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Comparison of 3D Volumetric T1 Weighted Fat Saturated Post Contrast Sequence on 3T MRI versus Routine Plain MR Fistulogram Sequence

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ABSTRACT

MRI is the imaging method of choice for preoperative evaluation of fistula in ano. Plain MR imaging has been studied for preoperative evaluation of fistula in ano, but few studies have compared 3D volumetric T1-weighted fat-saturated post-contrast sequence on 3T MRI to routine Plain MR Fistulogram sequence. This study aimed to compare 3D VIBE post-contrast and plain MRI in the pre-operative assessment of ano fistula. Thirty participants, suspected of having peri-anal fistula were enrolled in the research and underwent and surgery later on. This study was done in a cross-sectional prospective way in a single medical center.

Keywords: Perianal fistula, Inter and transsphincteric fistula, branching tract, horse shoeing and abscess, fibrous tract.

INTRODUCTION

An aberrant tract or cavity that communicates with the perianal skin is what is known as a fistula-in-ano in medical literature. Even after surgery, as many as one-quarter of patients will encounter a recurrence of the fistula within a year. Appropriate preoperative diagnosis of the primary fistulous tract, the presence of additional branches, the location of such branches, and abscesses is crucial for successful therapy of perianal fistula. Due to its high sensitivity, specificity, accuracy, and predictive values, an MRI Fistulogram is required prior to any surgical procedure. For preoperative assessment of fistula in ano, studies have been conducted using plain MR imaging; however, there have been relatively few studies on 3D VIBE on 3T MRI sequence. 3D VIBE MRI may identify enhanced granulation tissue suggestive of active infection from abscesses. Contrast MRI with 3DT1 is quicker than several Plain MR sequences and may better differentiate disease activity and fibrosis.

LITERATURE REVIEW

Anal fistulas have been described since Hippocrates' time, although they didn't receive much attention until the 19th century (14). Frederick Salmon founded the Charitable Clinic and today, this facility is known across the world as the world-renowned St. Mark's a London-based hospital. Surgical treatment of fistula-in-ano is known for its high recurrence rates, with recurrence seen in 25% of cases [1]. The goal of treatment in the perianal fistula is to eliminate the primary opening, associated tracts, & secondary openings without continence loss [2]. Conventional fistulography, computed tomography, and ultrasonography are insufficient for the complete & correct disease assessment [2]. MRI plays a critical role in the identification

& localising entire course fistula, external opening, internal opening, primary track, secondary tracks, & abscesses. Therefore, it is essential for fistula classification & treatment (5).

MATERIALS & METHODS

The study was carried out at the AIMS, Kochi's Radiodiagnosis Department. Thirty participants, suspected of having peri-anal fistula were enrolled in the research for two years from 2020 and underwent routine MRI & 3D VIBE post-contrast sequence, followed by surgical exploration.

After receiving approval from the Thesis Protocol Review Committee, this prospective, cross-sectional study was carried out (Scientific, Ethical & Financial).

Study location: Department of Radiodiagnosis, AIMS, Kochi.

All of the patients participating in the trial provided their informed permission

Statistical Analysis

Statistical analysis was done using IBM SPSS 20. (SPSS Inc, Chicago, USA). Mean & standard deviations were used to express the numerical variables. The quantitative variables like age were presented as mean. The qualitative variables like gender, primary fistulous tracts, & their complications were represented in frequencies & percentages (in routine plain MRI, 3DT1 VIBE, & surgical findings).Chi-square test was utilized to determine statistical significance of 3D T1 VIBE post-contrast sequence on 3T MRI & the routine plain MR Fistulogram sequence, using surgical results as the gold standard (for comparison of fistula type, secondary tracts, & its complications). Mc Nemar chi-square test was used with validity

parameters (such as sensitivity specificity, PPV, NPV, & Accuracy) to evaluate the diagnostic accuracy of 3D volumetric T1 weighted fat, saturated post-contrast sequence on 3T MRI & routine plain MR Fistulogram sequence in detection & characterization of perianal fistula & correlating with surgical findings. A p-value <0.05 was considered statistically significant, indicating agreement between MRI & surgery in detecting perianal fistula & its complications. As the reference standard, the kappa analysis method was used to evaluate in accordance with the surgical results.

