Purpose: To assess the value of the combination of contrast enhanced T1 spoiled gradient (SPGR) MR and maximum intensity projection (MIP) MR imaging in the complete pre-operative evaluation of peri-anal fistula.

Patients and methods: This prospective study contained 28 patients with clinical diagnosis of peri-anal fistula, they were performed MRI using the following sequences in both axial and coronal planes: Pre contrast T2FSE, T1FSE and Post contrast SPGR. MIP reformated images were done using the SPGR sequence. Fistulas were classified according to Parks (6) classification, they were evaluated regarding site, type, extensions, complications and diagnostic accuracy of each sequence. Our findings were correlated with operative findings.

Results: Fourteen patients had inter-sphincteric fistulas (50%), 8 patients had trans-sphincteric fistulas (28.6%) and 6 patients had supra-sphincteric fistulas (21.4%). Simple non branching tracts were found in 22 patients, branching tracts in 6 patients, abscess cavity in 5 patients, horseshoe extension in 4 patients. Overall diagnostic accuracy of post contrast T1 SPGR was 97.3% and MIP MR imaging was 100%. Post contrast T1 SPGR accurately evaluated all patients but missed one faint horseshoe extension and other fine para anal branches. MIP imaging accurately evaluated all the extensions and ramifications but was poor in depth orientation.

Keywords: MRI of peri-anal fistula; Post contrast MRI of fistula in ano; MIP imaging in peri-anal fistula

Abbreviations: EAS, external anal sphincter; EUA, examination under anesthesia; FSE, fast spin echo; SPGR, spoiled gradient; IAS, Internal anal sphincter; MIP, maximum intensity projection.

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Value of contrast enhanced spoiled gradient (SPGR) MR and MIP MR imaging in diagnosis of peri-anal fistula

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1. Introduction

Idiopathic perianal-fistulas result from anal gland sepsis located at the dentate line in the mid anal canal. However, peri-anal fistulas may also be caused by other conditions and events, including Crohn’s disease, tuberculosis, trauma during childbirth, pelvic infection, pelvic malignancy, and radiation therapy (1–5). Infection can penetrate the internal sphincter to lie in the intersphincteric plane, tracking downward to the peri-anal skin in 70% of patients, alternatively, infection may pass through both layers of the anal sphincter to reach the ischio-anal fossa and, eventually, the peri-anal skin (trans-sphincteric fistulization) in 25%. In other cases, infection tracks upward over the levator muscle to reach above the levator plane and then penetrate inferiorly through the ischio-anal fossa (suprasphincteric fistulization) in 5%. Sepsis arising within the pelvis may track down to the skin through the ischio-rectal fossa, resulting in fistulas that are referred to as extrasphincteric in less than 1%. Abscess cavities may develop along the course of fistulous tracts (6–10).

Imaging of peri-anal fistula done previously by fistulography is unreliable and difficult to interpret. Because the sphincter complex and levator ani sling are not directly visualized and secondary fistulous tracks often fail to fill with contrast material. Anal endosonography has proved inferior to expert clinical assessment. The sphincter mechanism and intersphincteric plane are usually well visualized with endosonography, but the external sphincter can be difficult to assess in some individuals. In addition, infection cannot be distinguished from fibrosis and insufficient depth penetration results in a failure to identify secondary ramifications and more distant sepsis (11–13). In computed tomography, performed with rectally and intravenously administered contrast media, the attenuation values for the sphincters, levator ani, fibrotic fistulous tracks, and active fistulas are so similar that it is difficult to characterize these structures accurately, unless the track contains gas or leaked contrast material (11–10).

MRI has become the method of choice for evaluating perianal fistulas due to its ability to display the anatomy of the sphincter muscles orthogonally. The MR imaging appearance of this condition shows greater concordance with surgical findings than does any other imaging evaluation. Infection tracks upward over the levator muscle to reach above the levator plane and then penetrate inferiorly through the ischio-anal fossa (suprasphincteric fistulization) in 5%. Sepsis arising within the pelvis may track down to the skin through the ischio-rectal fossa, resulting in fistulas that are referred to as extrasphincteric in less than 1%. Abscess cavities may develop along the course of fistulous tracts (6–10).

