Manuscript title: The accuracy of MRI in classification of perianal fistulae

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ABSTRACT:
Introduction: Ano-rectal fistulas are chronic inflammations of perianal tissues with a connection between the skin of the perineum and the anal canal. Anal fistula affects roughly 10 persons in 100,000. MRI plays an important role in the preoperative evaluation of the ano-rectal fistulas as it allows identification of the infected tracts its grading, associated finding like abscess, secondary tract, internal opening and anatomic descriptions of the relationship between the fistula and the anal sphincter complex.
Aim: Aim our study isto describe the MRI findings in perianal fistula and validate MRI findings in terms of its sensitivity, specificity, diagnostic accuracy.
Material and methods: Our study comprising of 55 patients who presented clinically with complains of peri anal fistula, has underwent MRI of gluteal region. MRI findings of fistulae were compared with post-operativesurgical findings.
Result: Our study reveals high diagnostic accuracy of MRI in diagnosis of inter sphincteric (92.7%), trans sphincteric (89.09%), supra levator (96.36%) fistulae, secondary tract (94.5%), abscess (96.36%) and for horseshoe extension (100%).
Conclusion: High sensitivity and specificity of MRI findings were recorded in the present study for the assessment of surgically important parameters (primary tract, internal opening, secondary tract, abscess and horseshoeing) of perianal fistulae comparing with the operative observations. In conclusion, the role of imaging is very important for surgeon to prevent unintentional damage to the anal sphincter, which can lead to anal incontinence.
Key word: MRI-Magnetic Resonance Imaging, Perianal fistulae, horseshoe shape, anal sphincter**.**

I. INTRODUCTIONS:

Ano-rectal fistulas are chronic inflammations of perianal tissues with a connection between the skin of the perineum and the anal canal. Anal fistula affects roughly 10 persons in 100,000[1]. Perianal fistulae commonly occur in middle-aged men and Men are three times more likely to be affected than women, due to the higher abundance of anal glands. The most common presenting symptom is discharge (65% of cases), but local pain due to inflammation is also common. The disease usually begins as an abscess and later on develops into a fistula in about 60% of the cases.[2] Other established etiologies include trauma during childbirth, malignancies several inflammatory conditions and events, including Crohn's disease, pelvic infection, tuberculosis, diverticulitis, trauma during childbirth, pelvic malignancy, and radiation therapy. However, even with meticulous clinical examination and seemingly adequate surgery, there was significantly high rate of recurrence. The need for revision of the diagnostic methods and treatment planning was felt with the increasing knowledge of inadequate treatment response in most patients. Hence, radiological imaging was introduced in the management of perianal fistulas. Recurrence is one of the most important problems following surgery, so identification of the extensions of the ano-rectal fistula with proper imaging methods decreases the percentage of its recurrence.The magnetic resonance imaging (MRI) plays an important role in the preoperative evaluation of the ano-rectal fistulas as it allows identification of the infected tracts and abscesses as well as detailed anatomic descriptions of the relationship between the fistula and the anal sphincter complex.There are two main classification systems for ano-rectal fistula; the classification proposed by Parks et al.[3] in 1976, which was created for surgical use, and the St. James University Hospital classification, which was developed based on an MRI examination.[4]The role of imaging is very important to outline all hidden tracts and define the relationship of the fistula to the anal sphincter so the unintentional damage to the anal sphincter, which can lead to anal incontinence can be easily avoided.With an aim to help the patients and reduce the post-operative complications we intend to study the role

of MRI in preoperative assessment of ano-rectal fistula by tracing its full extent and relationship to the sphincter complex, using different MRI sequences.

Aims and objectives:
Primary objectives of our study are to describe the MRI findings in perianal fistulae in terms of its grading, associated finding like abscess, secondary tract, internal opening and to relate MRI findings with intra-operative surgical findings.Secondary objective is to find out validity of MRI findings in perianal fistulae in terms of its sensitivity, specificity, diagnostic accuracy.

Material and method: After obtaining written informed consent of patients referred from departments of surgery and gastro-intestinal surgery having suspicion of fistula in ano, MRI scan of pelvis was done. Imaging was done on 3.0 tesla magnetic resonance imaging from Phillips

ingenia. MRI findings were confirmed by the consultant radiologist. MRI findings were compared with the operative finding of the patients and accuracy of MRI findings were evaluated.

II. STASTICAL ANALYSIS:
Continuous variable was summarized as mean & standard deviation where as nominal, categorical variable as proportional (%).
Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated by using standard formula.

