al.*** [23] that included 36 males (77%) and 11 females (23%) with mean age of 41.7 years. On the other hand, they found that perianal fistulas were most common in people aged 41–70 years in 27 cases (57.5%). As regard the site of internal opening in our study, the commonest site was found at 6 o'clock in 24% of the cases. This came in agreement with **Fahmy and Dawoud**[27] who reported that the most common site of internal opening was at 6 o'clock in 35% of cases.

In the current study, grade II fistula (38%) was the most common followed by grade I (30%) and the least common was grade V (2%). On the other hand, **Reddy *et al.*** [25] found that among 54 patients with perianal fistulas, grade I was the most prevalent (33%) followed by grade 2 (22%), but similar to our results the least was grade V (11%). As regard St. James's classification, there was no significant statistical difference between different MRI sequences (T2WI, DWI, T2W + DWI, post contrast T1sequence) in grading of perianal fistulas with P value =0.232. In agreement with our results, **Mohsen and Osman**[28] reported that, no significant difference was noted as regard grading of perianal fistula between combined (T2WI+ DWI) and combined (T2WI+post-contrast images) with 97.8% of cases were correctly classified using combined T2WI+DWI.

Regarding the associated complications, in the current study, secondary tracts and extensions of the fistula were reported in 38% of the cases and associated abscesses were reported in 32% of the cases. In agreement with our study, **Soydan**[29] reported associated abscess formation in 36.7% of cases, but he reported higher incidence of secondary branching in 56.7% of cases. On the other hand, **Khater *et al.*** [30] reported lower incidence of associated abscesses in 11.15% of the included cases. Different selection criteria, hygiene and presentation time may explain the variation in the activity and complications between studies. Delayed presentation is usually associated with more complications [31,32].

In this study, inter-sphincteric fistulas were the commonest seen in 34 cases (68%), trans-sphincteric fistulas were seen in 15 cases (30%) while supralevator and translevator extensions seen in 1 case (2%). This was in agreement with **Abd-Elwahab *et al.*** [24] who found inter-sphincteric fistula in 60.9%, trans-sphincteric fistula in 21.7%, and extra-sphincteric fistula in 17.4% of cases.

There was a significant statistical difference between the different MRI sequences as regard the visibility score (p= 0.020). Visibility score 2 was reported in 90%, 84%, 94% and 96% in T2WI, DWI, T2WI + DWI and T1 + C respectively. In a study conducted by **Boruah *et al.*** [26] on 59 perianal fistulas, visibility score 2 was reported in 79.6% of cases on DWI, 91.5% on T2WI, 98.3% on combined DWI-T2W, and 96.6% on T1 + C. The visibility scores on DWI were not significantly different from that of T2WI. In their study, the visibility scores of the combined DWI-T2WI were higher than that of DWI, T2WI and post contrast study. Similarly, **Anwar *et al.*** [23] found that among the included 79 fistulas, 92.4% were well visualised on T2-WI, 97.4% were well visualised on DWI, while 100% of cases were well visualised on both combined T2+DWI and post-contrast fat supressed T1 sequences.

In our study, the mean ADC value of fistulas was $1.34 \pm 0.15 \times 10^{-3}$ mm^2/s (range 0.99 -1.66) while lower mean ADC value of $0.95 \pm 0.2 \times 10^{-3}$ mm^2/s (range 0.68 - 1.33) was recorded in the associated abscesses. Similarly, **Abd-Elwahab *et al.*** [24], reported that the abscesses had mean ADC value of $0.93 \pm 0.197 \times 10^{-3}$ mm^2/s, while the perianal fistulas had higher mean ADC value of $1.31 \pm 0.165 \times 10^{-3}$ mm^2/s with a significant difference between the two entities ($p < 0.001$).

Other studies suggested promising role of DWI in evaluation of fistula activity and also in differentiating abscess from inflammatory tissue. **Anwar *et al.*** [23] reported a high significant statistical difference in ADC values between perianal abscess and

inflammatory tissue ($p < 0.05$). **Soydan**[29] also reported that the mean ADC value was significantly different between active fistulae (0.919 ± 0.165 $x10^{-3}$ mm^2/s) and inactive fistulae (1.235 ± 0.220 $x10^{-3}$ mm^2/s) with $p<0.0035$.

As regard detection of primary fistula tract, the accuracy was 99%,96%,96%, 100% and 100% for (T1+C),T2, DWI, combined T2+(T1+C) and combined T2+DWI respectively. The accuracy was higher and equal (100%) for both combined T2+ (T1+C) and combined T2+DWI. As regard detection of internal opening, the accuracy was slightly higher (97%) for (T1+C) followed by equal accuracy (96%) for combined T2+ (T1+C) and combined T2+DWI.

As regard secondary extension, the accuracy was 100%, 79%,100%,100% and 94% for (T1+C),T2, DWI, combination of T2+(T1+C) and combination of T2+DWI respectively. The accuracy was higher and equal (100%) for (T1+C), DWI and combination of T2+ (T1+C). As regard detection of associated abscess, the accuracy was higher and equal (100%) for all except T2WI (84%).