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1.1. Aim of the work

The aim was to assess the value of the combination of contrast enhanced T1 spoiled gradient (SPGR) MR and MIP MR imaging in the complete pre-operative evaluation of peri-anal fistula.

2. Patients and methods

Our prospective study was conducted at a private center in Mansoura, Egypt from the period of June 2010 till December 2011. It contained 28 patients (21 males and 7 females), their age ranged from 28 to 50 years with a mean age of 39 years, all referred from surgical clinic of Mansoura University hospital to perform MRI, they were initially diagnosed by the surgeon to have peri-anal fistula or abscess by clinical examinations. Patients’ complaints were local pain ± discharge. No history of diabetes mellitus or recurrent perianal fistula or pelvic diseases was found. Fistulas were classified anatomically according to Parks et al (6) classification: inter-sphincteric, trans-sphincteric and supra-sphincteric fistulas. Location of internal opening was determined in axial images with respect to the clock face with 12 o’clock being directed anterior.

All patients performed MRI using GE 1.5 Tesla medical system with a phased array body coil. Patients were placed in a supine head-first position with the coil centered on the hip joints. No bowel preparation or catherization of the anal canal or fistulas was required.

Sequences used were: pre contrast: axial, coronal T2FSE/ 
TI FSE, post contrast: axial and coronal T1 SPGR. All images were done with fat suppression. MIP reformatted algorithms were done using the SPGR sequence. Oblique coronal images were obtained parallel to the anal canal, and axial images were obtained perpendicular to the coronal plane.

2.2. Parameters used

2.2.1. Axial and coronal T2 FSE
2.2.2. Axial and coronal T1 FSE
TR/TE: 480–600/9.5, FOV: 26 × 26, NEX: 2, matrix: 320 × 224, slice thickness: 5 mm, time: 1.40 min.

2.2.3. Contrast enhanced axial and coronal T1 SPGR
TR/TE: 410–460/3, FOV: 26 × 26, NEX: 2, matrix: 512 × 192, slice thickness: 4–5 mm, time: 2.30 min. Dose of I.V. Gadolinium was: 0.1 mmol/kg body, injected automatically at a rate of 1 mL/s.

Post contrast MIP reformat in axial, coronal and oblique projections, time: 2.30 min.

Images covered the levator muscle, the anal canal, the sphincter muscles, the ischio-rectal fossa, and the pelvis to evaluate the presence of supralevator extension.

MRI findings were correlated with the surgical results and exploration.

Written consent was obtained from our patients. Approval of the ethics committee was taken.

2.3. Image analysis

In each case, careful evaluation of the following data was made: type of the fistula according to the Parks classification: intersphincteric, transsphincteric, suprasphincteric and extraspincteric, the radial site and location of the internal opening (defined as either the continuation of the primary tract itself into the anal mucosa or the site closest to the maximal inflammation found in the intersphincteric region), fistulous tract whether simple or branching, abscess formation, possible secondary tracts, possible supralevator extension, horseshoe tracts (crossing the midline), distance between the internal opening and anal verge.

3. Results

Our study contained 28 patients (21 males, 7 females) with their age ranging from 28 to 50 years with a mean age of 39 years. Fourteen patients had intersphincteric fistulas (Figs. 1, 8) with transspinhincteric and 6 had suprasphincteric fistulas (Figs. 3 and 4). All patients had active fistulous tract (containing fluid inside). Twenty-two patients showed non branching fistulas (inter and transspinhincteric) while 6 patients showed branching fistulas (trans and supra sphincteric). Five patients showed para anal abscess. Four patients showed horseshoe tract, these findings were shown in Table 1.

T2 FSE with fat suppression revealed simple non branching tract in 20 patients (out of 22), revealed 4 patients with branching tracts (out of 6). It detected the internal opening in 25 patients (out of 28), horseshoe extension in 2 patients (out of 4), supra levator extension in 4 patients (out of 6). It successfully detected all patients with para anal abscess (5).