III. RESULT:
This study was carried out in the Department of Radiodiagnosis, Sawai Man Singh Hospital, Jaipur, Rajasthan from jan 2017 to dec 2018. Total of 55 patients were included in the study. The following observations were made during the study:-

Table 1: Mean age

Mean age	SD	Median	Minimum	Maximum
32.5	12.9	32	19	46

Table 2: Distributions of cases according to age group

Age group (yrs)	Male	female	total
<20 or 20	2 (3.63%)	0	2 (3.63%)
21-40	37 (67.27%)	3 (5.45%)	40 (72.72%)
>40	11 (20%)	2 (3.65%)	13 (23.63%)
	50 (90.9%)	5 (9.09%)	55 (100%)

Table 3: Distributions of cases according to type of fistula on MRI

Types of Fistulae (Radiological)	No	%
Inter Sphincteric	29	52.7
Supra Levator and Translevator disease	6	10.9
Trans Sphincteric	20	36.3
Total	55	100

Table 4: Distributions of cases according to associated findings on MRI

Associated findings (Radiological)	No	%
Branching	19	34.5
Horse shoe extension	6	10.9
Paraanal abscess	17	30.9

Table 5: distribution of cases according to internal opening of fistula on MRI

Location of internal opening at O'clock (Radiological)	No	%
3	2	3.63
5	8	14.54
6	25	45.45
7	7	12.72
9	2	3.63
11	6	10.9

Not seen	5	9.09
Total	55	100

Table 6: Surgical correlation of types of fistula
(chi square= 63.155 with degree of freedom 4, P<0.001)

Types of Fistulae (Radiological)	Types of fistulae (Surgical)			Total
	Inter sphincteric	Supralevator	Trans sphincteric	
Inter Sphincteric	27	0	2	29
Supra Levator	0	5	1	6
Trans Sphincteric	2	1	17	20
Total	29	6	20	55

In our study mean age was of 32.5 years.

In our study, majority of patients belonged to the age group 21-40 years constituting about 72.72%.

In our study, 29 patients (52.7%) had inter sphincteric fistula, 20 patients (36.3%) had transsphincteric fistula and 6 patients (10.9%) had supra/trans levator fistula on MRI.

In our study, 19 patients (34.5%) had branching pattern, 17 patients (30.9%) had paraanal abscess and 6 (10.9%) patients had horse shoe extension on MRI.

In our study out of 55patients, 25 patients (45.45%) had internal opening at 6 o'clock position, 8 patients (14.54%) had at 5 o'clock position, 4 patients (11.43%) had at 11 o'clock position, 7 patients (12.72%) had at 7 o'clock position, 2 patients (3.63%) had at 9 o'clock position, 2 patients (3.63%) had at 3 o'clock position and in 5 patients (9.09%) internal opening were not seen on MR.

Out of 55 patients, peritrack inflammation was seen in 47 patients (85.45%). Out of 55patients, active fistulous tracks were seen in 49 patients (89.09%). Rest of 6 patients (10.90%) showed inactive tracks.

In our study, 17 patients (30.9%) had grade 1, 13 patients (23.63%) had grade 4, 7 patients (12.7%) had grade 3, 12patients (21.8%) had grade 2 and 6 patients (10.9%) grade 5 on MRI.

In our study,2 fistulae out of 29, which was diagnosed as inter sphincteric on MRI found as transsphincteric on surgery. Similarly, 1 fistula out of 20, which was diagnosed as trans sphincteric on MRI, found as supra levator and 2 were inter sphincteric on surgery. Similarly, 1 fistula out of 6, which was diagnosed as supra levator on MRI found as transsphincteric.

In our study, Out of 55 patients 32 patients were not show any branching pattern on both MRI and surgery.

Out of remaining 23 patients 17 were correctly diagnosed branching pattern on both MRI and surgery.4 patients which were not show branching pattern on MRI, were show branching pattern on surgery and 2 patients which was diagnosed as branching fistulae on MRI were not show branching pattern on surgery. (Chi-square = 18.332 with 1 degree of freedom; P <0.001).

In our study, 6 patients had horse shoe extension and were correctly diagnosed on both MRI and surgery. (Chi-square = 23.483 with 1 degree of freedom; P< 0.001.)

In our study,Out of 55 patients 38 patients were not show any abscess on both MRI and surgery.Out of remaining 17 patients 16 were correctly diagnosed abscess on both MRI and surgery. 1 patient which was diagnosed as abscess fistulae on MRI were not show abscess on surgery.(Chi-square = 27.670 with 1 degree of freedom; P <0.001).

In our study,Sensitivity, specificity, PPV, NPV and accuracy of inter sphincteric fistulae were 93.1%, 92.3%, 93.1%, 92.3% and 92.7% respectively.

Sensitivity, specificity, PPV, NPV, and accuracy of transsphincteric fistulae were 85%, 91.4%, 85%, 91.4% and 89.09% respectively.

Sensitivity, specificity, PPV, NPV, and accuracy of supra levator fistulae were 83.34%, 97.9%, 83.34%, 97.9% and 96.36% respectively.

In our study,Sensitivity, specificity, PPV, NPV and accuracy of branching were 80.96%, 94.11%, 89.48%, 88.89% and 89.09% respectively.

Sensitivity, specificity, PPV, NPV and accuracy of horse shoe extension were 100%.

Sensitivity, specificity, PPV, NPV and accuracy of paraanal abscess were 100%, 97.40%, 94.11%, 100% and 98.19% respectively.

