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MRI of Recurrent Fistula-in-Ano: Is it Different from Treatment-Naïve Fistula-in-Ano and How Does it Correlate with Anal Sphincter Morphology?

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Abstract

Objectives The main aim of this study was to compare magnetic resonance imaging (MRI) findings of recurrent and treatment-naïve fistula-in-ano and to correlate imaging findings with anal sphincter morphology in recurrent fistula-in-ano.

Methods This is a retrospective study of adult patients who underwent MRI for suspected fistula-in-ano in 2018. After excluding patients with alternative diagnosis, patients were stratified into recurrent ($n = 103$) and treatment-naïve ($n = 106$) fistula-in-ano groups. Two blinded radiologists reread MRI scans in consensus for fistula characteristics and anal sphincter morphology. We compared imaging features of recurrent and treatment-naïve fistula-in-ano, assessed the incidence of anal sphincter scarring among patients with recurrent fistula-in-ano, and studied its association with fistula features.

Results Two-hundred nine patients (187 males) with mean age of 40.6 (standard deviation: 12.2) years were included. Trans-sphincteric, inter-sphincteric, extra-sphincteric, and supra-sphincteric fistula-in-ano were seen in 63.6, 33, 2.9, and 0.5%, respectively. There were secondary tracts, supralevator extension, and secondary cause for fistula in 49.3, 12.9, and 14.8%, respectively. There was no difference between the fistula features of recurrent and treatment-naïve fistula-in-ano, except for significantly fewer external openings among recurrent fistula-in-ano ($p = 0.005$). Among patients with recurrent fistula-in-ano, MRI detected anal sphincter defect/scarring was seen in 53.4% ($n = 55$) and was significantly associated with posterior fistula-in-ano ($p = 0.031$), collections and/or supralevator extension ($p = 0.010$), and secondary tracts ($p = 0.015$).

Conclusion Fistula features of recurrent and treatment-naïve patients were mostly similar. There was high incidence (53.4%) of MRI-identified anal sphincter scarring/defect among recurrent fistula-in-ano, which was significantly associated with posterior fistula, collections, supra or translevator extension, and secondary tracts.

Keywords
- fistula-in-ano
- MRI
- recurrent
- anal sphincter
- incontinence

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Key Points

- MRI-identified anal sphincter scarring is very common among patients with recurrent fistula-in-ano and seen in more than half of them.
- There was significantly higher incidence of sphincter scarring among patients who had posterior fistula, collections, supralevator/translevator extension, and secondary tracts.

Introduction

Fistula-in-ano is an abnormal tract or cavity between the anal canal and the perianal skin.[1] The majority of fistula-in-ano is a sequela of poorly managed cryptoglandular infection, which starts in the intersphincteric space and then spreads.[2] Parks classification was the earliest classification of fistula-in-ano, and was based on the location of the fistula tract with respect to the anal sphincter complex as observed during the surgical treatment.[3] With the availability of magnetic resonance imaging (MRI) scan, better evaluation of fistula was possible. The subsequent imaging classification proposed by Morris et al was based on the location of the primary track, presence of secondary ramifications, and associated abscesses.[4] More recently, Standard Practice Task Force (SPTF) classified fistula-in-ano into simple or complex depending on the risk of fecal incontinence after fistulotomy.[5]

The goals of treatment of fistula-in-ano include resolving acute-on-chronic inflammatory process, maintaining continence, and preventing future recurrence.[6,7] Failure to excise the primary tract with its secondary extensions or incomplete drainage of septic focus may eventually result in persistence or recurrence of fistula-in-ano.[6] Despite treatment advances, the recurrence rates are astoundingly high ranging between 7 and 50%, and often need multiple surgeries.[8–10] The rates of fecal incontinence after different types of treatments for fistula-in-ano have been reported to be as high as 64%.[11]

Preoperative MRI is the investigation of choice for fistula-in-ano.[12] MRI is useful for accurately mapping the fistula tract and for identifying features known to be associated with recurrence. Thus, MRI positively affects the outcome of fistula treatment. While interpretation of fistula-in-ano in treatment-naïve patients is straightforward, MRI interpretation in a setting of recurrent fistula-in-ano can be challenging. This is because of complex nature of the residual/recurrent fistula-in-ano, disturbed anatomy, and scarring from previous treatment attempts. Though there are numerous studies that emphasize the value of MRI in fistula-in-ano in general, the number of studies on recurrent fistula-in-ano and studies assessing anal sphincter morphology on these patients are far and few. One of the studies on recurrent fistula-in-ano showed that surgery performed with the guidance of MRI findings reduced the chance of further recurrence by 75%.[13] Moreover, the association between characteristics of recurrent fistula-in-ano, the degree of anal sphincter scarring, and fecal incontinence is complex and less well understood.