Post contrast T1 SPGR revealed simple non branching tract in all the 22 patients, revealed 5 patients with branching tracts (out of 6). It detected the internal opening in all the 28 patients, horseshoe extension in 3 patients (out of 4), supra levator extension in all the 6 patients. It successfully detected all patients with para anal abscess (5).

Post contrast MIP reformat revealed simple non branching tract in all the 22 patients, revealed all the 6 patients with branching tracts. It detected the internal opening in all the 28 patients horseshoe extension in all the 4 patients, supra levator extension in all the 6 patients. It successfully detected all patients with para anal abscess (5).

Overall, diagnostic accuracy of T2 FSE was: 84.9%, post contrast T1 SPGR was: 97.3%, post contrast MIP imaging was: 100%. These findings are shown in (Table 2).

4. Discussion

The aim of surgical treatment of peri-anal fistulas is to treat the patient’s symptoms, with low recurrence rates and risk of incontinence. The anal canal is 2.5–4 cm long. The dentate line (histologic junction between anal squamous epithelium and rectal columnar epithelium) runs underneath the anal valves. Correct anatomical mapping of fistulas and potential peri-anal suppuration, secondary extensions and relationship to the pelvic floor, sphincters and adjacent peri-rectal structures is of paramount importance for treatment decisions and surgery planning (17,18).

External anal sphincter is striated muscle (is the continuation of the pelvic floor musculature) appears on MRI as hypointense signal on T1WI, T2WI, and fat suppressed T2WI. Internal sphincter is smooth muscle (is the continuation of the inner circular muscle layer of the lower rectum) appears hypointense on T1WI, T2WI, and relatively hyperintense on fat suppressed T2WI, shows enhancement in post contrast study. The pubo-rectalis ring is thickening of the superior fibers of EAS, merges superiority with levator plate (19,20).

Low peri-anal fistulas are defined as fistulas of which the fistula tract is located in the lower third of the external anal sphincter. High fistulas are fistulas in which the fistula tract runs through the upper two-thirds of the external sphincter muscle. Low peri-anal fistulas can be treated safely by fistulotomy. At present, rectal advancement is the gold standard for the surgical treatment of high trans sphincteric peri-anal fistulas (21,22).

Investigators in a large study in which endo-anal MRI was compared with body coil MRI found a surgical concordance rate of 68% for endo-anal MRI as compared to 96% for body coil MRI because endoluminal coils are susceptible to motion artifact, has limited field of view (about 2–3 cm from the coil) missing distant extensions, sometimes difficult to place owing to anal stenosis or local pain as a result of extensive infection and expensive tools [single use] (23–24), in our study, body coil MRI with different sequences successfully detected all fistulous tracts and extensions.

The exact location of the internal opening can be difficult to define, whatever the imaging modality used. Two questions need to be answered. What is the radial site, and what is its level? The vast majority of anal fistulas open into the anal canal at the level of the dentate line. Furthermore, most fistulas also enter posteriorly, around the 6-o’clock position (4). In our study, T2FSE accurately detected the internal opening in 25 patients. Post contrast T1 SPGR and MIP images detected the internal opening in all the 28 patients, they were located approximately at the dentate line, half of them around 6 o’clock (Figs. 3–5), other half in other different sites (Figs. 1 and 2).

The commonest type of extension is one that arises from the apex of a transspinhincteric tract and extends into the roof of the ischioanal fossa. The major benefit of MR imaging findings is...
that they can alert the surgeon to extensions that would otherwise be missed. It is also important to search for supralevator extensions since these are not only difficult to detect but pose specific problems with regard to treatment. In the contrast study, the internal sphincter muscle enhances to a higher degree than the external sphincter muscle. Therefore, the delineation of intersphincteric fistulous tracts and horseshoe extensions in the intersphincteric space may be improved (21,22). In our study, SPGR and MIP images accurately detected all the 6 patients with supralevator extensions. T2FSE detected 4 patients (Figs. 3 and 4).

Horseshoe extensions spread across both sides of the internal opening and are recognized on MR images by their unique configuration. Horseshoe extensions may be intersphincteric, ischio-anal, or supralevator. Complex extensions are especially common in patients with recurrent fistula in ano or in those who have Crohn’s disease (24–27). Our study revealed 4 patients with horseshoe extension, all detected by MIP imaging, while post contrast SPGR and T2FSE revealed 3 and 2 patients, respectively (Figs. 2 and 5).