IV.   DISCUSSION:

Perianal fistula constitutes a heterogenic group of pathologies of the terminal part of the gastrointestinal tract and perineal area, jointly termed as anorectal malformations. They are thought to be a result of anal gland obstruction, with secondary abscess formation and external rupture of the abscess.Idiopathic fistulae are generally believed to represent the chronic phase of intramuscular anal gland sepsis (cryptoglandular hypothesis).

Initial diagnosis of perianal fistula is based on history-taking and physical examination which should include a detailed anal inspection with a rectal examination. This allows for a correct diagnosis in 48% of cases[5]. Approximately 5% of fistulae have a difficult, branched, complex course, with the tract reaching above the puborectalis muscle. Frequently, the internal orifice is narrowed, small or periodically closed. If the internal orifice with an infected intersphincteric gland is not removed, and if all additional canals of the fistula are not found and properly drained or also removed, then the probability of recurrence is high[5]. Many failures of surgical treatment are related to insufficient identification of the fistula course, or failure in finding all of the branches or internal orifices. Additionally, difficult anatomical conditions limit aggressive diagnostics and treatment before and during surgery, due to the concern of sphincter injury and subsequent faecal incontinence[5]The successful surgical management of perianal fistula depends upon accurate preoperative assessment of the course of the primary fistulous tract, the presence and site of any secondary extensions or abscesses. Role of MRI in evaluation of perianal fistula was first studied by Koelbelet al[6] and was followed by many studies till date. MRI is the optimal technique for distinguishing complex from simple perianal fistulae. MRI allows identification of infected tracks and abscesses that would otherwise remain undetected. Furthermore, radiologists can provide detailed anatomic descriptions of the relationship between the fistula and the anal sphincter complex, thereby allowing surgeons to choose the best surgical treatment, significantly reducing recurrence of the disease or possible secondary effects of surgery, such as faecal incontinence. Initial reports by Lunnisset al[7] suggested a concordance rate of 86% to 88% in detection of fistulous tracks. Later studies have shown up to 100% sensitivity for detecting and grading the primary tract[8].

In our study comprising 55 patients, the mean age of affected population was 32.5 years and there was overwhelming male preponderance. Age group between 20-40years accounted for maximum number of cases (72.7%). This is in agreement with a study by Halliganet al[9] which stated that the disease predominantly strikes young adults, and men are more commonly affected.

History of perianal discharge was present in 39 patients (71%), 15 patients(29%) had history of both discharge and pain in perianal region. These observations corroborate with the observations of Sainio[10] who reported that the most common presenting symptom is discharge (65% of cases), but local pain due to inflammation is also common.

In our study, classification of fistula was done according to St. James's University Hospital Classification of perianal fistula. The distribution of fistulae was as follows:

17 patients (30.9%) had Grade 1 fistula, 12 patients (21.8%) had Grade 2 fistula, 7 patients (12.7%) had Grade 3 fistula, 13 patients (23.63%) had Grade 4 fistula and 6 patients (10.9%) had Grade 5 fistula.So, in our study, Grade 1 fistulae were most common (30.9%) followed by Grade 4 fistulae (23.63%). The Grade 5 fistulae were the least common type (accounting for only 10.9% cases).The incidence of intersphincteric (Grade 1 and 2) fistulae was highest is our series accounting for 52.73% of cases. These observations corroborate with the study done by Parks et al[3] who reported that intersphincteric type as most frequently encountered fistula.

In our study, 21 patients (38.19%) had ramifications. 10 patients (18.19%) had single branching and 5 patient (9.09%) had multiple branching. Ramifications or secondary tracts will have features similar to those of the primary tract, and their course should be defined relative to the sphincters, levatorani and overlying skin. These appear as hyperintense regions on T2-weighted and STIR images and enhance if intravenous contrast material is used. Collateral inflammation can be present to a variable extent. Ramifications may be of the horseshoe type 6 patients (10.9%), crossing the midline, or may branch in the ipsilateral intersphincteric plane in case of intersphincteric fistulae. They may be seen as extension in ischioanal/ischiorectal fossa in case of transsphincteric fistulae.

16 patients (20.09%) had evidence of abscess formation. Perianal abscesses may occur anywhere along a fistula tract and typically have central hyperintense signal on T2-weighted and STIR imaging corresponding to pus, with isointense signal at wall. The abscesses appear slight hypo- or isointense signal on T1 weighted imaging.

As in study done by Mendoza et al[11] and Torkzad et al[12], it was assumed that fluid collection larger than 10 mm in diameter is an abscess; whereas a fluid filled tubular structure with a diameter smaller than 10 mm is a fistula. 14 patients (25.45%) had both ramification and abscess formation.

Peritrack inflammation was seen in 47 patients (85.45%). Peritrack inflammation is characterized by mild T2 and STIR hyperintense signal surrounding the more hyperintense fistulous track. This is attributed to oedema or inflammation in the fat surrounding the fistulous track, seen in the ischiorectal and ischioanal fossa region.