The two objectives of this study were to compare the MRI findings of patients in recurrent and treatment-naïve fistula-in-ano and to correlate the presence and degree of anal sphincter scarring seen on high resolution MRI with the fistula characteristics of patients with recurrent fistula-in-ano.

Materials and Methods

Setting and Patients

This is an institution review board (IRB min no. = 13193,22.7.2020) approved retrospective study conducted by radiology department and a dedicated colorectal surgery department of a tertiary care teaching hospital. Consecutive adult patients with clinically suspected fistula-in-ano who underwent MRI for its evaluation between January 2018 and December 2018 were identified from picture archiving and communication system. Patients with fistula-in-ano on MRI were included, while those with alternative diagnosis on MRI like pilonidal sinus, fissure-in-ano, and neoplasms of anorectal, presacral, and ischiorectal fossa regions were excluded (►**Fig. 1**). Similarly, poor-quality studies with artefacts and imaging performed elsewhere were excluded.

MRI Protocol and Image Interpretation

All MRI studies were performed in one of the following two MRI scanners: Magnetom Avanto fit, 1.5T (Siemens Healthcare Erlangen, Germany) or Intera 22 Achieva 3.0T (Philips Healthcare, Best, Netherlands). MRI pelvis was performed with patients in supine position using 16 channel external

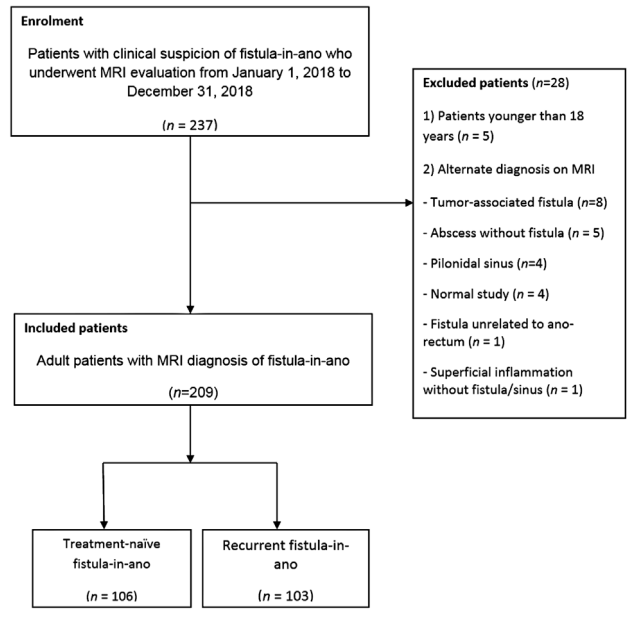

Fig. 1 Consort statement of patients included in the study. MRI, magnetic resonance imaging.

phased-array body coil. MRI protocol included T2 fast spin echo and T2 spectral attenuated inversion recovery (TR/TE of 4500-6500/60-70 milliseconds, large field of view axial images of the pelvis, high resolution which were acquired as small field of view with in plane resolution $\leq$0.7 mm) T2-weighted and T2 short tau inversion recovery (STIR) images in sagittal, oblique axial, and oblique coronal planes obtained perpendicular and parallel to the anal canal. We did not routinely perform gadolinium-enhanced MRI or diffusion-weighted imaging for patients with fistula-in-ano. Two radiologists blinded to clinical and laboratory findings reread the MRI scans in consensus.

The type of fistula according to Parks classification and St James classification, the site and the side of fistula-in-ano, the number of internal and external openings, the distance between the anal verge and the internal and the external openings, the length of the primary tract, secondary tracts, supralevator extension, presence and the location of abscess or collections, activity of the tract, and the morphology of the anal sphincter complex were documented for every patient.

