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Real-time contrast-enhanced endoanal ultrasound vs. MRI in perianal fistula: Which modality leads to better surgical mapping?

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ABSTRACT

Introduction: Perianal fistula (PAF) is a benign anorectal disease that can seriously affect the quality of life of patients if diagnosis and treatment are delayed. In this study, we compared the diagnostic performance of Magnetic Resonance Imaging (MRI) and contrast-enhanced anal ultrasonography (EAUS), which are commonly used before surgical planning for PAF treatment.

Materials and Methods: Between 2022-2024, the records of 40 patients who underwent contrast-enhanced EAUS and MRI examinations and subsequent surgical treatment for PAF at Sakarya University Training and Research Hospital during the preoperative period were retrospectively evaluated. Using intraoperative findings as the "gold standard" reference, the sensitivity, specificity, and positive/negative predictive values of both preoperative diagnostic methods for mapping the fistula tracing, detecting the internal orifice, and identifying existing abscesses were investigated.

Results: The mean age of the patients was 41 years (19-73) and 72.5% were male (n=29). Of the 40 patients, 29 were classified as having primary (72.5%) and 11 as having recurrent perianal fistulas (27.5%). Contrast-enhanced EAUS accurately mapped the fistula tracts 85% of the time, with a success rate of 100%, especially in primary fistulas. In contrast, in the presence of recurrent disease, the diagnostic sensitivity of EAUS was insufficient in 22 patients (54.5%). EAUS was found to be advantageous in detecting submucosal or small abscesses, whereas MRI was more effective in identifying multiple and complex tracts because of its advantage of wide anatomical mapping. In addition, real-time evaluation of EAUS was found to be an important advantage in determining the relationship between the fistula tract and anal sphincter structures.

Conclusion: Contrast-enhanced EAUS and MRI are complementary modalities for the preoperative mapping of perianal fistulas. Although MRI provides superior anatomical details in the presence of complicated and recurrent disease, EAUS provides real-time evaluation, is easily reproducible, and can be used even in the operating room. The sequential or combined use of both methods, especially in the presence of complicated or recurrent disease, can significantly contribute to increasing surgical success.

Keywords: Contrast-enhanced endoanal ultrasound, magnetic resonance imaging (MRI), perianal fistula, surgical mapping

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Introduction

Benign perianal pathologies are a group of diseases commonly encountered in current surgical practice that can significantly impair patients' quality of life if left untreated. Perianal fistulas (PAF), which are benign perianal diseases that can develop in 15–38% of cases following anal abscesses, are included in this group. Treatment options include various surgical interventions.[1] Accurate diagnosis and classification of perianal fistulas are critical for determining effective treatment strategies.[2,3]

The primary imaging methods currently used in the evaluation of perianal diseases are Magnetic Resonance Imaging (MRI) and Endoanal Ultrasonography (EAUS).[4,5] Preoperative mapping performed radiologically provides the opportunity to determine the strategy for the surgical procedures that can be performed as well as allowing for changes in the surgical procedure during the intraoperative period. In this way, it is clear that performing invasive procedures with a "road map" in the complex anatomical structure of the perianal region will have a significant effect on postoperative outcomes, providing a wide range of positive results, from patient satisfaction in the postoperative recovery process to the prevention of temporary or permanent complications.[6,7]

Although there are various publications in the literature regarding the different working principles, advantages, and disadvantages of Magnetic Resonance Imaging and EAUS, studies investigating the diagnostic performance of these two methods in PAF patients are quite limited.[8] In this study, we aimed to compare the diagnostic data obtained with MRI and contrast-enhanced EAUS in the preoperative period of PAF patients with the findings detected during surgery. Thus, the contributions of both methods to the preoperative surgical strategy determination process were evaluated, and the accuracy of MRI and EAUS in the diagnosis of PAF was revealed in terms of surgical outcomes.

