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ORIGINAL ARTICLE

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Magnetic resonance imaging with rectal Gd-DTPA: new tool for the diagnosis of perianal fistula

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Abstract This study investigated the effectiveness of magnetic resonance imaging (MRI) with rectal administration of the enteral contrast agent gadolinium diethylene triamine pentaacetic acid (Gd-DTPA) in the diagnosis of recurrent perianal fistulae, assessing the number, anatomical extent, location, and signal intensities of various lesions. Fistulas were examined by MRI before and after rectal administration of Gd-DTPA in 50 patients (excluding fistulas due to inflammatory bowel disease). Surgical findings were compared with both pre- and postcontrast T1-weighted, T2-weighted, and short T1 inversion recovery (STIR) sequences. Of the 68 fistulous tracts detected surgically, precontrast imaging identified 16 by T1-weighted images (hypointense), 27 by T2-weighted images (hyperintense or iso- to weakly hyperintense), and 54 by STIR. Postcontrast imaging identified 29 by T1-weighted images, 58 by T2-weighted, and 54 by STIR. MRI with rectal administration of Gd-DTPA thus facilitates determination of fistula tracts, which are better resolved by precontrast STIR than by either precontrast T1- or T2-weighted images. Postcontrast T2-weighted images were substantially superior to T1-weighted. Both noncontrast STIR and postcontrast T2-weighted sequences were adequate for classifying fistulas in ano, but in complex recurrent anal fistula postcontrast T2-weighted images were more helpful.

Keywords Perianal fistula · Rectal Gd-DTPA administration · Magnetic resonance imaging

Introduction

Anal fistula is a condition in which recurrences are relatively common. Surgery especially in recurrent fistula in ano is potentially difficult [1, 2,3]. Successful management of anal fistulas depends upon accurate assessment of the entire primary tract and draining any secondary extensions. Since the anatomy of the anal region should be known as well as possible by the surgeon for fine mapping of the fistula tract preoperatively. This type of perianal fistula requires proper imaging techniques especially in recurrent cases before a second intervention [3, 4,5].

Numerous diagnostic methods have been proposed for the preoperative assessment of anal fistulas, such as digital examination under anesthesia [5,6], fistulography [7], endoanal ultrasonography [8], and magnetic resonance imaging (MRI) with various techniques [9,10]. With careful digital examination by an experienced colorectal surgeon, the anatomy of anal fistula can be accurately evaluated in most cases. However, results of this type of assessment may vary from surgeon to surgeon [6]. Another tool is fistulography, in which delineation of fistulous track with water soluble contrast medium are provided, but it has been claimed that the sensitivity and specificity of this technique are not as high as it has been thought at first [7]. Endorectal ultrasonographic examination is unable to assess primary superficial, suprasphincteric, or extrasphincteric tracks or secondary su-

pralevator or infralevator tracks. In addition to this, it has been claimed that this technique overdiagnoses the intersphincteric collection [8]. Although improvements in ultrasonography will occur, to date the technique has not been shown to be any more accurate than digital examination [11]. The results of computed tomography (CT) have proved disappointing. The exact site of pathology in relation to levators on axial CT scans can be inferred only indirectly by the relationship of any abnormality to the piriformis and coccygeus muscles. The levators are not well identified [12] and sphincter resolution is poor. Coronal imaging is rarely possible, and there are many pitfalls in interpreting the images [13]. CT also involves ionizing radiation and the need for contrast media.

MRI has been advocated as the imaging method of choice in assessing anal fistulas, and its use may lead to a reduction in the recurrence rate due to inaccurate surgical assessment. MRI also has some major advantages such as noninvasiveness, multiplanar capabilities, high inherent soft tissue contrast, operator independence, and radiation sparing. MRI can be performed either with or without contrast medium [10]. This prospective study was undertaken to assess the role of MRI with the contrast medium gadolinium diethylene triamine pentaacetic acid (Gd-DTPA) administered as enema for the delineation of anal fistula tract and comparing it with other noncontrast MRI sequences.