For those with multiple internal or external openings, the longest tract was assumed to be the primary tract and the other communicating tracts as secondary tracts. Abscess/collection was defined as a localized widening of the primary or the secondary tract for more than 1 cm (►**Fig. 2**). Activity of the tract was assessed based on the signal intensity of the fistula tract on T2 and STIR images. An active tract was defined as a tract that was completely hyperintense on T2 and STIR images. Those tracts that were partly active (hyperintense on STIR and T2) and partly fibrotic (hypo intense on T2 and STIR images) and the tracts that were hyperintense on STIR but isointense or hypointense on T2-weighted images were defined as healing tracts. On the other hand, a healed tract was completely hypointense on both T2 and STIR images (►**Fig. 3**).

Anal sphincter complex was assessed for scarring and defects on T2 high-resolution oblique axial and oblique coronal images according to definitions in previously published work.[14] Scarring was defined as T2 markedly hypointense tissue replacing the internal and/or external sphincter. Sphincter defect was defined as focal thinning or discontinuity of the sphincter other than the fistula tract (►**Fig. 4**). The degree of sphincter abnormality was documented in both length and circumference.

Patients' details including clinical symptoms, laboratory test findings, and treatment history were obtained from electronic medical records. For this study, MRI done at our center during the study period was used as the index MRI. Patients were stratified as recurrent and treatment-naïve fistula-in-ano based on the date of the index MRI and past treatment history available on electronic medical records.

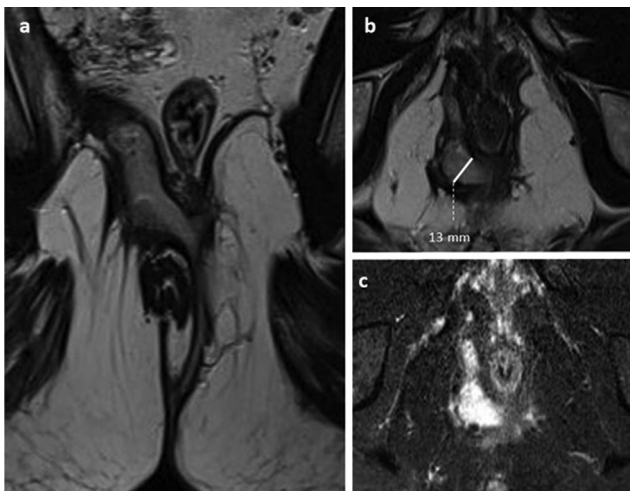

Fig. 2 (**a**) High-resolution T2-weighted coronal, (**b**) axial, and (**c**) short tau inversion recovery magnetic resonance images demonstrate an intersphincteric fistula-in-ano with supralevator extension. A portion of intersphincteric and supralevator component of the tract is widened more than 10 mm representing an abscess.

