

Role of MR Fistulography Combined with Diffusion-Weighted Magnetic Resonance Imaging in Evaluation of Perianal Fistula

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is the imaging method of choice for assessing perianal fistulae because of its ability to highlight the connection between perianal fistulae and anal sphincters, fistula extensions, secondary ramifications, and related disorders.

Objectives: This study aimed to evaluate the role of MRI compared to DWI in perianal fistula, to provide a roadmap to surgeons to prevent recurrences or sphincter incontinence, and to evaluate recurrent perianal fistula after surgery.

Patients and methods: This prospective cohort study was conducted in Qena University Hospital, South Valley University, Qena, Egypt in the duration from January 2021 to January 2022. The study included 30 patients with perianal fistula. **Results:** In the present study more than half of the studied patients had grade 1 when it was classified by St. James's University Hospital classification by MRI (56.7%) or by Combined T2W and DWI (60.05). highly significant agreement between St. James's University Hospital classification by MRI and Grading by Combined T2W and DWI with agreement equal to 89.0%. When compared to T2-weighted imaging on its own, our findings indicated that DWI provided a considerable benefit to the diagnostic process when attempting to identify a perianal fistula. This seem to imply that DWI should be routinely incorporated as an additional step to the more standard strategy for the investigation of perianal fistula using MRI. **Conclusion:** According to our findings, DWI significantly improved upon T2-weighted imaging alone in the identification of perianal fistula. As a result, it is suggested that DWI be routinely incorporated to the MRI examination of perianal fistula protocol.

Keywords: Intersphincteric, Magnetic resonance imaging, Perianal fistulae, Transsphincteric, DWI, St. James's University Hospital classification.

INTRODUCTION

Fistula in ano (FIA) is a morbid disorder that is becoming more prevalent, with a prevalence of 1 per 10,000 people. It has its own underlying causes as anal glandular infection, Crohn's disease, radiation, and secondary malignancy⁽¹⁾. Even though anorectal fistulas are easily repaired surgically, the risk of secondary recurrence is significant because the treatment neglected infection foci. Surgery is performed with the primary objective of preserving the functionality of the anal sphincter while at the same time eliminating all foci of infection associated to the fistula and the fistula tract⁽²⁾. It is essential for successful surgical outcomes to have a clear visualisation of the extent of the fistula tract as well as its connections to the anal sphincter. At the present time, magnetic resonance imaging (MRI) continues to be the imaging modality of choice for evaluating patients prior to surgery and investigating post-surgical recurrence of perianal fistula⁽³⁾.

The fistula tract, abscess formation, and secondary tracts may all be evaluated using MRI, and the fistula tract's connections to the levator plate and the ischiorectal fossa can be clearly seen. When it comes to visualising diseased tracts and abscesses, MRI is well known to be more effective than the other modalities. Preoperative MRI is recognised to be especially significant in recurrent and complex disease, since it significantly lowers the postoperative recurrence rate⁽⁴⁾. T1-weighted sequences are typically used when performing an MRI exam to make a diagnosis of perianal fistula, T2-weighted sequences and STAIR

sequences are frequently used in MRI to diagnose perianal fistulas⁽⁵⁾. The MRI fistula tract protocol now includes gadolinium chelate-enhanced imaging because it makes it easier to see abscesses and distinguish between active illness and fibrous tracts. However, there are several drawbacks to using gadolinium chelate⁽⁶⁾. As a direct consequence of this fact, DWI has become increasingly significant in the identification of perianal fistula. On diffusion-weighted imaging (DWI), the acute inflammatory process can be distinguished from the normal-appearing tissues that are located in close proximity to it thanks to the stark contrast that can be detected between the two. Recent studies in a variety of medical journals have demonstrated that DWI has a high degree of sensitivity and specificity for the diagnosis of perianal fistula, as well as for the evaluation of fistula activity and any accompanying abscesses^(5,7,8).

