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Research Article

Accuracy of Endocavitary and Transperineal Ultrasound in Evaluating Fistula-in-Ano

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Abstract

Background: Fistula-in-ano is an abnormal connection between the anal canal and the skin of the perineum, affecting 1.7-2.3/10,000 persons/year. Appropriate evaluations and imaging are necessary to decrease recurrence rate. ***Objective***: Determining accuracy of endocavitary and transperineal ultrasound relative to magnetic resonance imaging in evaluation of perianal fistulas. ***Methods***: A cross-sectional study was conducted on 40 patients with perianal fistula. Endocavitary, transperineal ultrasound and magnetic resonance imaging (MRI) were done for all patients. Many variables were recorded, including location, number of tracts, their relation to the anal sphincters (course), internal opening, external openings, length of tract, distances from the anal verge, and any associated abscess or side branching. ***Results***: Of the 40 patients studied, both modalities showed compatibility between US and MRI for location of fistula, nearly perfect for opening to skin and opening to anal mucosa, and substantial for course of fistula, association collection, and side branching. For fistula length, the analysis revealed a statistically significant mean bias of 4.575 ($p<0.001$), indicating that MRI measurement is higher than US. For distance from anal verge bias, it is 2.575 ($p<0.001$), with the MRI measurement being higher than the US. ***Conclusions***: Ultrasonography is a reliable, cost-effective alternative to MRI for assessing fistula in ano. Although MRI may still be preferred for more complex cases, ultrasound demonstrated high agreement in evaluating location, opening positions, course of fistula, and associated anatomical features.

Keywords: Diagnostic accuracy; Endocavitary ultrasound; Fistula in ano; MRI; Parks classification; Transperineal ultrasound.

دقة الموجات فوق الصوتية في الغلاف الكهفي والسحان في تقييم الناسور في المقعد

الخلاصة

الخلفية: الناسور في المقعد هو اتصال غير طبيعي بين قناة الشرج وجلد العجان، حيث يؤثر على 1.7-2.3 من 10,000 شخص سنويا. التقييمات والتصوير المناسب ضرورية لتقليل معدل تكرار المرض. **الهدف**: تحديد دقة الموجات فوق الصوتية في الفراغ الداخلي والعرضي للعجان بالنسبة لتصوير الرنين المغناطيسي في تقييم الناسور حول الشرج. **الطرائق**: أجريت دراسة مقطعية على 40 مريضا يعانون من ناسور حول الشرج. تم إجراء تصوير بالموجات فوق الصوتية عبر السجان، والتصوير بالرنين المغناطيسي (MRI) لجميع المرضى. تم تسجيل العديد من المتغيرات، بما في ذلك الموقع، وعدد المسارات، وعلاقتها بمصرة الشرج (المسار)، والفتحة الداخلية، والفتحات الخارجية، وطول المسار، والمسافات من حافة الشرج، وأي خراج أو تفرع جانبي مرتبط. **النتائج**: من بين 40 مريضا تمت دراستهم، أظهرت كلتا الطريقتين توافقا بين الناسور الروسي والرنين المغناطيسي لتحديد موقع الناسور، وهو تقريبا مثالي لفتح الجلد وفتح المخاط الشرجي، وكبير لمسار الناسور، وجمع الارتباط، والتفرع الجانبي. بالنسبة لطول الناسور، كشف التحليل عن متوسط دلالة إحصائية يبلغ 4.575 ($p<0.001$)، مما يشير إلى أن قياس الرنين المغناطيسي أعلى من قياسي. بالنسبة للمسافة من انحياز حافة الشرج، فهي 2.575 ($p<0.001$)، مع قياس الرنين المغناطيسي أعلى من الولايات المتحدة. **الاستنتاجات**: يعد التصوير بالموجات فوق الصوتية بديلا موثوقا وفعالا من حيث التكلفة للتصوير بالرنين المغناطيسي لتقييم الناسور في الحمض الطبيعي. على الرغم من أن تصوير الرنين المغناطيسي قد يفضل للحالات الأكثر تعقيدا، إلا أن الموجات فوق الصوتية أظهرت توافقا عاليا في تقييم الموقع، ووضعيات الفتح، ومسار الناسور، والخصائص التشريحية المرتبطة بها.