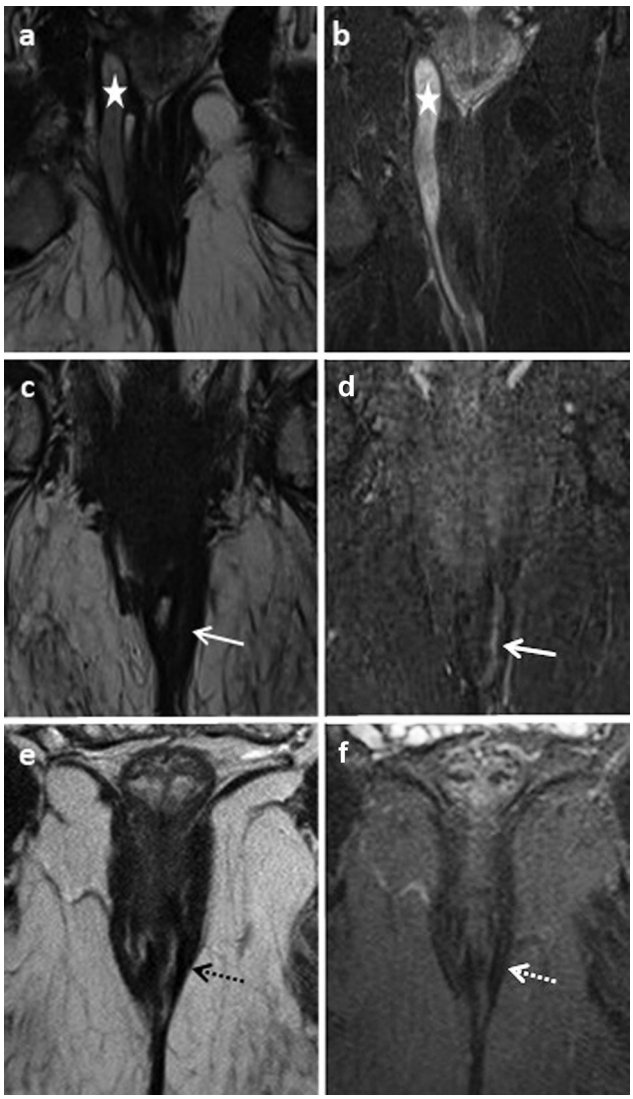

Fig. 3 T2 coronal images and corresponding short tau inversion recovery (STIR) coronal images demonstrate examples of the activity of fistula. (**a**, **b**) Active tract (asterisk) is completely hyperintense on both T2 and STIR images. (**c**, **d**) A healing tract (solid arrow) is mostly T2 hypointense with faint STIR hyperintensity. (**e**, **f**) A healed tract (dashed arrow) is completely hypointense on both T2 and STIR images.

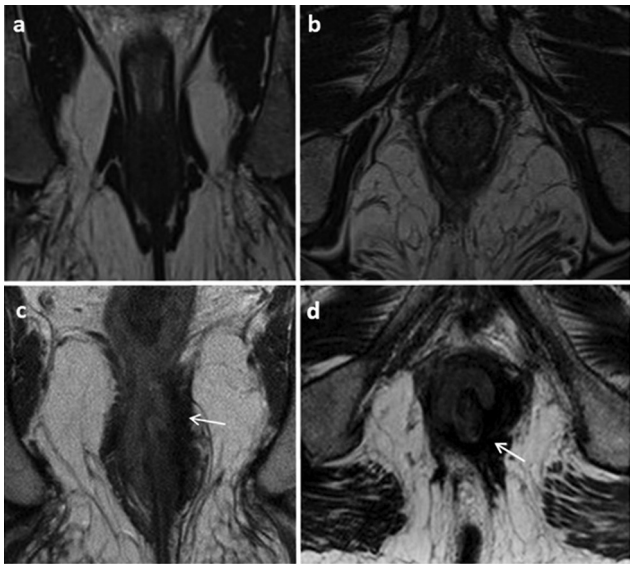

Fig. 4 (**a**, **b**) Normal anal sphincter complex on T2 coronal and axial images show T2 hypointense external anal sphincter continuous with the levator ani muscle, T2 mildly hyperintense internal anal sphincter continuous with the muscularis propria of the rectum and there is T2 hyperintense intersphincteric plane. (**c**, **d**) Anal sphincter scarring (arrow) is seen as thick T2 hypointense tissue replacing and distorting the left posterior aspect of the anal sphincter complex. Note the focal defect in the internal anal sphincter at 4 O'clock.

Statistical Analysis

For continuous data, the descriptive statistics were reported in terms of mean and standard deviation (SD) and for non-normally distributed data, median values (interquartile range) were reported. Number of patients and percentage were presented for categorical data. To understand the difference in the fistula characteristics between the treatment naïve and recurrent fistula-in-ano, imaging features of both these groups of patients were tabulated and compared using one of the following tests: independent sample *t*-test, nonparametric Mann–Whitney U test, Pearson chi-squared test, or Spearman's correlation coefficient. We also studied the anal sphincter morphology among patients with recurrent fistula-in-ano and correlated anal sphincter abnormalities with imaging features seen in patients with recurrent fistula-in-ano. A *p*-value of less than 0.05 was considered statistically significant. Statistical analysis was done using SPSS v.22 software (SPSS Inc., Chicago, Illinois, United States).

Results

Demographic Data

►**Fig. 1** shows the flowchart of patients included in the study. A total of 209 patients (187 males, 22 females) with a mean age of 40.6 (SD: 12.2) years and range of 18–73 years were included for final analysis. Of the 209 patients, 106 patients had treatment-naïve fistula-in-ano and 103 patients had recurrent fistula-in-ano. The majority (71.3%) of patients were between 30 and 59 years, 21.1% patients were below 30 years, and the rest (7.7%) were 60 years or above. Transsphincteric, intersphincteric, extrasphincteric, and suprasphincteric fistula-in-ano were seen in 63.6, 33, 2.9, and 0.5%, respectively. The most common location of the internal ($n = 96$, 45.9.%) and the external opening ($n = 102$, 48.8%) was posterior, between 5 and 7 O'clock. MRI showed no internal opening in 25 (12%) patients and no external opening in 16 (7.7%) patients. A small proportion ($n = 13$; 6.3%) had more than one internal opening with two internal openings in 11 patients and 3 internal openings in two patients. The mean length of primary tract was 6.1 ± 3.4 cm. Secondary tracts were seen in nearly half of the patients (49.3%) and supralevator extension was seen in 12.9%. Underlying cause for fistula-in-ano was found in 31 patients (14.8%): inflammatory bowel disease ($n = 24$), tuberculosis ($n = 4$), trauma ($n = 3$). The majority (80.4%) of patients had one or more active tracts, 15.8% patients had partly healed fistula tracts, and 3.8% patients had completely healed tracts. Demographic data is summarized in the ►**Supplementary Table 1**, online only.