RESULT

The study included 30 patients, 22 (73.3%) of whom were male and 8 (26.7%) females. This was similar to a previous study done by Lunniss PJ et al. (4) found that men were afflicted two to four times more often than women. This incidence may be partially due to a higher abundance of anal glands in the intersphincteric plane in men. The mean age of distribution was 1.4667, a median of 1. 000. Out of 30 patients included in the study, the majority belonged to the category of 30-40 years (40.00%). Sainio P et al. (5) also showed a maximum incidence of a perianal fistula between the third & fifth decades.

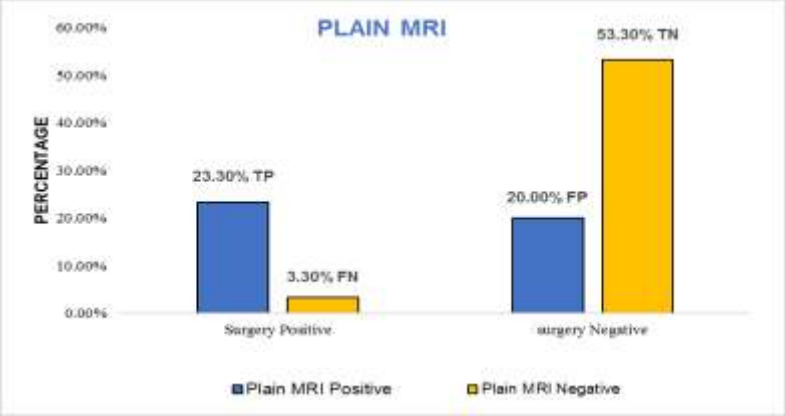
Both the axial & coronal MRI protocols were required for interpretation. The coronal sequences revealed details about the puborectalis & levator ani. The axial sequences yielded more information about the intersphincteric space. Active fistulous tracts were hypo-intense on T1 compared to muscle and hyper-intense on T2 (best visualised with fat saturation). Lumen tract fluid causes T2-weighted hyperintensity. In fat-saturated T2-weighted sequences, fluid, granulation tissue, and pus were hyperintense against low signal intensity suppressed fat, making fistulous tracts more visible. Previous research has yielded similar results [5].

TABLE No:01: Diagnostic accuracy of plain MRI with surgical findings in detection of intersphincteric tract

Plain MRI	SURGERY		Total	p-value	Kappa	p-value
	Positive (%)	Negative (%)				
Positive (%)	7 (23.3%)	6 (20.0%)	13	0.125	0.502	0.003
Negative (%)	1(3.3%)	16 (53.3%)	17			
Total	8	22	30			

Out of 30 patients included in the study, 7 (23.3%) patients (True positive) were found to have intersphincteric fistula in plain MR sequence & surgery; having a sensitivity of 87.50% & diagnostic accuracy of 76.67%. On evaluation there was a weak agreement between plain MRI & surgical findings (P value 0.003) in assessing the intersphincteric tract.

FIGURE No: 01: Diagnostic accuracy of plain MRI with surgical findings in detection of intersphincteric tract



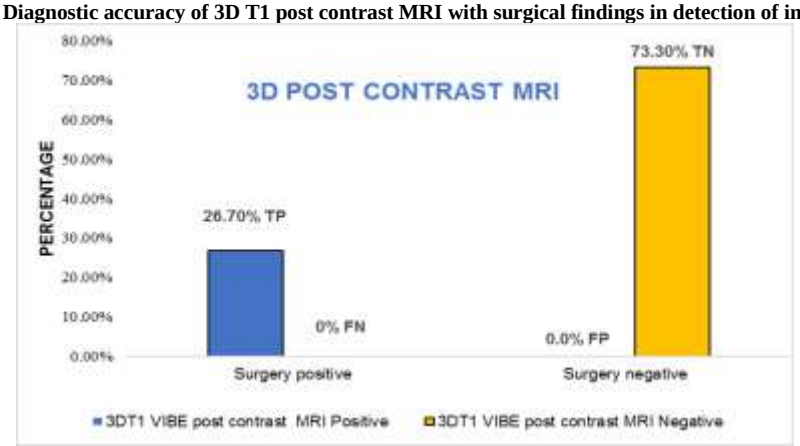
Statistic	Value	95% CI
Sensitivity	87.50%	47.35% to 99.68%
Specificity	72.73%	49.78% to 89.27%
Positive Predictive Value	53.85%	35.97% to 70.79%
Negative Predictive Value	94.12%	71.53% to 99.03%
Accuracy	76.67%	57.72% to 90.07%