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INTRODUCTION

Perianal fistula (or "fistula-in-ano") is a pathological tunnel connecting the anal canal to the perianal skin, often resulting from chronic inflammation of anal glands [1-3]. This condition can cause symptoms like perianal discharge, pain, and recurrent abscesses—imposing a substantial burden on patients' quality of life [4-5]. Because the anatomy of the anal canal and perianal region is complex—involving internal and external sphincters, perianal spaces, and potential secondary tracts or abscesses—accurate preoperative imaging is essential for optimal surgical planning and reducing recurrence risk [1,3,5]. Currently, Magnetic Resonance Imaging (MRI) is considered the reference standard for preoperative assessment of perianal fistula. MRI offers high-resolution, multiplanar visualization that can delineate fistulous tracts, their relationship to the sphincter complex, secondary branches, and associated abscesses—features critical for surgical decision-making [1]. On the other hand, Endoanal Ultrasound (EAUS)—and its variants, including three-dimensional (3D) ultrasound and transperineal/transrectal approaches—has also been widely used, thanks to its relative accessibility, lower cost, and real-time capability. [2,6,7]. According to a meta-analysis in 2012, EAUS and MRI showed comparable pooled sensitivities (~ 87%) for detecting perianal fistulas [6]. More recent evidence continues to

support that EAUS may have reliable performance, especially for simpler fistulas or when identifying the primary tract and internal opening [2,8,9]. However—and here lies the gap—despite advances in ultrasound technology (e.g., 3D EAUS, different probe frequencies, transperineal vs endocavitary approaches), it remains unclear how consistently accurate ultrasound is compared with MRI for all relevant anatomical features in everyday clinical settings. For example, while some studies suggest that EAUS may outperform MRI in detecting intersphincteric or transsphincteric fistulas, MRI remains superior in identifying high (suprasphincteric) fistulas, complex branching, deep collections, or abscesses [1,8]. Moreover, many previous studies rely on data from older ultrasound and MRI technologies or have limitations such as small sample sizes, retrospective design, or absence of blinding—which may affect generalizability [2,6]. Given variability in operator expertise, equipment, and patient population, the real-world diagnostic "equivalence" between ultrasound and MRI remains a debated issue. Therefore, we conducted the present study to assess the diagnostic accuracy of endocavitary and transperineal ultrasonography compared to MRI for evaluation of perianal fistula within our population and using current imaging protocols. Our main aim is to determine whether ultrasound can reliably identify key parameters (fistula location, number of tracts, relation to sphincters, internal/external openings, tract length, distance from anal verge, associated collections or secondary branching) with sufficient agreement to MRI. This study aims to determine the accuracy of endocavitary and transperineal ultrasound relative to magnetic resonance imaging in the evaluation of perianal fistulas.

METHODS

Study design and setting

This analytical cross-sectional study was conducted in the Ultrasound and MRI Departments of Al-Imamain Al-Kadhimain Medical City, Baghdad, Iraq. Data were collected from patients evaluated for clinically suspected perianal fistula between November 2023 and December 2024. A convenience sampling approach was used to recruit eligible patients attending the radiology departments during the study period. A total of 40 patients with a clinical diagnosis of perianal fistula were enrolled. The mean age was 43 ± 7.5 years. All participants underwent both ultrasound (US) and magnetic resonance imaging (MRI) as part of their diagnostic assessment.

Inclusion criteria

Clinically suspected perianal fistula. Positive MRI confirmation of fistulous tract.

Exclusion criteria

Absence of a visible external opening. Presence of perianal abscess or sinus without evidence of fistula. Contraindications to MRI (e.g., metallic implants, cardiac pacemakers, severe claustrophobia).