Comparison between Treatment-Naïve and Recurrent Fistula on MRI

►**Table 1** shows the comparison between patient and fistula characteristics of treatment-naïve and recurrent fistula-in-ano. We found no significant difference in the age and gender distribution between the two groups. There was no difference in the fistula types, length of the primary tract, location and the number of internal openings, secondary tracts, supralevator extension, or collections seen in patients with treatment-naïve and recurrent fistula-in-ano. There were significantly fewer external openings among patients with recurrent fistula-in-ano, $p = 0.005$. The proportion of patients with active tracts (83 vs. 77.7%) and secondary causes for fistula-in-ano (17.9 vs. 11.7%) was higher among the treatment-naïve group compared to recurrent fistula-in-ano, but this was not statistically significant.

MRI-Identified Anal Sphincter Scarring in Recurrent Fistula-in-Ano

Out of 103 patients with recurrent fistula-in-ano, 55 (53.4%) patients had features of anal sphincter defect or scarring on MRI. Among them, there was sphincter abnormality involving more than a third of the sphincter circumference in 41 (74.5%) patients and more than a third of anal canal length in 33 (61.1%) patients. While external sphincter was scarred in nearly all these patients ($n = 53$, 96.4%), internal sphincter scarring and defect were seen in 33 (60%) and 31 (56.4%) patients, respectively. There was severe thinning of the external sphincter in 16 (29%) patients.

Association between Imaging Findings and Sphincter Scarring in Recurrent Fistula-in-Ano

►**Table 2** compares the imaging findings between patients with and without sphincter abnormality on MRI. The side of fistula, the length of the primary tract, the distance of internal and external opening from the anal verge, and the number of internal and external openings had no association with sphincter abnormality ($p > 0.05$). Location of internal opening had a significant association with sphincter abnormality, $p = 0.031$. We found 58.8% of patients with sphincter

Table 1 Comparison between treatment-naïve and recurrent fistula on MRI

	Treatment-naïve fistula ($n = 106$)	Recurrent fistula ($n = 103$)	*p*-Value
Mean age	43.1 ±11.7	40.6 ± 12.2	0.133
Sex (M:F)	97:9	90:13	0.331
Type of fistula			
_ Intersphincteric	38 (35.8%)	31 (30.1%)	0.471
_ Transsphincteric	64 (60.4%)	69 (67%)	
_ Supra and extrasphincteric	4 (3.8%)	3 (1.9%)	
Location of internal opening			
_ Anterior (11–1 O'clock)	20 (21.3%)	23 (25.6%)	0.532
_ Left (2–4 O'clock)	17 (18.1%)	10 (11.1%)	
_ Posterior (5–7 O'clock)	49 (52.1%)	47 (52.2%)	
_ Right (8–10 O'clock)	8 (8.5%)	10 (11.1%)	
Location of external opening			
_ Anterior (11–1O'clock)	24 (25.3%)	19 (19.4%)	0.795
_ Left (2–4 O'clock)	16 (16.8%)	19 (19.4%)	
_ Posterior (5–7 O'clock)	49 (51.6%)	53 (54.1%)	
_ Right (8–10 O'clock)	6 (6.3%)	7 (7.1%)	
No. of internal opening			
_ None identified	12 (11.3%)	13 (12.6%)	0.777
_ One	89 (84%)	82 (79.6%)	
_ Two or more	5 (4.7%)	8 (7.8%)	
No. of external opening			
_ None identified	11 (10.4%)	5 (4.9%)	0.005
_ One	68 (64.2%)	87 (84.5%)	
_ Two or more	27 (25.5%)	11 (10.7%)	
Primary tract length (cm)	6.2 ± 3.3	6.0 ± 3.6	0.768
Mean distance (internal opening to anal verge [cm])	2.5 ± 1.5	2.6 ± 1.5	0.444
Mean distance (external opening to anal verge [cm])	3.9 ± 2.9	3.4 ± 2.6	0.244
Secondary tracts	49 (46.2%)	54 (52.4%)	0.370
Supralevator extension	13(12.3%)	14 (13.6%)	0.775
Collections	44 (41.5%)	41 (39.8%)	0.802
_ Intersphincteric	26 (24.5%)	22 (21.4%)	0.352
_ Ischiorectal and peri-anal	21 (19.8%)	23 (22.3%)	0.655
_ Supralevator	12 (11.3%)	16 (15.3%)	0.371
_ Others: abdominal wall/retroperitoneum	11 (10.4%)	14 (13.6%)	0.464
Secondary cause	19 (17.9%)	12 (11.7%)	0.202
Activity of tract			
_ Active tract	88 (83%)	80 (77.7%)	0.574
_ Healing tract	15 (14.2%)	18 (17.5%)	
_ Healed tract	3 (2.8%)	5 (4.9%)	