Materials and Methods

Study Design and Ethical Approval

This study had a retrospective single-center design. Patients diagnosed with PAF who underwent surgery at the General Surgery Clinic of Sakarya University Education and Research Hospital between 2022-2024 were included in this study. Ethical approval for the study was obtained from the Scientific Research Ethics Committee of Sakarya University (No: E-43012747-050.04-428168-163, Date: 20/11/2024). This study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Selection

The medical records of the patients diagnosed with PAF during the study period were retrospectively reviewed. Patients who had undergone medical treatment, those with fistulas associated with inflammatory bowel disease, pregnant women, those with incomplete medical records, and those who refused to participate in the study were excluded from the study.

Patients who were diagnosed with PAF during the specified period and underwent contrast-enhanced EAUS and MRI examinations before surgery, followed by surgical treatment, were evaluated in this study.

Imaging Methods

EAUS examinations were performed by two surgeons using an Arietta 65 endorectal probe (Hitachi, Japan). The rectum was emptied with a rectal enema prior to examination, which was performed in the prone position. Hydrogen peroxide (H_2O_2) was administered simultaneously with the fistula external opening during ultrasonographic evaluation using a gray-colored branule to create a contrast agent and perform mapping. EAUS was used to classify fistulas (intersphincteric, transsphincteric, suprasphincteric, extrasphincteric, or superficial). Mapping of the fistula tract(s) (trajectory, extension area, etc.), presence or location of the internal opening of the fistula, presener of accompanying abscesses, whether the fistula is a multiple-tract (branched), and the relationship of the fistula tract with the internal and external sphincters (damage, invasion, etc.) were analyzed.

Magnetic resonance (MR) examinations were performed by a radiologist using 1.5 T MR (Siemens, Germany) devices available in the institution's radiology unit. The protocol primarily used T2, T2 fat-suppressed sequences, and contrast-enhanced sequences, when deemed necessary. The same parameters used in EAUS were used in the fistula evaluation.

Surgical Evaluation

The findings obtained during surgery were considered 'reference findings.' The surgical team carefully explored the anal canal and perianal region in all cases to evaluate fistula tracts, internal orifice localization, possible additional cavities or abscesses, and sphincter integrity. The parameters reported during the operation were compared with the EAUS and MRI results and analyzed. Diagnostic consistency (agreement) analyses were performed by comparing the surgical findings with EAUS and MRI reports.

Data Collection

The dataset created for each patient was processed into a single Excel table containing the following basic variables (Table 1).

Statistical Analysis

SPSS 22 (IBM SPSS Statistics, Armonk, NY, USA) software was used for statistical analyses. Continuous variables are presented as mean±standard deviation or median (min-max), and categorical variables are presented as numbers and percentages. The agreement between EAUS and MRI with the surgical findings was evaluated by calculating the sensitivity, specificity, positive predictive value, and negative predictive value. Differences between the two methods were compared using the chi-square test or Fisher's exact test, with $p<0.05$ considered statistically significant.

Results

The information of 192 patients diagnosed with PAF within a specified period was retrospectively evaluated. After excluding 152 patients based on the exclusion criteria mentioned above, the remaining 40 patients were included in the study.

Of the patients, 29 (72.5%) were male and 11 (27.5%) were female, with a mean age of 41 years (range, 19–73 years). The mean age was 32 years (range, 19–49 years) for female patients and 44 years (range, 24–73 years) for male patients. Of the 40 patients included in the study, 29 (72.5%) were diagnosed with primary PAF, and 11 (27.5%) with re-