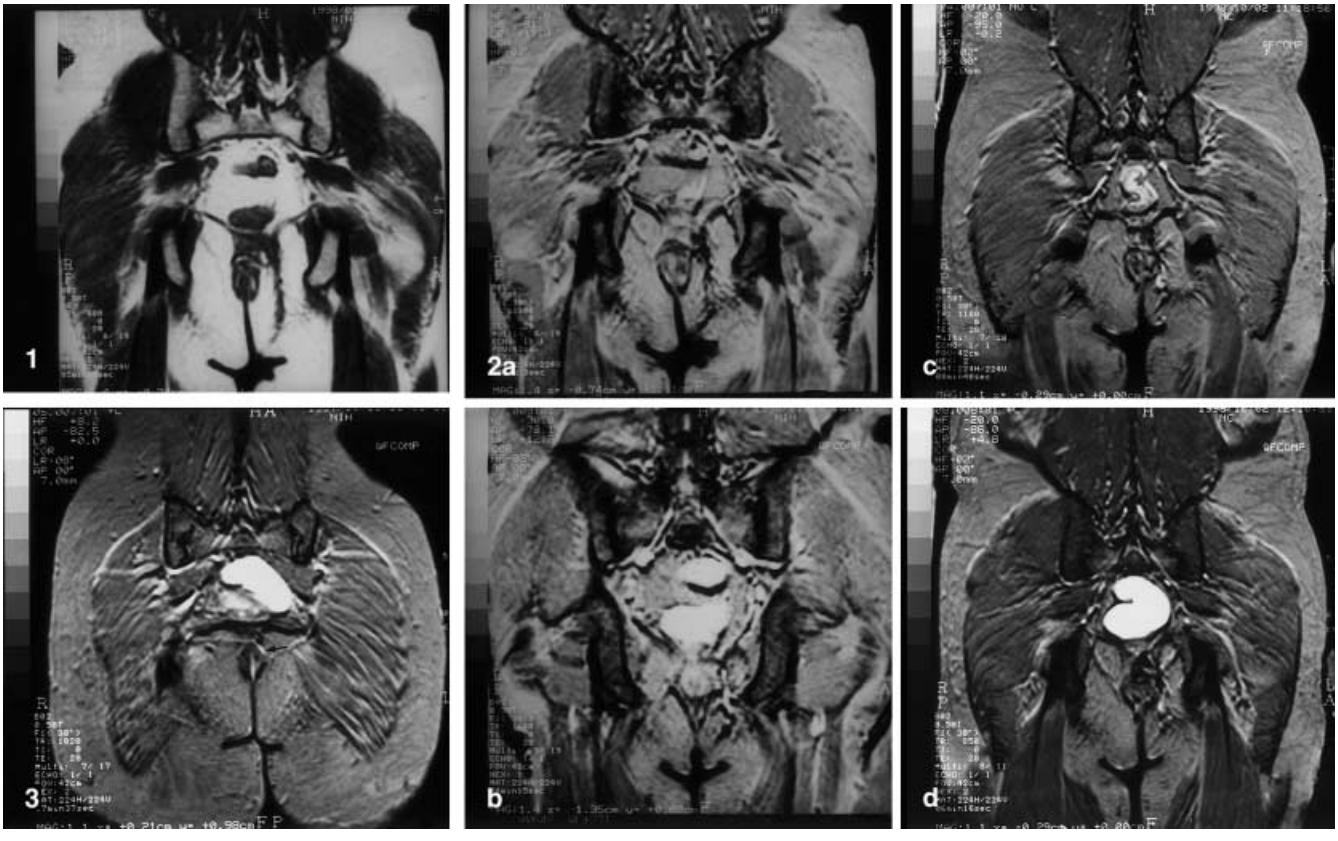
Materials and methods

The local ethics committee approved the study protocol, and all participants provided informed consent before starting the study. Fifty patients admitted with signs of recurrent anal fistula in the outpatient department of general surgery were recruited to this prospective study (44 men, median age 42.3 years, 28–56; 6 women, median age 38.7 years, 24–44). Patients with anal fistula caused by inflammatory bowel diseases such as ulcerative colitis and Crohn's disease were excluded from the study. This is because perianal fistula in ano secondary to inflammatory bowel disease, which is usually associated with sepsis and rectal involvement, should be treated medically first because of the high risk of iatro-