TABLE No:02: Diagnostic accuracy of 3D T1 post contrast MRI with surgical findings in detection of intersphincteric tract

3DT1 VIBE	SURGERY		Total	p-value	Kappa	p-value
	Positive (%)	Negative (%)				
Positive (%)	8 (26.7%)	0 (0.0%)	8	1.000	1.000	<0.001
Negative (%)	0(0.0%)	22 (73.3%)	22			
Total	8	22	30			

8 (26.7%) patients (True positive) were found to have intersphincteric fistula in the 3DT1 VIBE sequence and the surgery, having a sensitivity of 100.00% & diagnostic accuracy of 100.00%. On evaluation there was a perfect agreement between 3D VIBE post contrast images and surgery in assessing the intersphincteric tract (P value < 0.001).

Figure No:02: Diagnostic accuracy of 3D T1 post contrast MRI with surgical findings in detection of intersphincteric tract.



Statistic	Value	95% CI
Sensitivity	100.00%	63.06% to 100.00%
Specificity	100.00%	84.56% to 100.00%
Positive Predictive Value	100.00%	
Negative Predictive Value	100.00%	
Accuracy	100.00%	88.43% to 100.00%

3D VIBE image was superior to the routine plain MR imaging in the assessment of the intersphincteric tract due to high sensitivity, specificity, predictive values and diagnostic accuracy.

Out of 30 patients included in the study, 16 (53.3%) Patients (True positive) were found to have transsphincteric fistula in plain MR sequence & surgery, having a sensitivity of 69.57% & diagnostic accuracy of 66.67%. 23 (76.7%) patients (True positive) were found to have trans sphincteric fistula in the 3DT1 VIBE sequence & surgery having a sensitivity of 100.00% & diagnostic accuracy of 100.00%. On evaluation there was a perfect agreement between 3D VIBE post contrast images and surgery in assessing the transsphincteric tract (P value < 0.001). Whereas there was only a minimal agreement between plain MRI & surgical findings (P value 0.199). Therefore, 3D VIBE image was superior to the routine plain MR imaging in the assessment of the transsphincteric tract.

4 (13.3%) patients were found to have supralevatoric tract in routine plain MR & 3D T1 VIBE post-contrast sequence when compared to surgical findings. There was a sensitivity of 100% & diagnostic accuracy of 100.0% in both sequences. On evaluation there was a perfect agreement between 3D VIBE post contrast images with surgery as well as in the case of routine plain MRI with surgery in assessing the supralevatoric tract (P value < 0.001). Hence there was no significant difference between both the imaging methods in the evaluation of the supralevatoric tract.

Out of 30 patients included in the study, 26(86.7%) patients (True positive) were found to have infralevatoric fistulous tract in plain MR sequence & surgery; having a sensitivity of 96.3% & diagnostic accuracy of 96.67%. 27 (90.0%) patients (True positive) were found to have infralevatoric fistula in 3DT1 VIBE sequence & the surgery, having a sensitivity of 100.00% & diagnostic accuracy of 100.00%. On evaluation there was almost perfect agreement between 3D VIBE post contrast images and surgery in assessing the infralevatoric tract (P value < 0.001). Whereas there was substantial agreement between plain MRI & surgical findings (P value <0.001). Therefore, 3D VIBE image was superior to the routine plain MRI imaging in the assessment of the infralevatoric tract.