Table 1. Variables and definitions

Variable	Description / Unit
Patient ID	Unique patient identifier
Procedure Date	Date of ERUS/MRI examination (DD/MM/YYYY)
Sex	M: Male, F: Female
Age	Years
Diagnosis	Subtype of perianal fistula or other relevant diagnosis
IAS Diameter	Internal anal sphincter diameter (mm)
Sphincter Injury	Present / Absent
Fistula Characteristics (ERUS)	Features of the fistula as defined by ERUS
Fistula Characteristics (MRI)	Features of the fistula as defined by MRI
Fistula Location (ERUS)	Anatomical location determined by ERUS
Fistula Location (MRI)	Anatomical location determined by MRI
Fistula Type (ERUS)	Park classification of fistula based on ERUS findings
Fistula Type (MRI)	Park classification of fistula based on MRI findings
Abscess (ERUS)	Abscess present on ERUS (Present / Absent)
Abscess (MRI)	Abscess present on MRI (Present / Absent)
Fistula Length (ERUS)	Total fistula length measured by ERUS (mm)
Fistula Length (MRI)	Total fistula length measured by MRI (mm)
Surgical Findings	Intraoperative observations and descriptions
Concordance with ERUS (%)	Percentage agreement between ERUS findings and surgery
Concordance with MRI (%)	Percentage agreement between MRI findings and surgery

IAS: internal anal sphincter; ERUS: endoanal ultrasound; MRI: magnetic resonance imaging.

current PAF. Following surgical and radiological evaluation, 19 patients (47.5%) were diagnosed with simple PAF and 21 (52.5%) with complicated PAF.

The distribution of fistula types identified in the table is presented below. A comparison of endoanal ultrasound (EAUS) and magnetic resonance imaging (MRI) findings and their confirmation with surgical reference findings resulted in the following results (Table 2).

Fistula Tract Mapping

Endoanal ultrasound successfully mapped the fistula tracts in 34 of the 40 patients (85%). In all patients with primary fistulas (n=29, 29/29; 100%), fistula tracts were completely identified using EAUS. In only 5 of 11 (5/11; 45.5%) patients with recurrent PAF, mapping was possible with EAUS, whereas mapping could not be performed in 6 patients (6/11, 54.5%).

Internal Orifice Detection

In the endoanal ultrasound evaluation, the internal orifice was detected in 30 of 40 patients (75%), whereas it could not be identified in 10 patients (25%).

The rate of internal orifice detection in primary PAF patients was 86.2% (n=25/29), while in recurrent PAF patients, the same rate was 45.5% (n=5/11).

Abscess Detection

In six patients (15%), the presence of an abscess was determined during surgical examination and/or clinical follow-up, although no abscess was reported on MRI examinations; however, all of these abscesses were detected using EAUS. In one patient (2.5%), although an abscess focus was reported on MRI, the presence of this abscess could not be demonstrated using EAUS.

Table 2. Distribution of fistula types among study patients (n=40)

Fistula Type	No. of Patients	Percentage (%)
Intersphincteric	16	40.0
Transsphincteric	14	35.0
Submucosal	2	5.0
Extrasphincteric	1	2.5
Unclassified	7	17.5

Data are shown as the number of patients (%) in each fistula category. Classification was performed according to the Park et al. system. "Unclassified" denotes fistulas that did not fit standard Park categories.

Multiple (More Than One) Fistula Tract

In six patients (15%), EAUS detected multiple fistula tracts or side branches (additional tracts), but these additional tracts were not mentioned in the MRI reports. In one patient (2.5%), on the contrary, although multiple tracts were reported on MRI, EAUS determined that there was only one tract. Surgical findings confirmed the tracts detected by EAUS.

Sphincter Relationship

In 34 of the 40 patients (85%), the relationship with the sphincter (intersphincteric, transsphincteric, etc.) was clearly evaluated by EAUS. In the remaining 6 patients (15%), assessment of the sphincter-fistula relationship was not adequately performed due to granulation tissue, chronic inflammation, or technical difficulties. In one patient (2.5%), a transsphincteric fistula was identified by EAUS, while MRI classified the same fistula as an intersphincteric fistula. However, during surgical exploration, the classification was confirmed as transsphincteric fistula, and Laser Ablation of Fistula Tract (LAFT) was applied.

Recurrent Perianal Fistulas

In four of the patients in the recurrent group (n=4/11; 36%), the fistula tract and its branches could be mapped in detail with MRI, while EAUS failed to fully visualize and identify the fistula tract and its branches.