Fig. 1 Coronal pelvic T1-weighted spin-echo precontrast MRI, showing left suprasphincteric fistula tract. The hypointensity of the fistula tract contrasts strongly with the surrounding pelvic fat tissue

Fig. 2 **a** Coronal pelvic T2-weighted gradient-echo precontrast MRI, showing the left suprasphincteric tract. Note the chemical shift artifacts which obscure the fistulous tract. **b** Coronal pelvic T2-weighted postcontrast MRI clearly reveals the tract, high in signal intensity due to the passage of contrast material. **c**,**d** The same patient came 9 months after operation with recurrent anal fistula; the inflamed tract appeared slightly high in signal intensity on T2-weighted pre- (**c**) and postcontrast (**d**) MRI

Fig. 3 Coronal pelvic T2-weighted gradient echo in postcontrast MRI, revealed left intersphincteric fistula tract (*arrow*) which is high in signal intensity (precontrast image showed no difference)



genic sphincter damage following conventional fistula operations. All patients had bowel preparation using Fleet phospho-soda enema before the MRI examination

MRI was performed in a superconductive system operating on 0.5-T MR Max (General Electric, Milwaukee, Wis., USA) using a body coil. The patients were scanned in supine position with an enema tip placed within the anal canal. Of the gastrointestinal paramagnetic positive contrast agent Gd-DTPA (Magnevist enteral, Schering, Berlin) 300–500 ml was introduced rectally, with 100 ml in each vial, also containing 15 g mannitol. The content of each vial was diluted with 900 ml tap water in an enema bag used in all patients. Contrast medium was given rectally through a connecting tube to an enema bag hanging outside the magnet. A single radiologist blinded to the clinical findings read pre- and postcontrast images. The following criteria were considered: (a) Diagnostic information in precontrast MRI – considered informative if the fistula tract was seen, and noninformative if the tract was not seen; (b) general contrast effect in postcontrast images – considered sufficient when the contrast passage within the fistula tract was seen, and insufficient when the contrast not visualized. Intravenous hyocine *n*-buthylin (20 mg) was given before starting radiological examination, and repeated doses were used as indicated to reduce motional artifacts produced by intestinal peristalsis.

The sequences obtained were T1-weighted spin-echo (TR: 680/TE: 20), T2-weighted gradient-echo (TR: 1100–1440/TE: 28/FA: 30°) and short T1 inversion recovery (STIR) images (TR: 2700 ms/time to inversion T1: 100/TE: 30 ms), both before and after the administration of contrast medium. Coronal and axial planes 7 mm thick, with matrix size 224×224, and field of view 40 cm were imaged. Average total examination time was 45 min. The surgeons were blinded to the findings of MRI before the operation. All patients were operated on by one of the surgeons, and minimum follow-up period after the operation was 19 months (14–23). Only one recurrence was recorded during the follow-up time.

The χ^2 test with Yates' continuity correction was used in comparing the diagnostic findings in pre- and postcontrast T1- and T2-weighted images. The χ^2 test was also used to study the differences between precontrast T1-weighted, T2-weighted, and STIR sequences, on the one hand, and between postcontrast T1- and T2-weighted sequences, on the other. It should be noted that because no negative findings were detected surgically, use of the κ statistic would not have been suitable.