Data collection

Demographic and clinical data (age and symptoms) were retrieved from patient medical records. Imaging data were collected (MRI findings were recorded from finalized radiology reports, and ultrasound findings were documented during real-time examinations by the researcher). Moreover, the patient variables were recorded, including fistula tract course relative to the anal sphincters, number and location of external and internal openings, distance of internal opening from the anal verge, total tract length (external to internal opening), associated abscesses or fluid collections, and presence of secondary tracts/branching.

Ultrasound examination

Ultrasound was performed using a Philips Affiniti 30 system with a 2.0–6.0 MHz curved-array transducer, a 4.0–12.0 MHz linear-array transducer, and a 4.0–9.0 MHz endocavitary transducer. Examinations were performed by the researcher, blinded to MRI results, under supervision of a senior radiologist. Verbal consent was obtained before scanning. Patients were placed in the left lateral decubitus position with knees flexed and buttocks separated manually to facilitate visualization of the perianal region. Transducers were covered with sterile protective covers (nylon glove for abdominal probes, condom for endocavitary probes) with adequate gel. Gray-scale US was performed in sagittal, coronal, and axial planes. Lidocaine 2% gel was applied for patient comfort before endocavitary scanning. Using surgeons' anal clock reference: 12 o'clock anterior, 6 o'clock posterior, and 3 and 9 o'clock representing left and right lateral positions, we recorded fistula course (Parks classification: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric), location/number of internal and external openings, and tract length. Abscesses (>10 mm) and secondary branches.

MRI examination

MRI was performed using a 1.5 Tesla SIEMENS AG (2015) system with a body coil. No bowel preparation was required. Patients were scanned in the supine position, and imaging included the distal rectum, anal canal, sphincter complex, ischioanal fossae, and supralevator spaces. Oblique axial and coronal planes were oriented perpendicular and parallel to the anal canal using a sagittal T2 single-shot sequence for localization. The MRI protocol included T1-weighted images (with fat suppression) (TR: 400–600 ms, TE: 5–10 ms, slice

thickness: 4–5 mm, gap: 0.5–1 mm, FOV: 370–430 mm, and flip angle: 90°). T2-weighted images (with and without fat suppression) (TR: 4000–5000 ms, TE: 100–130 ms, and the same spatial parameters as T1-weighted scans). Post-contrast T1 Fat-Suppressed Images (following IV gadolinium: 0.1 mmol/kg body weight). MRI reports were completed by a specialized radiologist who was blinded to the US findings. The same data sheet used for the US was applied to the MRI for direct comparison.

Diagnostic definitions

Fistula tract: elongated tubular structure, hypoechoic on US and T2-hyperintense on MRI, possibly containing fluid or gas. Parks classification courses: Intersphincteric, confined to intersphincteric space. Transsphincteric, extending through the external sphincter. Suprasphincteric, ascending above puborectalis and then descending into the ischioanal fossa. Extrasphincteric, extending from perineal skin to rectum, bypassing sphincters. Internal opening, tract traversing internal sphincter. External opening, tract penetrating perianal skin, abscess, collection >10 mm, and branching, any secondary tract arising from the primary tract. Active tracts were differentiated from scar tissue based on the presence of fluid/gas and patient history of discharge; saline/contrast injection through the external opening was not performed.

Ethical considerations

Ethical approval was obtained from the Scientific Committee of the Iraqi Board of Diagnostic Radiology. Written informed consent was obtained from all participating patients after explaining the study purpose and ensuring confidentiality.

Statistical analysis

Continuous variables were presented as mean ± SD or median (range) for non-parametric data. Categorical variables were summarized as frequencies and percentages. Agreement between the US and MRI was assessed using Bland-Altman analysis for continuous variables, unweighted Cohen's kappa for categorical variables, and weighted kappa (square-weighted) for ordinal variables. A p-value < 0.05 was considered statistically significant. All analyses were performed using R software (version 4.2.2), employing *dplyr*, *gt*, and *ggplot2* packages.