If the b-value of the DWI is increased, the image will have a higher contrast, greater tissue diffusibility, and less T2 shine-through effect. In DWI, a higher b-value is linked to a lower apparent diffusion coefficient (ADC) value, in addition to a reduction in the T2 shine-through effect being seen in patients with perianal fistula and/or accompanying abscess. When the b-values are increased, the DWI images show a greater contrast between the perianal fistula or related abscess and the structures that are located around it. This is the case whether the fistula is linked with an abscess or not⁽⁹⁾. The gold standard of our study was to have successful surgical outcomes as it is important

preoperative and provides good evaluation of the site of the internal opening of the fistula, which is described on an MRI as the point at which a fistula is closest to the anal canal and is typically, observed in the intersphincteric space. Also, it is essential in recurrent and complex disease or with its complication as abscess formation and secondary tracts ⁽²⁾.

PATIENTS AND METHODS

This was a prospective cohort study in Qena University Hospital, South Valley University, Qena, Egypt. This study included 30 patients with perianal fistula in the duration from January 2021 to January 2022. Patients were clinically diagnosed to have perianal fistula

Inclusion criteria: Patients with known or clinically diagnosed to have perianal fistula.

Exclusion criteria: Patient with metal prosthesis which are not MRI compatible. Patient refused the examination or claustrophobic patients.

All patients were subjected to the following: Full history taking (all patients with perianal fistula or who were complaining of perianal discharge and pain), clinical examination (general by vital signs and local by DRE), investigation (Routine laboratory investigations: CBC, random & fasting blood sugar levels and lipid profile) and MRI Examination (by T1,T2 and STAIR weighted sequences combined with diffusion weighted sequences , the signal intensity on DWI using value of 0 , 500 , 1000 and 1500 s/mm²).

Ethical Approval: The study was approved by the Ethics Board of the South Valley University. An informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

SPSS 22.0 for windows (developed by SPSS Inc. in Chicago, Illinois, in the United States) and MedCalc 13 for windows (MedCalc Software byba, Ostend, Belgium) were utilised. Every statistical comparison was conducted with two different levels of significance using a two-tailed significance test. If the p-value was equal or less than 0.05, the difference was significant. If it was less than 0.001, the difference was considered extremely significant and those above 0.05 were non-significant.

RESULTS

The demographic data of the studied group showed that age ranged from 34-76 years with mean value of 51.00 ± 12.825 years. Male cases were 21(70.0%) while female cases were 9 (30.0%). History of previous surgery for anal fistula showed that 9 cases (30.0%) had history of previous surgery for anal fistula as shown in table (1).

Table (1): Distribution of studied sample according to demographic data

	Number	Percent
Age (years)		
<40	6	20.0
40 – 50	8	26.7
50 – 60	12	40.0
> 60	4	13.3
Range	34-76	
Mean ± S.D.	51.00 ± 12.825	
Sex		
Male	21	70.0
Female	9	30.0
History of previous surgery for anal fistula		
No	21	70.0
Yes	9	30.0

Regarding fistula or abscess and their sites, the majority had fistula (76.7%) and more than half of them the site of fistula was in inter-sphincteric (60.9%) while abscess was detected in 7 patients (Table 2).

Table (2): Distribution of studied sample according to fistula or abscess and their sites

	Number	Percent
Fistula	23	76.7
Inter-sphincteric	14	60.9
Trans-sphincteric	5	21.7
Extra-sphincteric	4	17.4
Abscess	7	23.3
Inter-sphincteric	3	42.9
Trans-sphincteric	3	42.9
Extra-sphincteric	1	14.3

The grading of the studied group showed that more than half of the studied patients had grade 1 when it was classified by St. James’s University Hospital classification by MRI (56.7%) or by combined T2W and DWI (60.05%) as shown in table (3)

Table (3): Distribution of studied sample according to St. James’s University Hospital classification by MRI and grading by combined T2W and DWI

	Number	Percent
St. James’s University Hospital classification by MRI		
Grade 1	17	56.7
Grade 2	5	16.7
Grade 3	4	13.3
Grade 4	3	10.0
Grade 5	1	3.3
Grading by Combined T2W and DWI		
Grade 1	18	60.0
Grade 2	4	13.3
Grade 3	5	16.7
Grade 4	2	6.7
Grade 5	1	3.3

The relationship and agreement between St. James’s University Hospital’s classification by MRI and grading by combined T2W and DWI showed that there was 89.0% agreement between the two (Table 4).