Results

In the 50 patients we diagnosed 68 fistula tracts; according to the Park and Kennedy classification [11] these were categorized as intersphincteric, transsphincteric, suprasphincteric, or extrasphincteric. Precontrast T1-weighted images identified 16 tracts as hypointense (Fig. 1), while the other 52 were not seen (Table 1). The contrast effect in T1-weighted images was considered sufficient in 29 fistula tracts appearing as hyperintense, while in 39 it was not. Precontrast T2-weighted images identified 27 fistula tracts (Fig. 2a), 17 of which were seen as hyperintense and 10 as iso- to mildly hyperintense; the other 41 fistula tract were not seen. Postcontrast T2-weighted images identified as the hyperintense in 58 fistula tracts (Figs. 2b, 3, 4a) while 10 fistula tracts were not seen and were thus recorded as insufficient (Table 2). Precontrast STIR images correctly identified the fistula tract in 54 cases as a hyperintense lesion (Fig. 4b) while 14 fistula tracts could not be seen. It was

Table 1 Comparison of T1-weighted pre- and postcontrast sequences of perianal fistulas

Tract	T1 precontrast		T1 postcontrast		Surgical findings
	Informative	Not informative	Sufficient	Insufficient	
Intersphincteric	4	14	7	11	18
Transsphincteric	6	18	10	14	24
Suprasphincteric	4	12	7	9	16
Extrasphincteric	2	8	5	5	10
Total	16	52	29	39	68

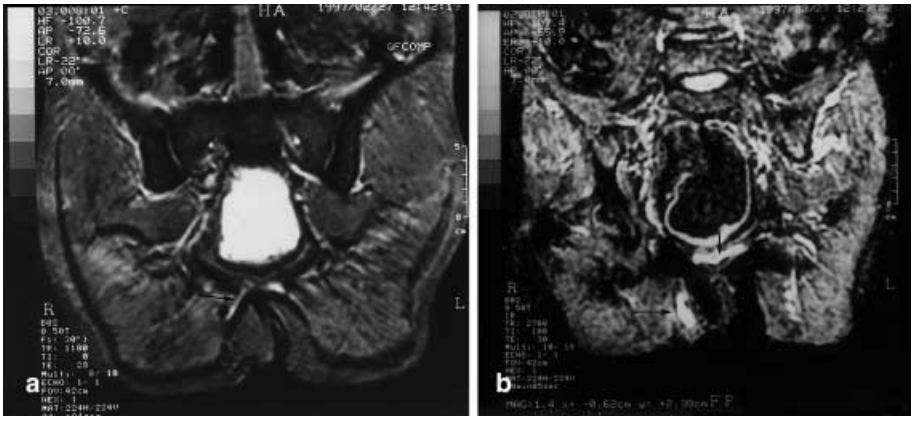


Fig. 4 Coronal pelvic T2-weighted gradient-echo postcontrast image (**a**) and precontrast STIR image (**b**) showing a right extrasphincteric fistula (*long arrow*) secondary to right transphincteric fistula tract (*small arrow*)

Table 2 Comparison of T2-weighted pre- and postcontrast of anal fistulas

Tract	T2 precontrast		T2 postcontrast		Surgical findings
	Informative	Not informative	Sufficient	Insufficient	
Intersphincteric	8	10	14	4	18
Transsphincteric	9	15	21	3	24
Suprasphincteric	5	11	14	24	16
Extrasphincteric	5	5	9	1	10
Total	27	41	58	10	68

not possible to assess the contrast effect in the whole postcontrast STIR images.

A significant gain was founded in the diagnostic accuracy using contrast in T1-weighted sequences (P=0.0287, Yates' continuity test). Because of the small samples that each fistula type contained, the results were less marked than when studying the total number. Using the same test, a very significant difference was found in comparing the diagnostic findings in pre- and postcontrast T2-weighted images (P=0.0000001). Due to the small samples in extrasphincteric group, Fisher's test was used in this group both in pre- and postcontrast T1-weighted and T2-weighted sequences, where the analysis also showed a significant difference (P>0.05).