Active fistulous tracks were seen in 49 patients (89.09%) and 6 patients (10.9%) showed inactive (partially fibrosed) tracks. Active fistulous tract appears as a hypointense linear structure on T1-weighted imaging and hyperintense on T2-weighted imaging (best visualized with fat saturation) relative to muscle. Granulation tissue with increased vascularity is thought to account for the T2-weighted imaging hyperintensity. Inactive tracts are also hypointense on T1-weighted imaging but lack the associated T2-weighted imaging hyperintensity, attributed to drained out secretions or pus, with subsidence of surrounding inflammation along with fibrotic changes. Beets-Tan et al[13] stated it is difficult to differentiate a healed fibrotic track from an open inactive track which agreed with our study, however the MRI appearance of a healed fibrotic track typically lacked the hyperintense signal of fluid inside the active fistula track.

In our study internal opening was demonstrated in MRI in 50 patients (90.9%) Out of 55 patients.The common location being 6 o'clock, seen in 25(45.45%) patients. The next common location was 5 o'clock patients seen in 8(14.54%) patients. This is in agreement with studies by Morris et al[14] and Halligan et al [9] which stated that fistulous tracks arising behind the transverse anal line are the most common type.

Out of 55 patients who underwent surgery, MRI showed agreement with surgical findings with respect to internal opening in 52 patients (94.54%). In the remaining 3 patients, internal opening was not found at surgery. The accurate location of internal opening can be sometimes difficult to recognize at surgery due to local anatomical conditions as it is usually narrow, small or intermittently closed. Demonstration of level of the internal opening at MRI is important since this will determine the extent of sphincteric division during fistulotomy. Stoker et al.[15] stated that the internal opening was successfully depicted by T2WI and STIR images and were in agreement with surgical findings. MRI is not able to distinguish clearly theinternal sphincter and anal mucosa, therefore the site of the internal opening is inferred by the proximity of the tract within the intersphincteric space.

Fistulous track was best visualized on fat saturated T2(SPAIR) weighted sequences. This is in corroboration with study by Charles et al[16] which stated that T2W images (FSE and fat-suppressed) provide a good contrast between the hyperintense fluid in the tract and the hypointense fibrous wall of the fistula, and providing a good delineation of the layers of the anal sphincter. T2 weighted images help differentiate the boundaries between internal and external sphincters because sphincters and muscles have low signal intensity while active tracks and extensions have high signal intensity. SPAIR sequence is better than conventional T2 weighted sequence because the high signal intensity of fat can hide active fistulous tracks or abscesses, which also have high signal intensity. On SPAIR images, fluid, pus, and granulation tissue are seen as areas of high signal intensity on a background of low-signal-intensity fat. Tissues surrounding the tract may also show hyperintensity on T2 weighted imaging if there is oedema or inflammation. Granulation tissue with increased vascularity is thought to account for the T2-weighted imaging hyperintensity.

STIR sequence was also good in delineating fistulous course and its ramifications, however this sequence was overall inferior to T2 SPAIR sequence. In some cases, STIR imaging failed to demonstrate secondary tracks, and in others it did not reveal small residual abscesses within oedematous inflammatory change. Furthermore, spurious incidences of high signal intensity in inactive tracks and pseudoramifications were also observed. This is in agreement with Delfautet al[17] which stated that STIR sequence provides good suppression of fat signal, but theimages tend to be of poorer spatial resolution than SPAIR, which provide better visualization of anatomic details.

Unenhanced T1 weighted images provide an excellent anatomic overview of the sphincter complex, levator plate, and the ischiorectal fossae. Fistulous tracks, inflammation, and abscesses, however, appear as areas of low to intermediate signal intensity and may not be distinguished from normal structures such as the sphincters and levatorani muscles.

The exact location of the primary tract (ischioanal or intersphincteric) is most easily visualized on axial images; the presence of

disruption of the external anal sphincter differentiates a transsphincteric fistula from an intersphincteric one. The internal opening of the fistula is also best seen in this plane. Coronal images depict the levator plane, thereby allowing differentiation of supralevator from infralevator infection. A combination of an axial and a longitudinal series (coronal, sagittal, or radial) will provide all the necessary details.In our study, sensitivity, specificity, PPV, NPV and diagnostic accuracy of MRI in intersphincteric type of fistula were 93.1%, 92.3%, 93.1%, 92.3% and 92.7%. In supralevator type of fistula were 83.34%, 97.9%, 83,34%, 97.9% and 96.36% and in trans sphincteric type of fistula were 85%, 91.4%, 85%9, 91.4%, and 89.09% respectively. In our study, sensitivity, specificity, PPV, NPV and diagnostic accuracy of MRI in branching pattern diagnosis were 80.96%, 94.11%, 89.48%, 88.89% and 89.09%. In Horse shoe extension were 100% and in paraanal abscess were 100%, 97.4%, 94.11%, 100% and 98.19% when correlated with surgical findings. The results are in agreement with studies by Siddiquiet al[18], Singh et al[19] and Becklingham et al [20] who reported sensitivity of 95%, 95.5% and 97% respectively. PPV was 97.7% in study by Singh et al[19]. However, studies by Daabiset al[21] and Beets-Tan et al[22] have even reported sensitivity of 100%.Mullen et al[23] who studied the indications and contribution of MRI of perianal fistula to surgical assessment, they studied on 40 cases and stated that MRI was considered helpful in 34 cases (85%) of all cases, while in our study MRI was helpful in all cases (100%).