Abbreviation: MRI, magnetic resonance imaging.

abnormality on MRI had posteriorly located internal opening, most commonly at 6 O'clock. Those without sphincter abnormality most commonly (41%) had anteriorly located internal opening. There was significant association between the location of fistula-in-ano and the extent of anal sphincter abnormality, both in terms of the circumference ($p = 0.037$) and the length ($p = 0.011$) of anal sphincter abnormality. We found that 67.6% of patients with scarring of more than a

Table 2 Comparison of fistula characteristics of patients with and without sphincter scarring

Sphincter scarring among recurrent fistula-in-ano ($n = 104$)	Present ($n = 55$)	Absent ($n = 48$)	p-Value
Mean age	41.9 ± 11.4	39.1 ± 13.1	0.259
Sex (M:F)	50:5	40:8	0.131
Type of fistula			
Intersphincteric	14 (25.5%)	17 (35.4%)	0.573
Transsphincteric	39 (70.9%)	30 (62.5%)	
Supra- and extrasphincteric	2 (3.6%)	1 (2.1%)	
Location of internal opening			
Anterior	7 (13.7%)	16 (41%)	0.031
Posterior	30 (58.8%)	17 (43.6%)	
Primary tract length (cm)	5.7 ± 2.6	6.5 ± 4.6	0.329
Mean distance of internal opening from anal verge (cm)	2.6 ± 1.1	2.7 ± 1.9	0.891
Mean distance of external opening from anal verge (cm)	3.2 ± 2.4	3.7 ± 2.9	0.330
Secondary tracts	35 (63.6%)	19 (39.6%)	0.015
Supralevator extension/collections	26 (47.3%)	11 (22.9%)	0.010
Secondary cause	3 (5.5%)	9 (18.8%)	0.036
Activity of tract			
– Active tract	42 (76.4%)	38 (79.2%)	0.083
– Healing/healing	13 (23.6%)	10 (20.8%)	

third of the sphincter circumference and 70% of patients with scarring of more than a third of the sphincter length had internal opening located at 6 O'clock. Similarly, majority (72.4%) of patients with internal sphincter defect had posterior fistula-in-ano with internal opening at 6 O'clock.

There was significant association between the presence of sphincter abnormality on MRI and the St James classification for fistula-in-ano. Higher grades of fistula-in-ano, which had collections or supralevator/ translevator extensions, were associated with the presence of anal sphincter abnormality ($p = 0.010$) and its severity. About 63.9% of patients with St James grade 2, 4, or 5 had associated sphincter defect or scarring. About 73.2% of patients with involvement of more than a third of sphincter circumference ($p = 0.008$) and 72.7% of patients with involvement of more than a third of sphincter length ($p = 0.006$) had St James grade 2, 4, or 5 fistula-in-ano. There was significant association between the presence of sphincter abnormality and secondary tracts with higher incidence among those with sphincter abnormality (63.6%) versus 39.6% among those without sphincter abnormality, $p = 0.015$. There was a significant inverse relationship between secondary causes of fistula-in-ano and sphincter abnormality, $p = 0.036$.