Active tracts are filled with pus and granulation tissue and, thus, appear as hyperintense longitudinal structures on T2-weighted images, active granulation tissue will enhance while fluid in the tract itself remains hypointense. Active tracts are often surrounded by hypointense fibrous walls, which can be relatively thick, especially in patients with recurrent disease and previous surgery. Occasionally, some hyperintensity in this fibrous area may be seen, probably reflecting edema. Hyperintensity may also extend beyond the tract and its fibrous sleeve, where it represents adjacent inflammation (24–27). Post contrast SPGR and MIP images in our study clearly depicted the fibrous tract, internal fluid and surrounding edema.

Abscess cavities may develop along the course of fistulous tracks. Characteristically, the abscesses associated with intersphincteric fistulas are peri-anal or indeed encysted within the intersphincteric space. Trans sphincteric fistulas are typically associated with ischiorectal fossa abscesses.

Intersphincteric abscesses and secondary fistulous tracks are well shown by dynamic contrast-enhanced MR imaging. On these contrast-enhanced images, the pus in the central cavity has low signal intensity and is surrounded by a brightly enhancing rim (2). In our study, abscess cavities were correctly identified using the three sequences: T2FSE, post contrast SPGR and MIP imaging (Figs. 2 and 4).
Fig. 2 (A–H). Patient with RT trans-sphincteric peri-anal fistula and abscess formation (Park type II). (A and B) Axial and coronal T2 FSE respectively showing faint RT trans-sphincteric fistula extending to peri-anal fat (arrow) with abscess formation (arrow head). (C–F) post contrast axial (C,D: from superior to inferior) and coronal (E,F: from posterior to anterior) T1 SPGR clearly showing fistulous tract with internal opening at 12 o’clock (arrow), fistulous tract (arrow head) and abscess formation (curved arrow). Note no supra levator extension. (G,H) Axial and coronal MIP imaging clearly depicts the fistulous tract extensions and ramifications.
The spoiled gradient recalled acquisition in the steady state (SPGR) method is characterized by faster acquisition, which minimizes artifacts from motion and vascular pulsation. It also gives better soft tissue contrast. Furthermore, SPGR can be performed with 1-mm thin sections, a theoretical advantage when attempting to detect small lesions (25). In our study post contrast SPGR with its better soft tissue contrast gave 97.3% diagnostic accuracy regarding full evaluation of perianal fistula, it successfully detected all cases of non branching tract, internal opening, para anal abscess and supra levator extension. It missed few fine branches (at the ischioanal fossa) of one patient and fine horseshoe branches in another patient.

Maximum Intensity Projection (MIP) is a technique used to visualize high-intensity structures within volumetric data. Although the MIP algorithm is sensitive to high signal from inflowing spins, it is also sensitive to high signal of any other etiology. It should be combined with other sequences as it lacks depth orientations. Three-dimensional gradient-echo imaging offers the possibility of image reconstruction like MPR and MIP, providing additional information from one data set (19). In our study MIP images gave 100% diagnostic accuracy regarding full evaluation of perianal fistula. The problem of depth orientation insufficiency can be countered by the combination with SPGR images.

Fig. 3  (A–I). Patient with RT supra-sphincteric fistula with horseshoe extension (Park type III). (A–C) Axial (A), coronal (B and C) T2FSE images showing RT peri-anal fistulous tract extending to the RT. Ischio-anal fossa. (D–F) Post contrast axial T1 SPGR showing internal opening at 5 o’clock (arrow), horse shoe extension of the fistulous tract around the anal canal posteriorly (arrow heads). (F and G) Post contrast coronal T1 SPGR showing RT supra levator extension(arrow), thick fistulous tract and RT ischio-anal fossa inflammation. Note thickened RT.levator ani muscle. (H and I) Axial, coronal MIP imaging clearly showing the horse shoe extension, congested RT pelvic veins (arrow head) and RT. supra levator extension (arrow).
MR fistulography subtracted images means visualization of fistulas as high-signal tubular structures containing varying degrees of low-signal fluid. The surrounding fat appeared dark because of the associated fat suppression technique. Because of the 3D data set, multiplanar reconstruction (MPR) and maximum intensity projection (MIP), generate an image impression similar to fistulography (3,21,22), in our study, we used MIP images to visualize the extensions due to their high sensitivity but without subtraction to avoid anatomical disorientation.