The 3D post-contrast sequence had higher sensitivity & diagnostic accuracy than the plain MR sequence in detecting the primary tract, especially the infralevatoric tracts. There was no added advantage in the evaluating supralevatoric tracts. It's been documented in the medical literature that different MRI sequences have varying degrees of accuracy in determining the kind of fistula present (6,7).

Accurate internal opening identification reduces recurrence and guides surgical treatment. Out of 30 patients included in the study internal opening was visible in 25(83.3%) patients (True positive) in plain MR sequence & surgery, having a sensitivity of 89.29% & diagnostic accuracy of 90.00%. 27 (90.0%) patients (True positive) were found to internal opening in the 3DT1 VIBE sequence & surgery with a sensitivity of 96.43% & diagnostic accuracy of 96.67%. This was similar to a previous study done by Torkzad, et al & Cerit et al (8,9)

In one of the cases, post contrast imaging was able to detect internal opening where the routine plain MRI sequence failed as depicted in (Figure No:03). It is inevitable to miss the tiny internal openings. The T1 3D VIBE can be reconstructed into millimetric slices and can clearly show some of the internal openings and the tiny fistulous tracts that cannot be detected in plain MRI. On evaluation there was a moderate agreement between 3D VIBE post contrast images and surgery in internal opening identification (P value < 0.001). Whereas there was a weak agreement between plain MRI & surgical findings (P value 0.001). Therefore, 3D VIBE image was superior to the plain MRI in identifying internal opening.

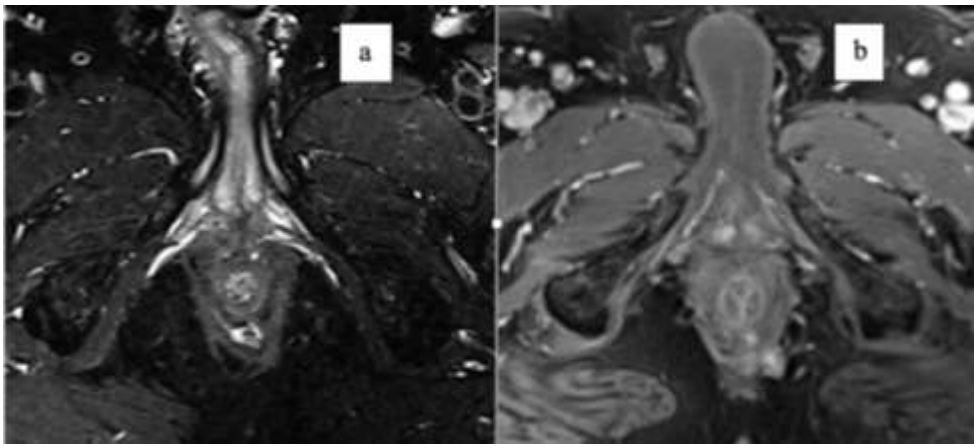


Figure No:03: (a) Axial STIR images demonstrating Transsphincteric with absent visualization internal opening. (b) Axial 3D T1 Post contrast image demonstrates an enhancing transsphincteric fistulous with an internal opening at 5 O'clock.

Out of 30 patients included in the study, 25(83.3%) patients (True positive) were found to have external opening in plain MR sequence & surgery; having a sensitivity of 96.15% & diagnostic accuracy of 93.10%. 26 (86.7%) patients (True positive) were found to have external opening in 3DT1 VIBE sequence & the surgery, having a sensitivity of 100.00% & diagnostic accuracy of 93.33%. Both the plain and the contrast study had high sensitivity and accuracy in detection of the external opening. On evaluation there was a moderate agreement between 3D VIBE post contrast images with surgery (P value < 0.001). This was similar in the case of routine plain MRI with surgery in assessing the external opening (P value < 0.001). Hence there was no significant difference in between both the imaging methods in the evaluation of the external opening.