V.   CONCLUSIONS:
MRI is a useful procedure for successful management of perianal fistulae by correct assessment of the extent of disease and relationship to sphincter complex.

It also helps in the identification of ramifications and abscesses resulting in complete evaluation and highest possible diagnostic accuracy aiding successful surgical interventions, aiming to reduce complications and recurrences.

The T2W SPAIR sequence in both coronal and axial planes provides most of the details necessary for accurate evaluation of perianal fistulae with the identification of ramifications and abscesses associated with the fistulous track.

Limitation: Limitations of our study: We have taken relatively small sample size.Interobserver variability was not assessed in our study.Complex fistulae and previously operated fistulae were excluded from study.
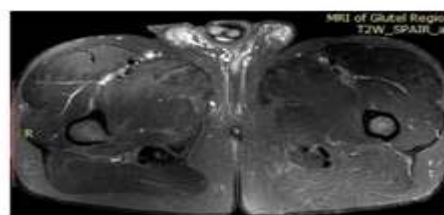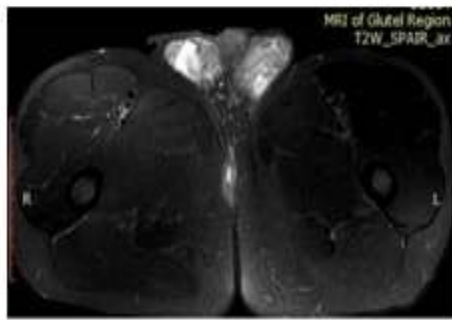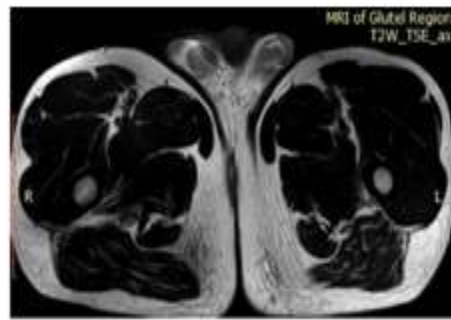
ILLUSTRATIONS

A

B

C

D
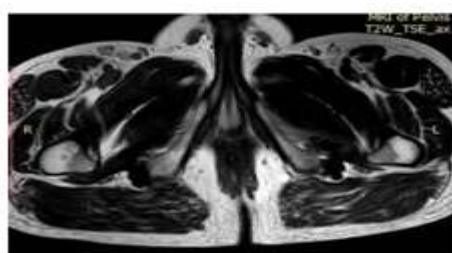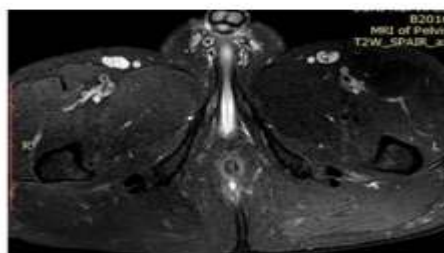
**FIGURE 1:** (A)On axial T2W axial, (B) and T2W SPAIR images of the anal canalshows the simple intersphinteric fistula to the right of the anal canal which is confined by the external sphincter and internal opening at 6 o'clock position. Another patient(C), (D) and (E) on axial T2W SPAIR (F) T2W images shows simple intersphincteric fistula to the right of the anal canal with external opening at 6 o'clock position. These findings had suggested the diagnosis of grade 1 fistula.
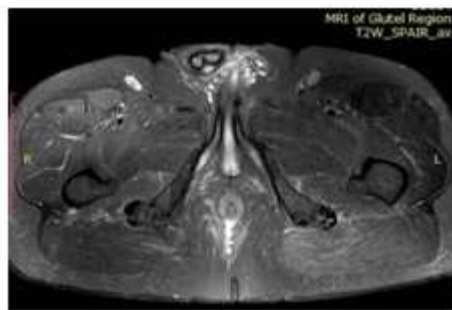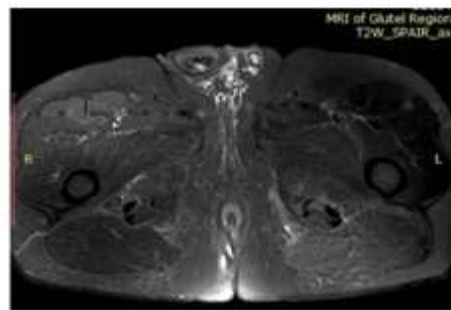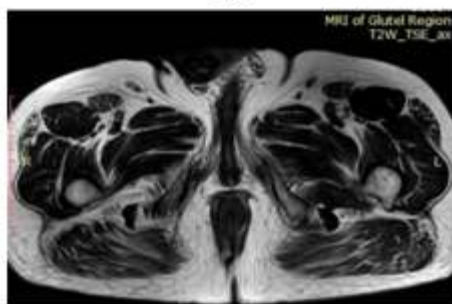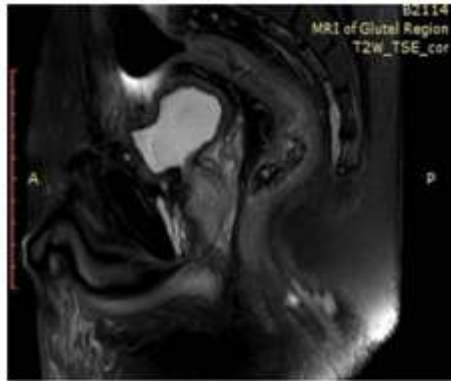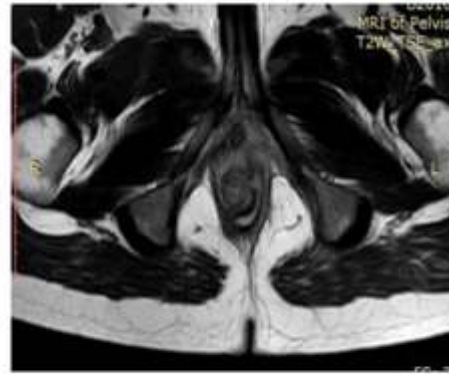
E   F