RESULTS

The demographics and clinical presentation of the study patients are shown in Table 1. The study included 40 individuals with a mean age of 43.0 ± 7.5 years. All participants were male, accounting for 100% of the sample population. In terms of clinical presentation, the majority of participants (85.0%) reported perianal discharge, while 15.0% presented with pain.

Table 1: description of study demographics, and clinical presentation (n=40)

Characteristic	Value
Age (year)	43.0±7.5
Sex	
Male	40(100)
Clinical presentation	
Peri-anal discharge	34(85)
Pain	6(15)

Values are presented as frequency, percentage, and mean±SD.

Table 2 summarizes the findings of ultrasonography and MRI in patients diagnosed with fistula in ano. Both modalities showed similar results for the fistula's location, with 55.0% being posterior to the transverse midline, 40.0% anterior to it, and 5.0% located at the transverse line. The mean length of the fistula was 42.9 ± 22.8 mm on ultrasonography and 47.5 ± 24.4 mm on MRI.

Table 2: ultrasonography and MRI findings in patients affected by the fistula-in-ano

Characteristic	Ultrasound	MRI
Location of fistula		
Posterior to transverse midline	22(55)	22(55)
Anterior to transverse midline	16(40)	16(40)
At transverse line	2(5)	2(5)
Length of fistula (mm)	42.9±22.8	47.5±24.4
Opening to the skin (O'clock) (median, range)	6 (1.0 - 12)	6 (1.0 - 12)
Opening to the mucosa (O'clock) (median, range)	6 (1.0 - 12)	6.0 (1.0 - 12)
Distance from the anal verge (mm)	18.8±8.9	21.4±10.2
Course of fistula		
Inter-sphincteric	22(55)	22(55)
Trans-sphincteric	18(45)	16(40)
Supra-sphincteric	0(0.0)	2(5)
Presence of associated collection	6(15)	8(20)
Presence of secondary tract	10 (25)	8(20)

Values are presented as frequency, percentage, median and range, and mean±SD.

The median opening to the skin and mucosa was consistently reported at the 6 o'clock position across both modalities, with a range from 1 to 12 o'clock. The mean distance from the anal verge was slightly shorter on ultrasonography (18.8 ± 8.9 mm) compared to MRI (21.4 ± 10.2 mm). The fistula's path was mostly inter-sphincteric in 55.0% of cases across both modalities. In 45.0% of cases, it was trans-sphincteric on ultrasonography and 40.0% on MRI. Supra-sphincteric involvement was only identified on MRI in 5.0% of

cases. Associated collections were detected in 15.0% of patients on ultrasonography and 20.0% on MRI. Secondary tracts were observed in 25.0% on ultrasonography and 20.0% on MRI, showing MRI's slightly higher sensitivity for complex anatomical features. Bland-Altman, as shown in Table 3 and Figure 1, analysis highlights the agreement between MRI (used as a reference standard) and ultrasonography for measuring fistula length and the distance to the anal verge.

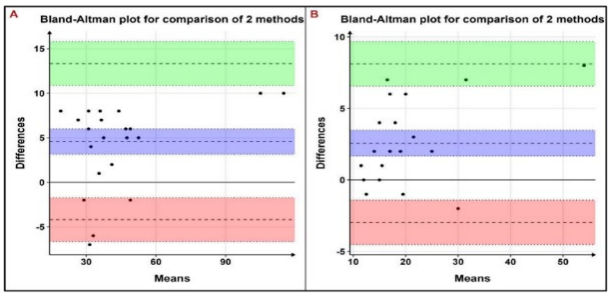

Figure 1: Bland-Altman plot between MRI and US in measuring. (**A**) Length of fistula (mm); (**B**) Distance from the anal verge (mm).

Table 3: The Bland-Altman analysis for the level of agreement between MRI and US for measuring fistula length and the distance to the anal verge

Parameter	Value
Length of fistula (mm)	
Bias	4.575
Standard Deviation of Bias	4.47
Spread of LoAs	17.53
Bias as % of LoA Spread (%)	26.1
p-value	<0.001
Distance from the anal verge (mm)	
Bias	2.575
Standard Deviation of Bias	2.82
Spread of LoAs	11.08
Bias as % of LoA Spread (%)	23.23
p-value	<0.001

LoA: limits of agreement.