A strong difference was found between the three precontrast sequences (P<0.0000006, χ^2). Moreover, there was a strong statistical difference between postcontrast T1- and T2-weighted results (P=0.0000006)

Discussion

Because the first operation is the best chance of cure, the anatomy of the fistula tract and its secondary extensions must be defined precisely prior to surgery [4]. MRI has been proposed as the best diagnostic tool in the preoperative assessment of fistula tracts [9, 14,15]. This can delineate the relationship between the rectum and the important surrounding structures such as puborectalis and levator ani muscles, which is important both in mapping the fistula tract and in deciding the type of surgical procedure [16, 17,18]. MRI can be performed either with or without contrast material, which is administered either intravenously or rectally [19, 20, 21,22], but it has been reported that the extent of fistula and secondary extensions is better delineated on dynamic contrast-enhanced images [23,24]. Numerous other types of enteral contrast agents have been proposed for increasing the sensitivity of MRI, including saline, peanut oil, milk, and finally Gd-DTPA [25, 26, 27,28]. We prefer Gd-DTPA as it has better specifications than other proposed agents.

Precontrast T1-weighted images identified only 16 of the 68 fistula tracts as hypointense (Fig. 1), and postcontrast images 29. Precontrast T2-weighted images identified 27 of the 68 fistulae (17 as hyperintense, Fig. 2c; 10 as iso- to mildly hyperintense). Tissot et al. [29] explained the tract's hyperintensity on T2-weighted sequences by its fluid contents; when these tracts contain only inflammatory tissue, they appear as iso- or weakly hyperintense. Rectal Gd-DTPA helped to delineate 58 fistula tracts on T2-weighted images, and these were therefore recorded as sufficient (Fig. 2b). This can be explained by the fact that the surrounding fat planes have low signal intensity appearance on T2-weighted image. As there are many fatty tissues in the pelvic region, T2-weighted images provided sufficiently high contrast between Gd-DTPA and fat [30] (Figs. 3, 4a).

Precontrast STIR images also revealed very clear findings (Table 3), which matched the surgical results. The fistula tract in STIR sequences appeared high in signal intensity (Fig. 4b) since the STIR images can minimize the signal from fat and highlights pus and granulation tissue [31]. Halligan et al. [32] concluded that STIR-based classification of fistula in ano is easier due to superior resolution of pelvic floor structures. They seldom fail to visualize inflammation in the tract, which helps in determining fistula anatomy. In STIR images the administration of contrast medium added no information over that obtained from precontrast sequences.

We prefer conventional body coil imaging because it field-of-view limitations are reported to make endoanal imaging less accurate than conventional body coil imag-

Table 3 Comparison of pre- and postcontrast STIR images in anal fistulas (*NS* nonsignificant contrast effect in fistula tract over that already seen as hyperintense before contrast administration)

Tract	STIR precontrast		STIR postcontrast	Surgical findings
	Informative	Not informative		
Intersphincteric	16	2	NS	18
Transsphincteric	20	4	NS	24
Suprasphincteric	10	6	NS	16
Extrasphincteric	8	2	NS	10

ing in the preoperative assessment of complex anal fistulas [33]. The rectally introduced Gd-DTPA caused some discomfort in four patients (8%) who had septic and inflamed fistulas. Nevertheless, all patients proved able to cope and complete the study.

Conclusion

This study showed that MRI with enteral Gd-DTPA is helpful when the findings of clinical examination are confusing or uncertain and in cases of complex recurrent anal fistulas where anal and fistula opacification may provide an additional understanding of vulnerable perineal anatomy. Postcontrast T2, and precontrast STIR sequences showed good results and discriminated between different patterns of lesions. Postcontrast T2-weighted images were superior to postcontrast T1-weighted images. This is explained by the fact that rectally introduced Gd-DTPA produces a shortening in T1 relaxation time, which increases signal within the bowel on T1-weighted images. However, when the contrast passes through the fistula tracts, which are relatively tiny and surrounded by fatty tissue in the pelvic area, the contrast effect between the hyperintense contrast agent and fat becomes minimal. The contrast effect was found to be more pronounced on T2-weighted sequences. There were some limitations in imaging technique such as large field of view, small matrix, and pixel size. Nevertheless, with the use of more recent instruments and modified sequences such as fat suppression with rectal Gd-DTPA it may improve the detectability of lesions especially in chronic recurrent cases.

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