Discussion

Our attempts to identify if there were differences in the imaging features of fistula-in-ano between the recurrent and treatment-naïve groups showed that there was no difference in the type, location, and the extent of fistula-in-ano between the two groups. However, those with recurrent fistula-in-ano had significantly fewer external openings. This was probably due to healing and fibrosis of one or more of previously active tracts and external openings.

Our study subjects underwent MRI with 16-channel external phased array coil. We could adequately evaluate the anal sphincter morphology on high-resolution T2-weighted MRI images in all the subjects irrespective of magnet strength (1.5 T or 3.0T). Endoanal ultrasonography and endoanal MRI are the main imaging modalities used for anatomical assessment of anal sphincter complex. However, previous studies have demonstrated comparable performance of MRI with external phased-array coil and endoanal coil for detecting clinically significant anal sphincter abnormalities.[15,16] Our study findings support the findings of these studies and establish the usefulness of high-resolution T2 MRI with external phased-array coil for delineating morphology of anal sphincter complex.

We found high incidence of MRI identified anal sphincter abnormality (53.4%) among patients with recurrent fistula-in-ano. Among these patients, those with posteriorly located fistula-in-ano, collections, supra, or translevator extension and secondary tracts have higher incidence and worse extent of anal sphincter scarring/ defect. These findings are in line with the classification system proposed by the SPTF, which classifies fistula-in-ano as simple and complex based on the risk of fecal incontinence after fistulotomy.[5] According to the SPTF classification, complex fistula-in-ano are tracks that cross 30 to 50% of external anal sphincter; for example, high trans-sphincteric, supra-sphincteric, and extra-sphincteric types of fistula-in-ano, anterior fistula in females, multiple tracks, and recurrent fistula-in-ano. Fistula-in-ano in

patients with preexisting incontinence, past pelvic irradiation, or Crohn's disease was also considered complex according to SPTF classification.

The incidence of fecal incontinence after any form fistula-in-ano treatment ranged from 0 to 64% in various studies with an average of 40%, though the majority of them were minor incontinence.[6,11,17–19] Quality of life study done on patients with fistula-in-ano showed no significant difference in the continence index between the primary and recurrence fistula-in-ano. However, nearly double the number of patients with recurrent fistula-in-ano (36.3%) experienced fecal urgency compared to primary fistula-in-ano (19.4%) leading to decreased overall quality of life among those with recurrent fistula-in-ano.[20] Given the high incidence of incontinence, the decreased quality of life experienced by patients with recurrent fistula-in-ano, and the paucity of literature available on MRI morphology of anal sphincter complex in this group of patients, the findings of our study are very relevant. Prior studies on outcomes of fistula surgery showed patients with high trans-sphincteric and supra-sphincteric type of fistula-in-ano had high postoperative incontinence.[6,21] The high incidence (64%) and worse MRI-identified anal sphincter scarring/defect among patients with St. James 2, 4, and 5 type of fistula in our cohort provide an indirect morphological correlate to prior workers findings. Unlike prior study, where the incidence of fecal incontinence was 2.8 times higher among patients older than 45 years, there was no age- and gender-based differences in the incidence of anal sphincter abnormalities in patients with recurrent fistula-in-ano.[6] This could be due to small sample size and alternatively, because of the population structure in our country, where the majority of patients are young.

Anal sphincter abnormalities in patients with recurrent fistula-in-ano could be either be due to sphincter defects from sphincter cutting surgical procedures or sphincter scarring from surgical procedure itself or due to healing of the infection.[19,21,22] These abnormalities can cause a range of symptoms that include incontinence, fecal impaction, and chronic anal pain. A small proportion (3.8%, $n = 8$) of symptomatic study subjects showed completely healed fistula tracks on MRI and no other abnormalities. The persistent anal or perianal pain in these patients was attributed to scarring associated with healed fistula. Thus, MRI was valuable not only for excluding recurrent fistula-in-ano but also for identifying a cause for patient's symptoms. A previous study assessing the value of MRI in chronic perianal pain showed painful perianal scarring in 11%.[23]