Submucosal Fistulas

In two patients (5%), submucosal abscesses were only detectable with EAUS, while these foci were not reported in the MRI findings.

Representative imaging of perianal fistula/lesion types according to the Park classification (contrast-enhanced where indicated) is shown in Figure 1, with Panels A–F illustrating the spectrum of common fistula anatomies and associated lesions.

Discussion

In this study, it was determined that both radiological methods provide important information in the preoperative period but that they have advantages and disadvan-

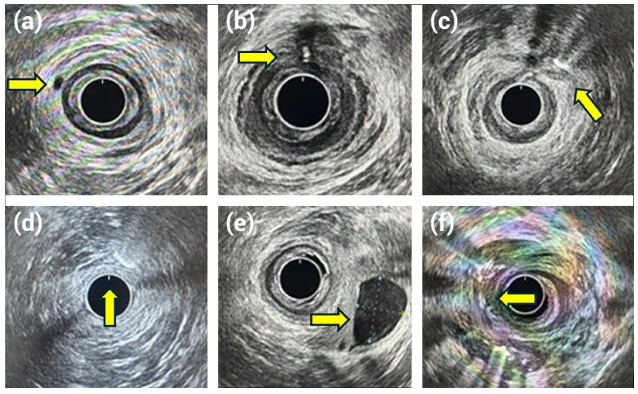

Image No	Fistula/Lesion Type	Park Classification
A	Intersphincteric fistula	Type I
B	Intersphincteric fistula with low transsphincteric extension	Type IIa (low transsphincteric)
C	High transsphincteric fistula	Type IIb (high transsphincteric)
D	Intersphincteric fistula (contrast-enhanced)	Type I
E	Perianal abscess	—
F	Intersphincteric "horseshoe" fistula	Type I (horseshoe variant)

Figure 1. Representative imaging of perianal fistula/lesion types according to Park classification. Panels A–F show the spectrum of common fistula anatomies and associated lesions as visualized on endoanal ultrasound (with contrast where indicated).

tages when compared to each other in certain subgroups of the disease. In studies comparing the two methods in the literature, it has been stated that MRI is particularly effective in complex and recurrent cases, while EAUS provides high accuracy in imaging submucosal or intersphincteric lesions.[9-12] In our study, similar to the literature, MRI provided more satisfactory preoperative examination results in patients with recurrent PAF due to its extensive anatomical mapping feature, while EAUS did not allow for adequate diagnostic evaluation in this patient group. In our study, it was observed that granulation tissue, scar tissue, or chronic inflammation that developed due to previous surgical interventions or repeated abscess drainage negatively affected the EAUS evaluation. However, the ability to perform nearly accurate evaluations with EAUS in patients with primary PAF supports our view. This leads us to conclude that EAUS examination may be sufficient on its own in the primary or simple fistula patient group, whereas MRI examination may be appropriate in more complex cases.

The ability to identify the internal orifice is important because it can influence the type and extent of surgery performed in PAF surgery. One of the most important advantages of EAUS is that it is applied in direct contact with the relevant anatomical region, thereby enabling a millimeter-level examination of the internal structure of the anal canal.[13] However, despite all efforts, it is sometimes not possible to identify the internal orifice either radiologically or surgically. This situation may arise, especially in recurrent cases, because the internal orifice is not clearly visible or deformed.[14] Consistent with these findings, in our study, the rate of detection of the internal orifice with EAUS was very high in patients with primary PAF, whereas MRI examination was found to be useful, especially in cases where EAUS was ineffective.