Table (4): The relation and agreement between St. James’s University Hospital classification by MRI and grading by combined T2W and DWI

Grading by Combined T2W and DWI	St. James’s University Hospital classification by MRI					Kappa Agreement test	P value
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5		
Grade 1	17(100%)	1(20%)	0	0	0	89.0%	<0.001*
Grade 2	0	4(80%)	0	0	0		
Grade 3	0	0	4(100%)	1(33.3%)	0		
Grade 4	0	0	0	2(66.7%)	0		
Grade 5	0	0	0	0	1(100%)		

In the case of perianal fistulas, 19 fistulas (63.3%) were well seen (score 2) on DWI, while 24 fistulas (80.0%) were well visualised on T2W. On the DWI, eleven fistulas were either not visible at all (score of 0; number of patients: 6) or weakly visualised (score of 1; number of patients: 5). On the other hand, only two of the fistulas could be seen (scoring one), and four of them were completely obscured from view (score 0). Both of these scores were lower than the visibility scores that were obtained from the combined DWI and T2W examination. The scores that were acquired from the T2W evaluation were not statistically different from the scores that were received from the DWI evaluation (p = 0.14), although this difference was not statistically significant (Table 5).

Table (5): Scores of visibilities for perianal fistulas between T2W and DWI, as well as between T2W and DWI combined

	Visibility of perianal fistulas			P value
	DWI	T2W	Combined T2W and DWI	
score 0 (not visualized)	6 (20.0%)	4 (13.3%)	2 (6.7%)	< 0.001*
score 1 (poorly visualized)	5 (16.7%)	2 (6.7%)	1 (3.3%)	
score 2 (well visualized)	19 (63.3%)	24 (80.0%)	27 (90.0%)	

The abscesses had an ADC value of 0.930.197 100-3 mm²/s, while the perianal fistulas had an ADC value of 1.310.165 10-3 mm²/s. There was a significant difference between the two entities (p 0.001) in terms of the ADC values (Table 7).

Table (7): ADC values between perianal fistulas and abscesses

	Fistula	Abscess	t	P value
Min. – Max.	0.98 – 1.65	0.67 – 1.32	5.053	<0.001*
Mean±S.D.	1.31±0.165	0.93±0.197		

The Sensitivity and specificity of T2W, DWI and combined T2W and DWI showed that DWI had sensitivity of 100% with specificity 26.09% and accuracy of 56.69% while T2W had sensitivity of 17.4% with specificity 100% and accuracy of 63.36% and the combined T2W and DWI had sensitivity of 100% with specificity 0 and accuracy of 70.03% (Table 8).

Table (8): Sensitivity, specificity of T2W, DWI ,and combined T2W and DWI

	Visibility of perianal fistulas		
	DWI	T2W	Combined T2W and DWI
Sensitivity	100	17.4	100
Specificity	26.09	100	0
PPV	29.2	100	100
NPV	100	26.9	25.0
AUC	0.630	0.587	0.543
Accuracy	56.69	63.36	70.03
P value	0.005*	0.031*	0.148