Table 3 Review areas while reporting MRI of fistula-in-ano

Imaging features	Description
Type of fistula	Simple—Single internal and external opening Complex—Multiple internal and/or external openings; multiple tracts
Low or high	Low—Lower third of anal sphincter High—Upper two thirds of anal sphincter -Puborectalis marks the ano-rectal junction -The length of the anal canal is measured between the anorectal junction and the anal verge
Park's classification	Intersphincteric Transsphincteric Suprasphincteric Extrasphincteric
Internal openings of each track	Location in terms of clock position and distance from anal verge
External openings of each track	Anatomical location and distance from anal verge
Secondary tracts or ramifications	Branching of a primary tract
Collection	Presence of fluid signal collection greater than 10 mm wide and its location (intersphincteric/ ischiorectal/mesorectal/ presacral/ extramesorectal pelvic space/ others such as abdominal wall/retroperitoneum, etc.)
Supralevator extension	Extension of the track/ collection above the levator ani
Activity of the tract	Active tract—Hyperintense (fluid signal) on both T2 and T2 SPAIR Healing tract—Partly active and partly fibrotic tracts or those that appear T2 hypointense and T2 SPAIR hyperintense. Fibrotic tract—Hypointense on both T2 and T2 SPAIR
Sphincter complex	Presence of scarring or thinning or defect involving the internal or external anal sphincter Does the sphincter abnormality involve greater than or less than a third of sphincter circumference and/ or its length? Presence of thinning or defect of levator ani
Secondary causes	Present/ absent, if present what cause?

Abbreviations: MRI, magnetic resonance imaging; SPAIR, spectral attenuated inversion recovery.

Secondary causes were more common among treatment-naïve group and there was an inverse relationship between secondary causes and anal sphincter abnormality. This can be explained by the fact that recurrence and sphincter scarring might be less likely when many of the secondary causes such inflammatory bowel disease, tuberculosis, and trauma are adequately treated or brought under good control. We saw higher incidence of secondary cause for fistula-in-ano in our cohort (14.8%) compared to 10% in other published literature. This probably reflects the pattern of referral to our center, which is a tertiary care teaching center in the region.[24,25]

There were few limitations, other than that posed by the retrospective study design. We did not try to further analyze the recurrent fistula-in-ano based on its etiology such as treatment failure, persistence of fistula-in-ano, or de-novo fistula-in-ano and this may have affected the incidence and the degree of anal sphincter abnormality. Since this study was conducted in a tertiary care referral center and the cohort was from a dedicated colorectal unit, our results may be prone to a degree of referral bias. This was indeed seen in the high rates of recurrent fistula-in-ano and secondary causes of fistula-in-ano in our practice. Though this can affect the generalizability of the results, we cannot disregard the fact that the results were in line with previous clinical studies. T2 signal differences between internal anal sphincter and scar tissue helped in delineating internal sphincter defects. However, due to somewhat similar signal intensity of both the scar tissue and external sphincter, it was not possible to differentiate external sphincter defects from scarring. Moreover, in patients with recurrent fistula-in-ano, both sphincter scarring and sphincter defects can be seen to a varying degree. Thus, further studies are needed to correlate anal sphincter abnormalities seen in fistula-in-ano patients and with the continence score and the quality of life. Lastly, this was mainly an imaging study which focused on the morphological abnormalities seen on MRI. Thus, correlation with clinical continence score and follow-up details were beyond the scope of the current study.

In conclusion, imaging features of recurrent and treatment-naïve fistula-in-ano were mostly similar except for fewer external openings and fewer secondary causes for fistula among the recurrent fistula-in-ano group. High-resolution T2-weighted MRI using external phased array coil was effective in identifying sphincter abnormalities among patients with recurrent fistula-in ano. There was high incidence (53.4%) of MRI identified anal sphincter abnormality among recurrent fistula-in-ano, which was significantly associated with posterior fistula, collections, supra- or translevator extension, and secondary tracts. Though further studies are needed to correlate morphological abnormalities of anal sphincter with fecal incontinence score, incorporating statements on the morphology of anal sphincter complex and making specific mention of imaging features that highly correlate with sphincter abnormality in radiology reports might be of significant clinical value. We have provided a comprehensive list of review areas while reporting fistula-in-ano in ►**Table 3**.

Authors' Contributions
All authors contributed to the study conception and design. Antony Augustine, Prerak Govindbhai Patel, and Ann Augustine contributed to material preparation, data collection and analysis. Antony Augustine and Anuradha Chandramohan wrote the first draft of the manuscript and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethical Approval
This study was performed in line with the principles of the Declaration of Helsinki.
Approval was granted by the Ethics Committee or IRB of Christian Medical College, Vellore (Date: 22.7.2020/ No. = 13193).

Informed Consent
Written informed consent was waived by the Institutional Review Board.

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Conflict of Interest
None declared.

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