Cavusoglu *et al.* [17] reported that the sensitivity and the specificity of combined DWI and T2-WI were statistically higher than that of T2-WI alone. They demonstrated that the combined DWI and T2-WI was equivalent to combined contrast enhanced T1-WI and T2-WI for the diagnosis of perianal fistula with no significant difference in between. **Abd-Elwahab *et al.*** [24], showed that adding DWI to T2-WI resulted in increased overall sensitivity, specificity and accuracy than that reported for each sequence alone, It was clear that combination of both sequences can overcome the drawbacks of each one alone. **Fahmy and Dawoud**[27] reported that there was no significant difference in overall accuracy of detection of perianal fistula and its complications between combined (DWI and T2-TIRM) and post contrast images. In detection of abscess cavity, DWI with ADC map showed similar accuracy (100%) as compared to post contrast images. It was superior to T2-TIRM images in differentiation between true abscess cavity and inflammatory reaction. Similar results are also reported by **Boruah *et al.*** [26] **as well as Mohsen and Osman**[28].

The addition of DWI to T2-WI can enhance the accuracy of diagnosing fistulas. Both fistula and surrounding inflammatory tissue have high T2-SI. However, on DWI, fistula displays high signal, while the surrounding signal is notably reduced so that the fistula extent can be more easily visualized [33]. It is also critical to differentiate between abscess and inflammatory tissue because abscesses necessitate surgical intervention and drainage while inflammatory lesions are treated conservatively. Both the abscesses and the inflammatory tissue display high T2-SI. On the other hand, abscess has a lower mean ADC value as compared to that of an inflammatory tissue [23]. However, it is also necessary to use imaging techniques with a high spatial resolution to assess the anatomic relation of fistula to the neighboring structures. Low spatial resolution is a disadvantage of DWI. So, DWI should be used as a supplementary sequence together with fat-suppressed T2-WI [30].

There are some **limitations** in the current study. Although surgical findings have been used as the reference standard, surgery can miss some fistulas and related complications. Also, all included fistulas were active, so we did not have the chance to assess the role of different MRI sequences in differentiating active from inactive disease. Lastly, relatively small number of cases included in the study.

CONCLUSIONS

Our study results confirmed the significant added value of DWI compared to T2WI alone in assessment of perianal fistulas and its associated complications. DWI should be added to the routine MRI protocol for perianal fistula. The combined T2+DWI sequences can effectively give similar diagnostic information as that of post contrast study. It can be used as a good alternative to post contrast study in patients where gadolinium contrast is not advised.

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REFERENCES

1. **Zanotti C, Martinez-Puente C, Pascual I *et al.* (2007):** An assessment of the incidence of fistula-in-ano in four countries of the European Union. Int J Colorectal Dis., 22 (12): 1459–1462.
2. **Alabiso M, Iasiello F, Pellino G *et al.* (2016):** 3D-EAUS and MRI in the activity of anal fistulas in Crohn's disease. Gastroenterol Res Pract., 16: 1895694. doi: 10.1155/2016/1895694.
3. **de Miguel Criado J, del Salto L, Rivas P *et al.* (2012):** MR imaging evaluation of perianal fistulas: spectrum of imaging features. Radiographics, 32 (1): 175-94.
4. **ElSharbatly R, Halim M, Shaker F *et al.* (2022):** Role of MRI special diffusion weighted imaging/diffusion tensor imaging techniques in the assessment of perianal fistula activity. Egypt J Radiol Nucl Med., 53: 54. https://doi.org/10.1186/s43055-022-00724-0
5. **Gage K, Deshmukh S, Macura K *et al.* (2013):** MRI of perianal fistulas: bridging the radiological-surgical divide. Abdom Imaging, 38 (5): 1033-1042.
6. **Reza L, Gottgens K, Kleijnen J *et al.* (2024):** European Society of Coloproctology: Guidelines for diagnosis and treatment of cryptoglandular anal fistula. Colorectal Disease, 26 (1): 145-96.
7. **Sharma A, Yadav P, Sahu M *et al.* (2020):** Current imaging techniques for evaluation of fistula in ano: a review. Egypt J Radiol Nucl Med., 51: 130. DOI:10.1186/s43055-020-00252-9
8. **Algazzar H, Eldib D, Bahram M *et al.* (2019):** Preoperative MRI of perianal fistula evaluation and its impact on surgical outcome. Egypt J Radiol Nucl Med., 50: 71. DOI:10.1186/s43055-019-0085-9