Magnetic resonance imaging (MRI) has become an integral part of the assessment of fistula as it can distinguish between sepsis and granulation tissue from sphincter muscles (28). A prospective study compared the preoperative MRI assessment

Fig. 4  (A–J) Patient with RT supra-sphenetic fistula with large para anal abscess (Park type III). (A and B) Axial and coronal T2FSE showing large RT. Para anal abscess. (C–E) Post contrast axial T1 SPGR from superior to inferior showing large RT. Para anal abscess, internal opening at 6 o’clock (arrow). (F–H) Post contrast coronal T1 SPGR from posterior to anterior showing large RT. Para anal abscess with mild supra levator extension (arrow). Note thickened RT levator ani muscle. (I and J) Axial and coronal MIP imaging showing the exact location of internal opening (at 6 o’clock, arrow). Note dirty RT para rectal fat above the levator ani muscles (arrow heads).
Fig. 5  (A–H) Patient with RT trans-sphincteric fistula with small horseshoe extension evident on MIP images not SPGR images (Park type III). (A and B) Axial and coronal T2FSE showing RT. Trans-sphincteric fistula extending to RT ischio-anal fossa. (C and D) Post contrast axial T1 SPGR showing internal opening at 6 o’clock (arrow) with caudal abscess formation. (E and F) Post contrast coronal T1 SPGR showing branching fistulous tract with no supra levator extension (arrow). (G and H) Axial and coronal MIP imaging showing small horseshoe extension of the fistula tract to LT side (crossing mid line, arrow). MIP images clearly visualize fistulous tract and extensions.
of the anal fistula and intra-operative findings. High concordance rates were reported in terms of recognizing the course of primary tracks [86%], demonstrating secondary tracks [91%], and horseshoe extension [97%], as well as identifying internal opening [80%] (29).

In their study, John A. Spencer et al. (30) stated that for the diagnosis of seven surgically confirmed cases of horseshoe tracks, STIR imaging had a specificity of 100% and a sensitivity of 71%, compared with dynamic contrast-enhanced MR imaging which had a sensitivity and a specificity of 100%.

Beckingham et al. (31) in their study reported MR sensitivity of 97%, specificity of 100% in detection of fistula in ano. Buchanan et al. (32) showed that fistula surgery guided by MRI can reduce anal fistula recurrence by 75%. Moreover, recurrence in patients with discordant findings by MRI and EUA, respectively, was always at the site identified by MRI, suggesting that surgery based on MRI would have prevented recurrence.

Our study revealed MR diagnostic accuracy for post contrast SPGR and MIP images (for detection of peri-anal fistula compared to surgical findings) 97.3% and 100% respectively.

Limitations of our study are the lack of the 4th fistula type presentation (extra sphincteric) as there were no patients with primary pelvic diseases were found in our study. Larger patients group probably would represent all the fistula types.

5. Conclusion

MRI is a reliable diagnostic modality in the evaluation of perianal fistulas. Post contrast T1 SPGR sequence with its high resolution images and excellent anatomical orientation provides almost all the necessary details for accurate evaluation. Although MIP images lack depth orientation but its high sensitivity, rotational 2D and 3D capabilities exquisitely depict all the fine ramifications and extensions. The combination of both provides complete evaluation and highest possible diagnostic accuracy aiding successful surgical interventions, aiming to reduce complications and recurrences.

References


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<td>Para anal abscess (5)</td>
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* Reformated from post contrast T1 SPGR.


(19) Yıldırım Nalan, Gökalp Gökhan, Öztürk Ersin, Zorluoğlu Abdullah, Yılmazlar Tuncay, Ercan İlker, Savel İdeal Gürsel. Combination of MRI sequences for perianal fistula classification and the evaluation of additional findings for readers with varying levels of experience. Turk Soc Radiol 2011.