Another important clinical finding in patients with perianal fistulas is the presence of abscesses. The presence of an abscess correlates with aggressive clinical symptoms and the necessity of medical treatment and is considered a limiting factor for definitive surgical treatment, except in emergency situations.[14,15] Therefore, accurate determination of the presence, location, and size of an abscess is extremely important in patients scheduled for surgical treatment. Small collections at the submucosal or internal sphincter level may sometimes remain unclear on MRI sequences, particularly fat-suppressed T2 or contrast-enhanced images. Similarly, the literature reports that this issue can be partially overcome using specialized sequences such as T2 TSE SPIR, but small submucosal abscesses may not always be optimally visualized.[15,16] In our study, all patients with small abscess foci were successfully identified with EAUS, while MRI reports did not mention these abscess foci. We believe that this is due to the high-resolution close-field scanning capability of EAUS, which allows the detection of small abscesses or submucosal cavities.

Perianal fistula surgery is a type of surgery that inherently carries a certain level of risk of incontinence. Therefore, accurately determining the presence of sphincter damage or the relationship between the fistula and sphincter prior to PAF surgery is extremely important in preventing the development of anal incontinence after surgery. In our study, the rate of accurate determination of the fistula-sphincter relationship using EAUS was very high (85%). In one case, the classification determined by EAUS was different from that determined by MRI, and the EAUS classification was confirmed by surgical findings. We believe that this difference may be due to the lack of standardiza-

tion of technical parameters in the MRI protocol or differences in interpretation experience. Similarly, according to literature EAUS has high sensitivity in clarifying sphincter involvement but that combined evaluation with MRI is preferred in recurrent cases.[4,9] Especially in patients with recurrent PAF, as also found in our study, MRI examination is more advantageous in identifying additional fistula tracts or fistula tracts extending more proximally in the anatomical plane. Therefore, combined examinations using both methods will be more effective and beneficial in determining the surgeon's surgical strategy in patients with recurrent PAF.

In general, our study is consistent with the results of other studies in the literature, showing that EAUS performs better in terms of sphincter integrity, abscess presence, and submucosal involvement and has a very high diagnostic value in primary PAF patients, while MRI is superior in cases of complex/transelevator or recurrent PAF because of its advantage in providing extensive anatomical mapping. Additionally, some studies in the literature report that T2 fat-suppressed and contrast-enhanced MRI sequences may facilitate the identification of detailed pathological foci; however, they also note that certain MRI-specific disadvantages, such as cost, accessibility, motion artifacts, and radiologist dependence, may limit their use.[9,11,12,14,15]

Limitations

The findings of this study should be evaluated within the framework of the following limitations. The retrospective nature of the study and its conduct at a single center may have caused sampling bias and limited the generalizability of the results to different institutions or patient populations. The analysis of 40 patients may have limited statistical power, particularly in subgroup comparisons such as primary and recurrent fistula cases. A larger cohort would strengthen the consistency and validity of the observed differences. Endoanal ultrasound examinations were performed by two experienced surgeons, whereas MRI examinations were conducted by a radiologist. The lack of measurement of inter-observer agreement leaves uncertainty as to whether the mapping accuracy is consistent across different operators.

Conclusion

Our study has demonstrated that contrast-enhanced EAUS and MRI are complementary in preoperative mapping in patients with perianal fistulas but offer different advantages in terms of their areas of application, costs, and accessibility. In cases with complex anatomical structures or recurrent and multiple fistula tracts, MRI provides clear mapping capabilities owing to its superior anatomical details and wide-field scanning. By contrast, EAUS stands out for its real-time imaging capability, low cost, and ease of repeatability. When performed by an experienced surgeon in the operating room before or during surgery, it allows for rapid modification of the surgical strategy, as needed.

In complex or recurrent cases, the sequential or combined use of MRI and contrast-enhanced EAUS can enhance surgical success rates by combining the advantages of both methods. This approach provides reliability and flexibility in preoperative planning, and contributes to the development of patient-specific surgical strategies.

Disclosures

Ethics Committee Approval: This non-interventional retrospective study was approved by the Non-Interventional Ethics Committee of the Faculty of Medicine, Sakarya University (No. E-43012747-050.04-428168-163, Date: 20/11/2024). The requirement for written informed consent was waived by the committee due to the study's retrospective design.

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