An abscess is described as any widening of primary or secondary tract or any fluid collection measuring more than 10 mm; Fistulas are fluid-filled tubular structures having a diameter less than 10 mm, according to Mendoza et al., & Torkzad MR (15, 8). Out of 30 Patients in the study, the routine plain MR could detect 11(36.7%) patients (True positive) with abscess. 3D T1 post-contrast could detect 15 (50.0%) patients (True positive) with abscesses. In comparison with 3D T1 post-contrast MRI, the routine plain MR failed to detect 4(13.3%) cases (patients) with abscesses. Plain MRI has a sensitivity of 73.33% & diagnostic accuracy of 76.67% in detecting the abscess. 3D T1 post-contrast VIBE MRI had a sensitivity of 100.00% & an accuracy of 93.33% in correctly detecting abscesses. Previous studies by Beets-Tan et al. (16) & Singh K et al. (11) also showed a similarly high sensitivity of 96% & 87.5%, respectively. On evaluation there was almost strong agreement between 3D VIBE post contrast images and surgery in detecting the abscess (P value < 0.001). Whereas there was a weak agreement between plain MRI & surgical findings (P value 0.003). Therefore, 3D VIBE image was superior to the routine plain MRI in detecting the abscess.

The primary fistulous tracks can be complicated by secondary tracts, which can have supralevator, ischiorectal, & horseshoe extensions.

Out of 30 patients included in the study, plain MRI could correctly detect secondary tracts in 8 (26.7 %) patients (true positive). There were 7(23.2%) cases with (false positive) secondary tract by plain MRI. 3D VIBE post-contrast MRI could correctly detect 9 (30.0 %) (True positive) cases with secondary tract, whereas 5 (16.7%) cases with (false positive) secondary tract by plain MRI. The plain MRI misinterpreted STIR hyperintense periprostatic vessels close to the fistulous tract as secondary ramifications, whereas in 3D VIBE post contrast Post contrast MR sequence

peripheral vessel enhancement was falsely diagnosed as the fistulous tract. In the literature, the surgical results have been considered the reference standard. However, some of the false positive can be explained by the fact that not all extensions may be visible during surgery in certain complex cases as in previous studies by Miguel Criado et al, Schaefer O et al and Halligan Steve et al (3,12,13).

Out of 30 patients included in the study, 4 (13.3%) (false negative) cases in Plain MRI & 3 (10.0%) (false negative) cases in 3D post-contrast MRI failed to detect the secondary tract. This was detected during surgery. Plain MRI had a sensitivity of 66.67% & an accuracy of 63.33%, while 3D T1 post-contrast MRI had a sensitivity of 75.00% & an accuracy of 75.00 % in detecting branching tracts. On evaluation there was a weak agreement between 3D VIBE post contrast images and surgery in detecting branching tracts (P value 0.011). Whereas there was a weak agreement between plain MRI & surgical findings (P value 0.136). Therefore, 3D VIBE image was relatively better in comparison with routine plain MRI in detecting branching tracts.

Horseshoe tracts are secondary tracts with circular extensions to either side internal opening. A horseshoe-shaped fistula contains two tracts and one internal orifice, commonly in the midline near to inferior boundary puborectalis muscle. It can have extensions of tracts or abscesses in the intersphincteric, ischioanal, or supralevator directions (11). 6 (20.0%) patients (True positive) were each found to have horseshoeing on plain MRI & contrast MRI on comparing with the surgery. The plain MRI falsely detected a horseshoe abscess in 3 (10.0%) (false positive) which was not found during post-contrast MR & surgery. This may be due to the contrast MRI sequences' exceptional sensitivity & specificity in detecting horseshoe abscesses. Plain MRI had a sensitivity of 100.00% & an accuracy of 90.00% in detecting horseshoeing, whereas 3D VIBE T1 post-contrast VIBE sequence had a sensitivity of 100.00% & an accuracy of 100.00%. On evaluation there was almost perfect agreement between 3D VIBE post contrast images and surgery in detecting horseshoe (P value < 0.001). Whereas there was a moderate agreement between plain MRI & surgical findings (P value < 0.001). Therefore, 3D VIBE image was superior to the routine plain MRI in detecting the abscess.