FIGURE 2: (A), (B) T2W SPAIR (C) T2W axial and (D) T2W sagittal and (E)T1W coronal images shows intersphinteric fistula with branching pattern on right side of the anal canal with internal opening at 6'oclock position and confined by external sphincter. Another patient of intersphinteric fistula shows horseshoe extension. These findings had suggested the diagnosis of grade 2 fistula.
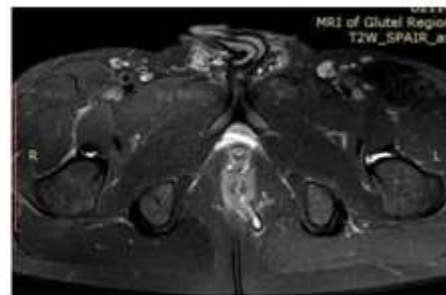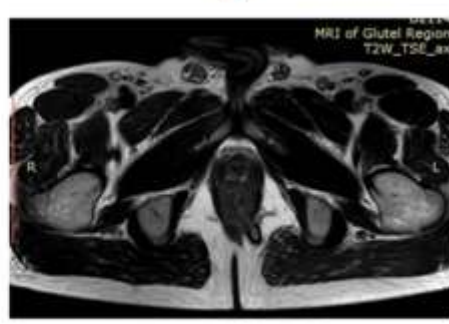

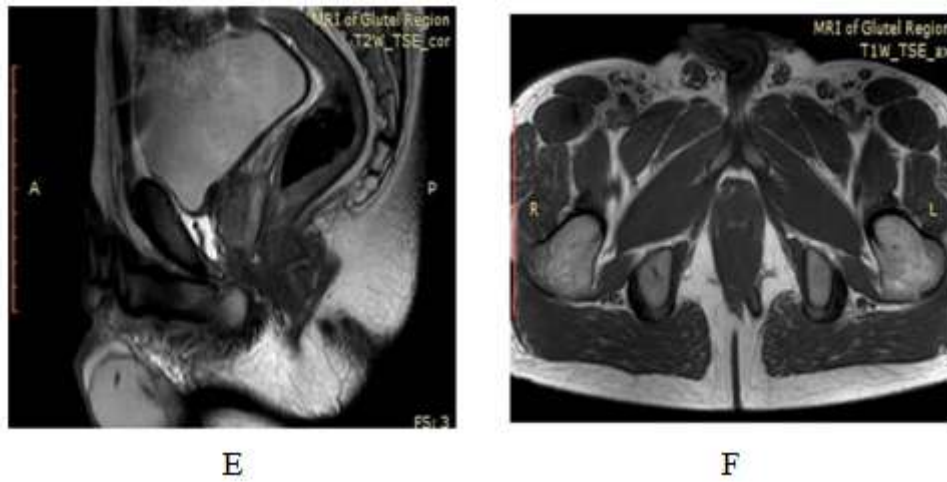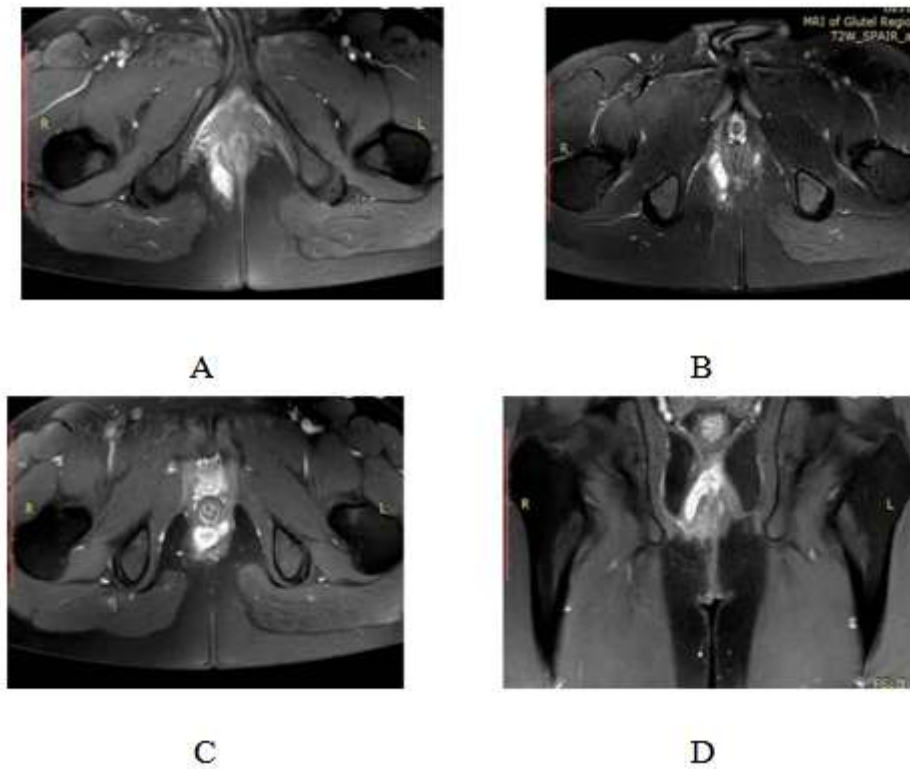A   B
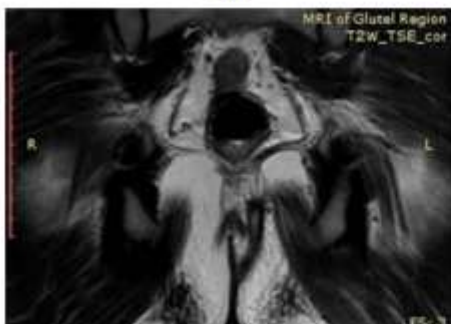
C   D