For fistula length, the analysis revealed a statistically significant mean bias of 4.575 ($p< 0.001$), indicating that MRI measurements were consistently higher than ultrasonography. The bias was stable across samples, as evidenced by a 95% confidence interval ranging from 3.14 to 6.01. The limits of agreement (LoA) ranged from -4.19 to 13.34, with a spread of 17.53. This shows the range in which most differences between the two methods are likely to be found. This variability indicates systematic differences, which may have implications for clinical interpretation. Additionally, the analysis found the bias to represent 24.08% of the lowest average measurement, emphasizing its relative magnitude. For anal verge distance measurements, the analysis showed a mean bias of 2.575 ($p< 0.001$), with MRI measurements consistently larger than ultrasonography. The bias fell within a 95% confidence interval of 1.67 to 3.48, confirming its significance. The LoAs ranged from -2.97 to 8.12, with a spread of 11.08, demonstrating moderate variability in agreement. Proportional bias was also noted, with it accounting for 22.39% of the lowest average and 4.77% of the highest. The standard deviation of the bias was 2.83, reflecting some variability in differences, while the standard error for LoAs was 0.77, indicating reliability in the range estimates. Figures 2 and 3 show examples of the cases.

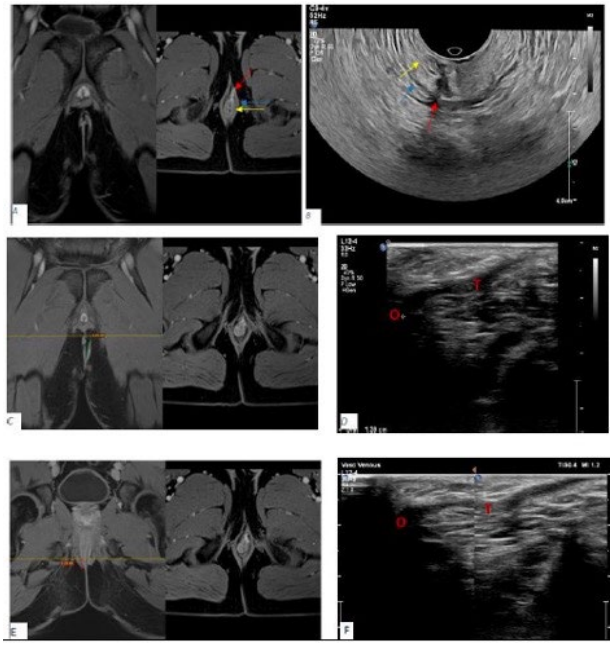

Figure 2: 36-year old male present with perianal discharge. **A**) MRI fat sat T1+C coronal and axial showing transsphincteric fistula (red arrow) cross through external (blue arrow) and internal sphincter (yellow arrow). **B**) endocavity probe US shows transsphincteric fistula (red arrow) cross through external (blue arrow) and internal sphincter (yellow arrow). C) MRI fat sat T1+C coronal and axial, and **D**) liner probe US showing distance from anal verge and open to mucosa. **E**) MRI fat sat T1+C coronal and axial, and **F**) linear probe US show length of fistula tract (T: fistula tract, O: open to mucosa).