Plain MRI has a sensitivity of 33.33% & an accuracy of 93.33% in correctly detecting ischiorectal fossa involvement. 3D T1 post-contrast VIBE MRI has a sensitivity of 100.00% & accuracy of 100.00% in detecting ischiorectal fossa involvement. On evaluation there was almost perfect agreement between 3D VIBE post contrast images and surgery in correctly detecting ischiorectal fossa involvement (P value < 0.001). Whereas there was a weak agreement between plain MRI & surgical findings (P value 0.002). In my study, contrast imaging performed better in assessing the ischiorectal fossa involvement than routine plain MRI.

Out of 30 patients in the study the Plain MRI has a sensitivity of 18.75% & an accuracy of 50.00% in correctly detecting fibrous scar. 3D T1 post-contrast VIBE MRI has a sensitivity of 100.00% & accuracy of 63.33% in detecting fibrous scar. On evaluation there was almost perfect agreement between 3D VIBE post contrast images and surgery in detecting fibrous scar (P value 0.051) Whereas there was a weak agreement between plain MRI & surgical findings (P value 0.743). Therefore, 3D VIBE image was superior to the routine plain MRI in detecting fibrous scar. Active tract walls displayed post-contrast enhancement due to granulation tissue. Inactive tracts were hypointense on T1- and T2-weighted images and lacked contrast enhancement due to fibrotic changes and inflammatory subsidence. Thus, post contrast investigation shows the fibrous scar better than MR sequence.

Compared to routine plain MRI imaging, the 3D sequence's acquisition time was shorter. 3D sequences with isotropic voxels provide high-quality multiplanar reconstruction images. This technique reduces imaging time & simplifies image processing by eliminating the need for 2D images in other planes. Our 3D VIBE post contrast study took 7 min, substantially less than the standard study. Anal fistula sufferers often have perianal discomfort, pus, restlessness, or other symptoms. routine plain MRI sequences might cause claustrophobia in anal fistula patients due to their long scanning period, which can cause image artefacts.

Before removing routine plain MR Sequences from perianal fistula imaging, 3D sequences must be evaluated. MRI research recommends the CE 3D T1 sequence for optimal diagnostic performance. There is a learning curve in evaluating 3D sequences before routine plain MR Sequences are removed, in perianal fistula imaging.

3D sequence requires a work station that allows flexibility in assessing the complex fistula and branching tract in multiplanar processed images, whereas routine plain MRI could not assess the oblique plane. 3D VIBE was a 1.2mm-thick high-resolution isotropic sequence, making it thinner than the typical study and requiring less scanning time. Thus, it can show very small lesions, secondary tract, and interior opening, and can be employed for very claustrophobic patients who cannot handle long scanning sessions. The 3D VIBE post contrast sequence outperforms routine plain MRI in diagnosing complex fistulous tracts and greater degrees of fistula

DISCUSSION

In comparison with routine plain MRI, postcontrast 3D VIBE was significantly superior in the evaluation of the infralevatoric tract (intersphincteric tract and transsphincteric) with perfect agreement between the 3D VIBE and surgery.

3D VIBE was considerably more superior in diagnosing internal opening, abscess, ischiorectal fossa involvement, and fibrous scar with perfect agreement with surgery. In contrast the routine plain MRI showed weak agreement with the surgery.

Both the routine plain MR and 3D VIBE post contrast showed perfect agreement was no significant difference in the evaluation of the supralevatoric tract with respect to the surgical findigs.3D VIBE did not confer any advantage over the routine plain MRI.

There was no significant difference in the evaluation of branching tracts and external opening between the routine plain MR and 3D VIBE with both sequences having moderate to weak agreement.

Multiplanar reconstruction of the 3D slab images and thinner reconstructed slices provide an added advantage to the 3D VIBE sequence.

CONCLUSION

3D T1 VIBE post contrast was significantly superior to the routine plain MRI in the evaluation of the infralevatoric fistulous tract.

3D VIBE was considerably more superior in to the routine plain MRI in diagnosing internal opening, abscess, ischiorectal fossa involvement, and fibrous scar.3D VIBE did not confer any advantage over the routine plain MRI in the evaluation of supralevatoric tract. There was no significant difference between the routine plain MR and 3D VIBE sequence in the evaluation of branching tracts and external opening

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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