FIGURE 3: On axial T2W SPAIR (A)(B), T2W coronal (C) axial(D) sagittal (E)and T1W images shows simple transsphincteric fistula on left side of the anal canal which is traversing the external sphincter without any associated complications and internal opening at the 5 o'clock position.
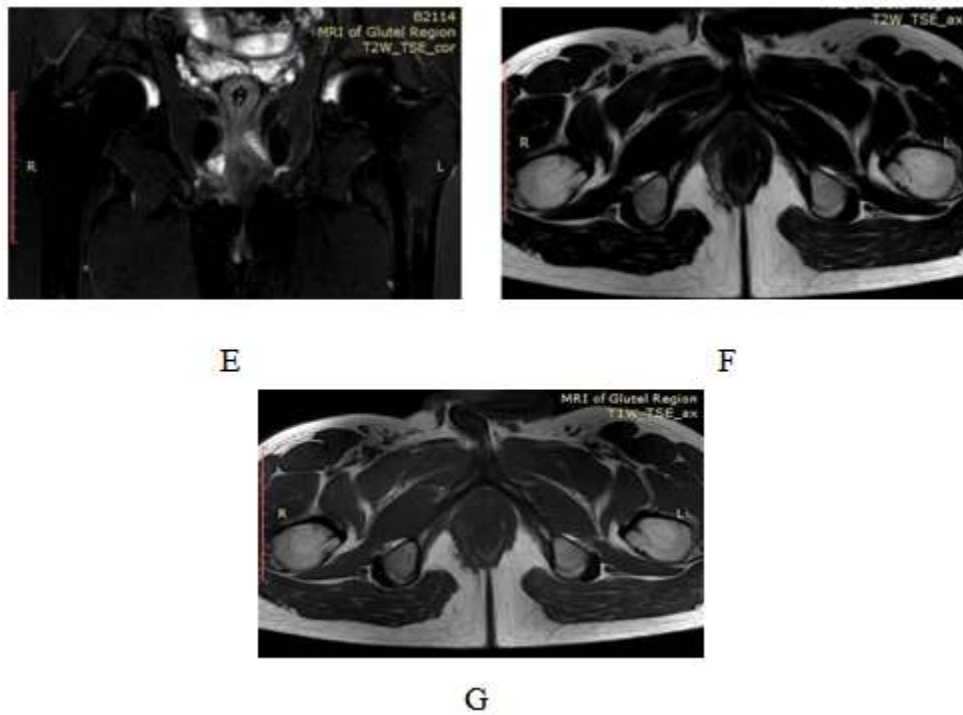
FIGURE 4: On axial (A)(B)(C) coronal (D) T2W SPAIR, T2W coronal(E)axial(F) and T1W axial (G) images show transsphincteric fistula on the right side of anal canal which shows minimal branching pattern and contralateral side extension, internal opening of fistula is at 9 o'clock position and hyperintensity also seen in right ischioanal region suggested small abscess formation. These findings had suggested the diagnosis of grade 4 fistula.