CASES

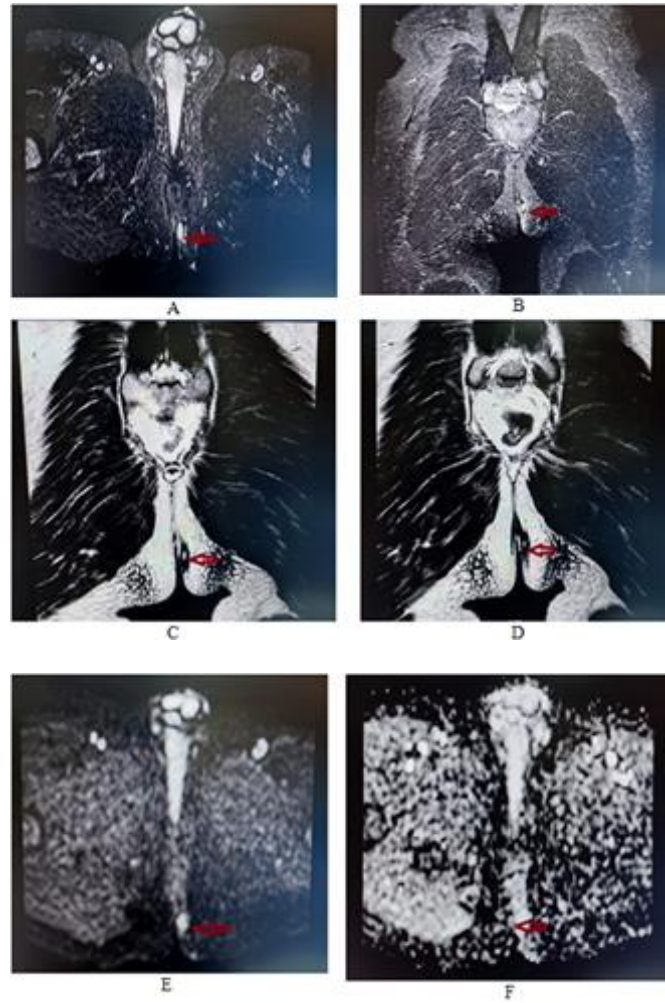
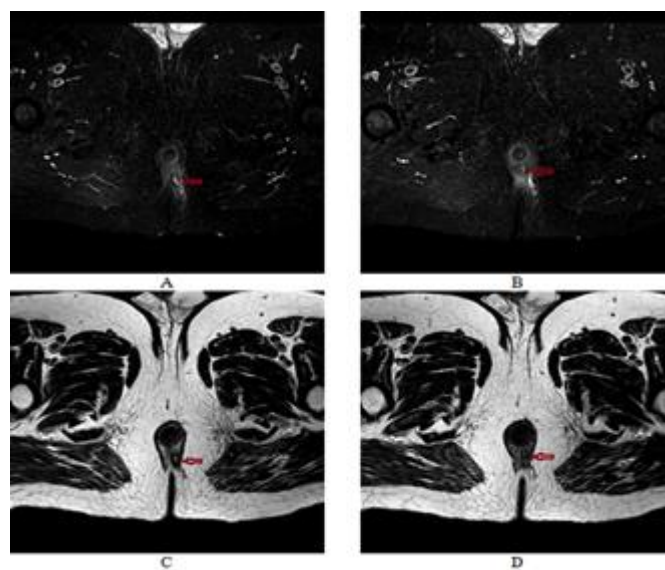


Fig (1): Sinus tract that demonstrate: (A-D) well visualization of the sinus tract on axial STIR and coronal T2 and STIR (red arrow) that showed high signal intensity on T2WI and STIR (Score 2). (E, F) the sinus tract showed restricted diffusion (red arrow), score 2 (well visualized) and ADC value = $1.22 \times 10^{-3} \text{ mm}^2/\text{s}$.