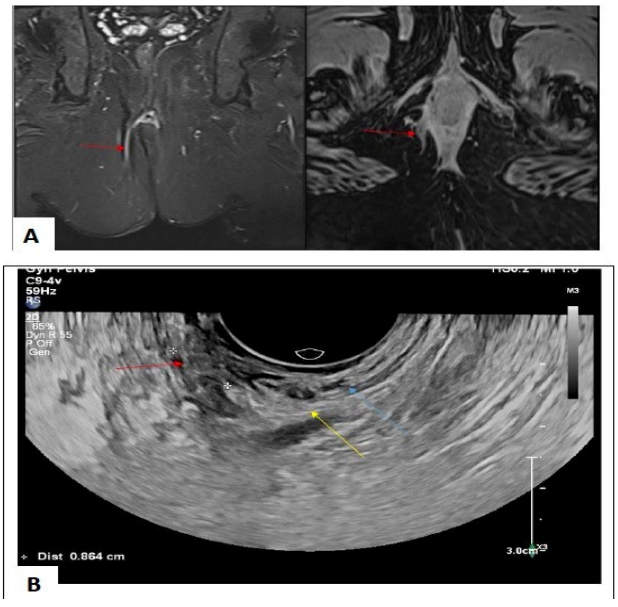

Figure 3: 36-year old male present with perianal discharge. **A**) MRI fat sat T1+C axial and T2 fat sat coronal showing transsphincteric fistula (red arrow); **B**) endocavity probe US show transsphincteric fistula (red arrow) cross through internal (blue arrow) and external sphincter (yellow arrow).

Table 4 presents the results of Cohen's Kappa analysis, which assesses the agreement between ultrasonography and MRI findings in patients with fistula in ano. The analysis revealed strong agreement across most parameters. The location of the fistula had a kappa statistic of 1.0, indicating perfect agreement between ultrasonography and MRI (Z-score = 4.9, $p< 0.001$). The opening to the skin (o'clock) and opening to the mucosa (o'clock) demonstrated nearly perfect agreement with squared weighted kappa values of 0.99 and 0.98, respectively (Z-scores of 6.28 and 6.22, $p< 0.001$).

Table 4: Cohen's Kappa analysis for assessing the agreement between ultrasonography and MRI findings

Parameter	Kappa-statistic	Z-score	*p*-value
Location of fistula[a]	1.0	4.9	<0.001
Opening to the skin (O'clock)[b]	0.99	6.28	<0.001
Opening to the mucosa (O'clock)[b]	0.98	6.22	<0.001
Course of fistula[b]	0.77	4.85	<0.001
Presence of associated collection[a]	0.83	5.31	<0.001
Presence of secondary tract[a]	0.86	5.48	<0.001

[a]Unweighted Cohen's Kappa; [b]Squared weighted Cohen's Kappa.

The course of the fistula showed a kappa of 0.77, indicating substantial agreement (Z-score = 4.85, $p< 0.001$). The presence of associated collections and secondary tracts had kappa values of 0.83 and 0.86, respectively, reflecting substantial agreement (Z-scores of 5.31 and 5.48, $p< 0.001$). These results demonstrate that ultrasonography and MRI are highly concordant for assessing various features of fistula in ano, with particularly strong agreement for the location and opening positions.