(J)

(K)
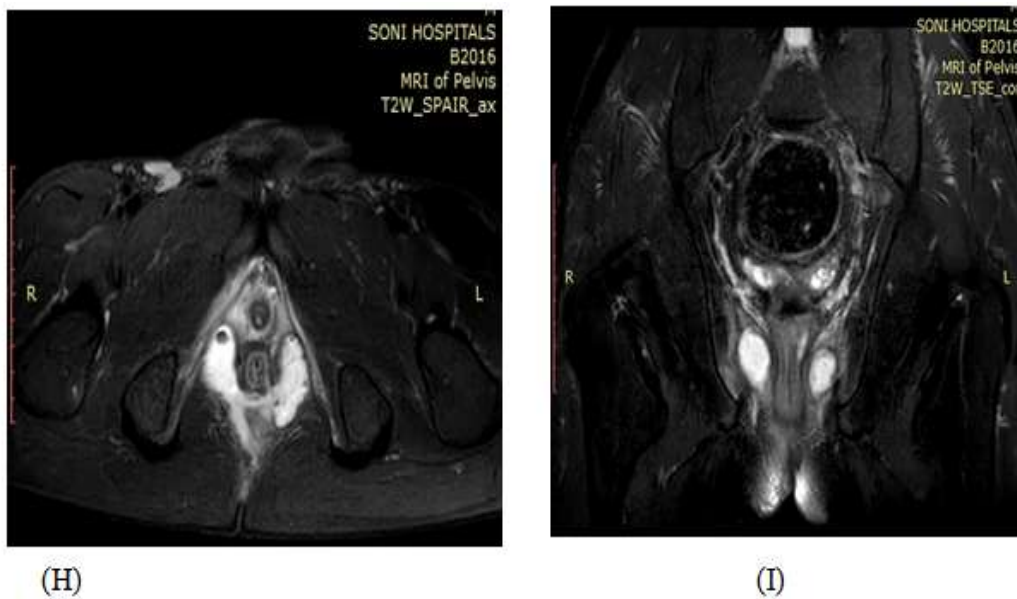
(H) axial T2 STIR (I) coronal STIR (J) T2 sagittal (k) coronal STIR show bilateral ischiorectal fossa abscess and tract does not cross levatorani muscle. Grade 4 fistula.
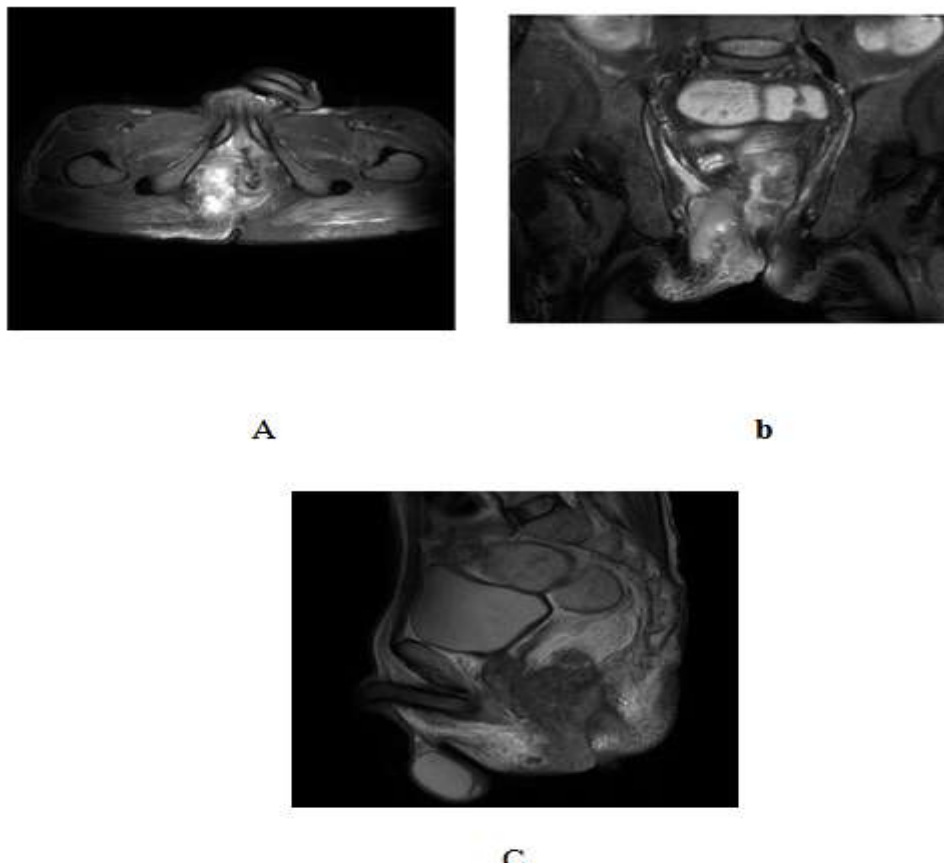

A

b

C

FIGURE 5: (A) Axial (B) coronal T2W SPAIR and (C) sagittal T2W images of theanal canal shows a supralevator abscess located the right side of the anal canal, and the left internal obturator muscle which crossing levatorani muscle.

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