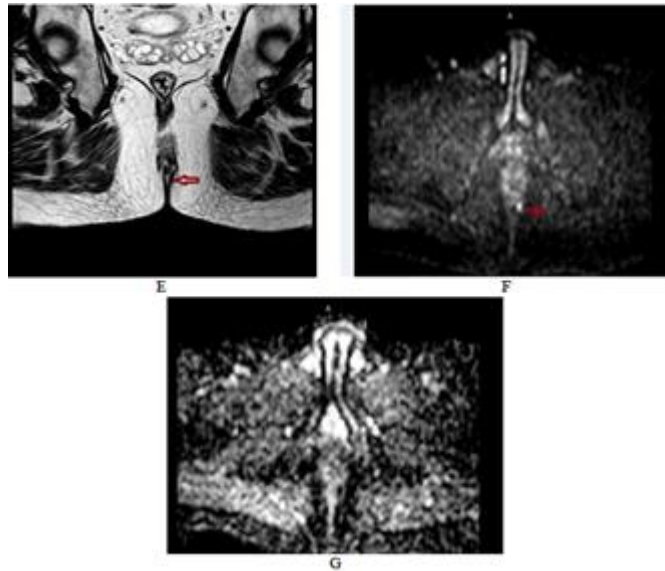


Fig (2): grade 1 intersphincteric fistula that showed (A-E) well visualization of fistulous tract on axial T2, STIR and coronal T2 images (red arrow) that showed high signal intensity on T2WI and STIR (score 2). (F, G) Restricted diffusion of fistulous tract on DWI (red arrow), score 2 (well visualized) and ADC value = $1.31 \times 10^{-3} \text{ mm}^2/\text{s}$.