9. **Barbosa P, Camilo D, Nunes T *et al.* (2020):** Comparison between conventional and structured magnetic resonance imaging reports in perianal fistula. Journal of Coloproctology, 40: 31-36.
10. **Balcı S, Onur M, Karaosmanoğlu A *et al.* (2019):** MRI evaluation of anal and perianal diseases. Diagn Interv Radiol., 25 (1): 21-27.
11. **Xu H, Xiao G, Zheng Y *et al.* (2023):** A magnetic resonance imaging-based decision-making tool for predicting complex anal fistulas healing in the early postoperative period. BMC Gastroenterology, 23 (1): 372. doi: 10.1186/s12876-023-02963-5.
12. **Yıldırım N, Gökalp G, Öztürk E *et al.* (2012):** Ideal combination of MRI sequences for perianal fistula classification and the evaluation of additional findings for readers with varying levels of experience. Diagn Interv Radiol., 18 (1): 11–19.
13. **McDonald R, McDonald J, Kallmes D *et al.* (2015):** Intracranial gadolinium deposition after contrast enhanced MR imaging. Radiology, 275: 772–82.
14. **Adityan R, Paul I (2021):** The Role of Diagnostic Medical Imaging Techniques in the Evaluation of Perianal Fistula: A Review. Int J Radiol Imaging Technol., 7: 84. DOI: 10.23937/2572-3235.1510084
15. **Baliyan V, Das C, Sharma R *et al.* (2016):** Diffusion weighted imaging: technique and applications. World J Radiol., 8: 785-798.
16. **Lefrançois P, Zummo-Soucy M, Olivié D *et al.* (2018):** Diagnostic performance of intravoxel incoherent motion diffusion-weighted imaging and dynamic contrast-enhanced MRI for assessment of anal fistula activity. PLoS One, 13: e0191822. doi: 10.1371/journal.pone. 0191822.
17. **Cavusoglu M, Duran S, Sözmen Cılız D *et al.* (2017):** Added value of diffusion- weighted magnetic resonance imaging for the diagnosis of perianal fistula. Diagn Interv Imaging, 98: 401-408.
18. **Liu X, Wang Z, Ren H *et al.* (2020):** Evaluating postoperative anal fistula prognosis by diffusion-weighted MRI. European Journal of Radiology, 132: 109294. doi: 10.1016/j.ejrad. 2020.109294.
19. **Aggarwal P, Malik R, Sarawagi R *et al.* (2024):** Comparing the Efficacy of a Combination of Diffusion-Weighted Imaging and T2-STIR (Short Tau Inversion Recovery) Imaging With Contrast-Enhanced MRI in the Evaluation of Perianal Fistula. Cureus, 16 (2): e53485. doi: 10.7759/cureus.53485.
20. **Morris J, Spencer J, Ambrose N (2000):** MR imaging classification of perianal fistulas and its implications for patient management. Radiographics, 20 (3): 623-35.
21. **Thipphavong S, Costa A, Ali H *et al.* (2019):** Structured reporting of MRI for perianal fistula. Abdom Radiol., 44 (4): 1295-1305.
22. **Wang Y, Gu C, Huo Y *et al.* (2018):** Diffusion tensor imaging for evaluating perianal fistula: Feasibility study. Medicine (Baltimore), 97 (29): e11570. doi: 10.1097/MD.0000000000011570.
23. **Anwar H, Reddy M, Kumar S *et al.* (2023):** A study of the diagnostic efficacy of diffusion-weighted magnetic resonance imaging in the diagnosis of perianal fistula and its complications. Polish Journal of Radiology, 88 (1): 113-8.
24. **Abd-Elwahab S, Mohamed A, Abdelhamid N *et al.* (2023):** Role of MR Fistulography Combined with Diffusion-Weighted Magnetic Resonance Imaging in Evaluation of Perianal Fistula. The Egyptian Journal of Hospital Medicine, 90 (2): 2945-51.
25. **Reddy A (2023):** Assessment of Role of Diffusion-Weighted Imaging in the Evaluation of Perianal Fistulae. Int J Acad Med Pharm., 5 (3): 461-4.
26. **Boruah D, Hazarika K, Ahmed H *et al.* (2021):** Role of diffusion-weighted imaging in the evaluation of perianal fistulae. Indian Journal of Radiology and Imaging, 31 (01): 091-101.
27. **Fahmy D, Dawoud M (2017):** Value of diffusion weighted MRI in assessment of simple and complicated perianal fistula. The Egyptian Journal of Radiology and Nuclear Medicine, 48 (3): 553-562.
28. **Mohsen L, Osman N (2020):** Diffusion-weighted imaging in the evaluation of perianal fistula and abscess. Egypt J Radiol Nucl Med., 51: 71. DOI:10.1186/s43055-020-00193-3
29. **Soydan L (2022):** Evaluation of Activity of Perianal Fistulas by Diffusion- Weighted Imaging. Turk J Colorectal Dis., 32 (4): 245-251.
30. **Khater T, Lakouz K, Alaa A *et al.* (2024):** Added Value of Diffusion Weighted Magnetic Resonance Imaging in diagnosis of Perianal Fistula at Zagazig University Hospitals. Zagazig University Medical Journal, 30 (4): 2311-2320.
31. **Limura E, Giordano P (2015):** Modern management of anal fistula. World Journal of Gastroenterology, 21 (1): 12-20.
32. **Wang D, Yang G, Qiu J *et al.* (2014):** Risk factors for anal fistula: a case–control study. Techniques in Coloproctology, 18: 635-39.
33. **Halligan S, Stoker J (2006):** Imaging of fistula-in-ano. Radiology, 239: 18-33.