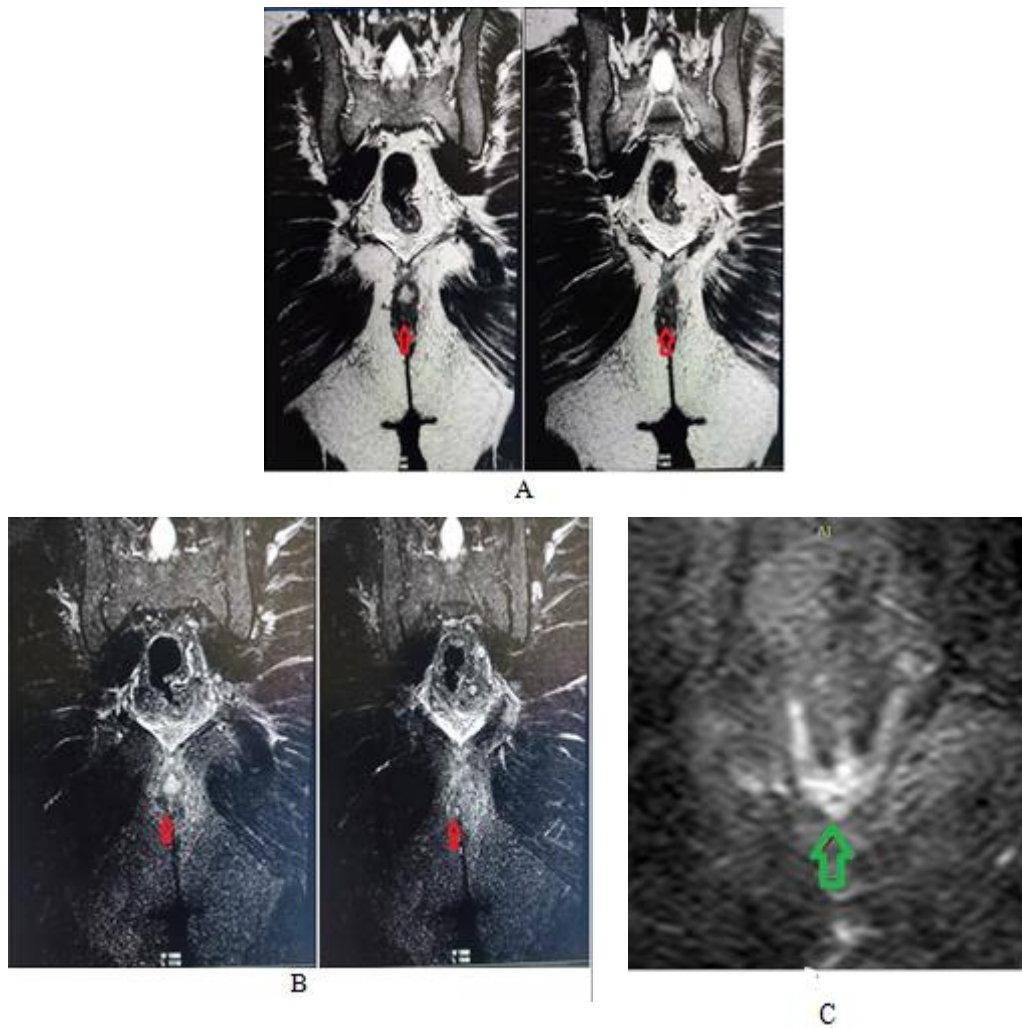


Fig (3): Grade 4 trans-sphincteric fistula with submucosal abscess formation that showed: (A-B) well visualization of fistulous tract on coronal T2 and STIR (red arrow) that showed high signal intensity on T2WI and STIR (Score 2) with fluid collection of high signal intensity in coronal T2 and STIR, seen submucosal and extending to both sides (green arrow). (C) The fluid collection showed restricted diffusion with low ADC value ($0.623 \times 10^{-3} \text{ mm}^2/\text{s}$).

DISCUSSION

It is of the utmost necessity to perform preoperative magnetic resonance imaging (MRI) in order to conduct a comprehensive analysis of the fistulous tract, secondary tracts, ramifications, grade of the fistula, and accompanying abscess in order to prevent complications during surgery. The most reliable method of preoperative imaging for a complete assessment of perianal fistulae is magnetic resonance imaging (MRI) ⁽¹⁰⁾.

It is crucial to undertake a comprehensive evaluation of the fistulous tract using preoperative magnetic resonance imaging. This evaluation should take into account any ramifications or secondary tracts, the grade of the fistula, and any concomitant abscesses (MRI). MRI is the imaging modality of choice for accurate preoperative imaging in the evaluation of perianal fistulae ⁽¹⁰⁾.

This is because MRI is superior to other imaging modalities in many ways. In addition to the traditional fistulogram, other imaging modalities include computed tomography fistulography, endoanal/endorectal ultrasonography, and perianal ultrasonography that are represented here. The superior contrast of MRI with respect to soft tissue and its capacity for multiplanar imaging make it the most suitable. Preoperative magnetic resonance imaging in patients with FIA can reduce the likelihood of recurrence, and change how various fistulae are surgically treated because of its superior soft-tissue contrast and multiplanar capabilities. In patients with fistula in atresia of the aorta, preoperative magnetic resonance imaging (MRI) can improve surgical planning ⁽¹¹⁾.

On diffusion-weighted imaging (DWI), there is a clear contrast between the acute inflammatory process and the normal-appearing tissues that are near to it. This contrast may be detected between the two ⁽⁷⁾. Recent research has demonstrated that DWI offers a high level of both sensitivity and specificity when it comes to making a diagnosis of perianal fistula, as well as for the assessment of fistula activity and the abscesses that can be complicated by it ^(5,7,8). Through the use of diffusion-weighted imaging, it is possible to differentiate between the acute inflammatory process and the adjacent tissues that seem to be normal (DWI).

Yoshizako et al. ⁽⁷⁾ reported that research has shown that DWI offers good sensitivity and specificity for finding perianal fistulas, measuring their activity, and identifying any concomitant abscesses. These are all things that needed to be done in order to diagnose perianal fistulas ^(5,7,8).

The image will have a stronger contrast, if the b-value of the DWI is increased, tissue diffusibility will improve, and there will be less of an influence caused by T2 shine-through. In DWI, a higher b-value is linked

to a lower apparent diffusion coefficient (ADC) value, in addition to a reduced effect of T2 shine-through in perianal fistula and/or concurrent abscess. This is the case because a higher b-value is associated with a smaller amount of apparent diffusion. In DWI pictures, b-values that are higher create a stronger contrast between the perianal fistula or associated abscess and the surrounding tissues, which makes the lesion much simpler to spot. Enhanced contrast, higher tissue diffusibility, and reduced T2 shine-through are just some of the benefits that come with increased b-values in diffusion-weighted imaging (DWI). There is a correlation between an increased b-value in DWI and a lower apparent diffusion coefficient (ADC) value. An elevated b-value in DWI is also connected with a number of other variables in addition to this. The perianal fistula and any accompanying abscess become more noticeable on higher b-value DWI images in comparison with the structures that are close ⁽⁹⁾.

The study revealed that age ranged from 34-76 years with mean value 51.00 ± 12.825 years. Male cases were 21 (70.0%) while female cases were 9 (30.0%). Nine people (30.0%) had a history of prior anal fistula surgery. The majority had fistula (76.7%) and more than half of them the site of fistula was in inter-sphincteric (60.9%), while abscess was detected in 7 patients in the inter-sphincteric region.

More than half of the studied patients had grade 1 when it was classified by St. James's University Hospital classification by DWI (56.7%) or by Combined T2W and DWI (60.05%). There was agreement between St. James's University Hospital's DWI categorization and Grading by Combined T2W and DWI, and the agreement between the two was 89.0%, which is a highly significant level of agreement.

In perianal fistulas, 19 fistulas (63.3%) were well visualised (score 2) on DWI, as opposed to the 24 fistulas that were well visualised (80.0%) on T2W. On DWI, eleven fistulas were either not observed at all (score 0, n = 6), or they were visualised very badly (scoring 1, n = 5). On the other hand, only two of the fistulas could be seen (scoring one), and four of them could not be seen at all (score 0).

Although it was not statistically significant, the visibility scores obtained from T2W were lower than those obtained from DWI ($p = 0.14$), additionally, both of these values were lower than the visibility scores that were derived from the combined DWI and T2W examination.

In comparison with 24 fistulas (80.0%) well seen on T2W, 19 fistulas (63.3%) were well visualised (score 2) on DWI. Eleven fistulas were either not apparent (scoring 0, n = 6) or were only faintly visible (scoring 1, n = 5). These findings were determined by using the DWI. On the other hand, only two of the fistulas on T2W displayed any form of visualisation at all, while

four of the fistulas did not display any form of visibility at all (score 0). There was no statistically significant difference between the two when it came to visibility ($p = 0.14$), despite the fact that the visibility ratings on the combined DWI and T2W evaluation produced lower scores than the T2W visibility ratings did. The ADC values for perianal fistulas were $1.310.165 \times 10^{-3} \text{ mm}^2/\text{s}$, whereas the ADC values for abscesses were $0.930.197 \times 10^{-3} \text{ mm}^2/\text{s}$. There was a significant difference between the two entities ($p 0.001$) in terms of the ADC values.

Based on our findings, we recommend for additional research with a bigger number of participants and across a wider geographic range to substantiate our conclusion.

CONCLUSION

It can be concluded that DWI alone did not provide better visibility of perianal fistulas and abscesses than T2W. Even though the T2W examination found more fistulas than the DWI did, this difference was not statistically significant. The combined DWI and T2W evaluation provided the best result, despite the fact that it was not significantly better than either sequence when it was utilised on its own. We are of the opinion that the DWI charge is more appropriate as a component of the overall MRI investigation and should not be used in place of the T2W sequence.

According to the results of our research, the diagnostic accuracy of DWI is noticeably higher than that of T2-weighted imaging on its own in the diagnosis of perianal fistula. This was the conclusion drawn from our investigation. As a result, it is suggested that DWI be routinely incorporated to the MRI examination of perianal fistula protocol.

DECLARATIONS

- **Consent for Publication:** I confirm that all authors accepted the manuscript for submission
- **Availability of data and material:** Available
- **Competing interests:** None

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