DISCUSSION

Perianal fistula is a prevalent condition characterized by an abnormal perianal tract that typically connects two epithelialized surfaces, such as the anal canal and the perianal skin. It is recognized as a chronic, recurrent inflammatory disorder that often necessitates surgical intervention and may require multiple procedures. Accurate preoperative radiological evaluation is therefore essential [10]. Among the available imaging techniques, MRI and endoanal ultrasound are widely accepted for the assessment of perianal fistulas, despite their respective limitations [11,12]. This study focused on determining the accuracy of endocavitary and transperineal ultrasonography in evaluating fistula in ano, using MRI as the reference standard. The study demonstrated that ultrasonography and MRI were highly concordant in the assessment of the opening to the skin and mucosa, with both modalities showing near-perfect agreement (kappa values of 0.99 and 0.98, respectively). This fact is a particularly noteworthy finding, as the accurate identification of the opening positions is critical for surgical planning and determining the appropriate treatment approach for patients with fistula in ano. However, the analysis also revealed some discrepancies in the identification of complex anatomical features. Both modalities showed that the fistula's path was mostly inter-sphincteric. However, MRI was better at finding supra-sphincteric involvement and related collection. In fact, MRI was the only modality that found supra-sphincteric involvement in 5.0% of cases. This highlights the advantage of MRI in evaluating complex cases or when advanced anatomical details are needed for treatment planning, especially in the context of recurrent or complicated fistulas. Similar findings were observed by Domkundwar *et al*. [13], in which they noted that ultrasound was less effective in evaluating suprasphincteric fistulas, emphasizing the need to choose imaging based on specific clinical scenarios. Akhoundi *et al*. [8] also found that ultrasound was more sensitive (87.38%) and accurate (82.25%) for transsphincteric and intersphincteric fistulas, while MRI was better for suprasphincteric types. In terms of anatomical features, ultrasonography showed similar results as compared with MRI in identifying the location of the fistula, with a predominance of posterior and anterior locations, consistent with typical clinical presentations. The measurement of fistula length and distance from the anal verge was comparable between the two modalities, although MRI consistently showed slightly longer measurements. This difference may be attributed to the inherent characteristics of each imaging technique. MRI, as a more detailed and high-resolution imaging modality, may be better suited to capturing the full extent of the fistula tract, leading to a more precise measurement compared to ultrasonography. The results demonstrated high agreement between both modalities, particularly in terms of fistula location, opening positions to the skin and mucosa, and detection of associated collections and secondary tracts ($p<0.001$). Similar to the results of the current study, previous research has demonstrated the reliability of ultrasonographic modalities in assessing perianal fistulas. Roman Boles *et al*. [14] reported that transperineal ultrasonography (TPUS) achieved an overall accuracy of 83.33% for identifying the internal opening of perianal tracts, a sensitivity of 91.30%, and 100% accuracy for detecting horseshoe collections. TPUS also showed an accuracy of 93.33% and specificity of 100% for detecting perianal abscesses. Domkundwar *et al*. [13] determined that transcutaneous perianal ultrasonography exhibited a positive predictive value of 85% for internal openings and a sensitivity of 100% for identifying tracts, concluding its applicability in selecting patients for MRI. Siddiqui *et al*. [6], in a systematic review and meta-analysis, demonstrated that MRI and endoanal ultrasound had comparable sensitivities for detecting perianal fistulas, though MRI showed higher specificity. Schwartz *et al*. [15] reported that endoscopic ultrasound achieved 91% accuracy in delineating the

anatomy of Crohn's perianal fistulas. Mallouhi *et al*. [16] highlighted the utility of transperineal gray-scale and color Doppler sonography, with both achieving 100% sensitivity and specificities of 100% and 94% for perianal fistulas and abscesses, respectively, while color Doppler significantly enhanced diagnostic confidence (p= 0.002). These findings collectively affirm the effectiveness of ultrasonographic techniques, aligning closely with the current study's results. In contrast to the findings of the current study, Sudol-Szopinska *et al*. [17] observed notable differences when surgical findings were used as the reference standard. Their study found that MRI was more accurate than endosonography in identifying types of high fistulas and detecting branches. However, endosonography was found to be more accurate in assessing the internal opening of the fistula. The overall agreement between the two modalities ranged from 53% to 67%, with the highest agreement observed in the assessment of branching. These differences highlight the variable performance of imaging techniques based on the specific anatomical features being evaluated and the reference standard used. Conflicting findings highlight the complementary roles of ultrasound and MRI in evaluating perianal fistulas. Mashhour *et al*. [18] determined that ultrasound is superior for localizing the internal opening and equally effective as MRI in detecting complications; however, MRI is more effective for characterizing fibrotic tracts and extra-sphincteric fistula.

Study Limitations

The study had several limitations. Female participants were not included due to cultural reasons, which may limit the generalizability of the findings. Additionally, the study did not assess inter-observer variability, an important factor that could influence the reliability of ultrasonography when performed by different clinicians or in different settings. Finally, the research was conducted at a single center, which may reduce the applicability of the results to a broader population.

Conclusion

Ultrasonography proved to be a reliable and cost-effective alternative to MRI for the assessment of fistula in ano, although MRI may remain the preferred modality for more complex cases. The findings showed that ultrasonography has a high level of agreement with MRI in evaluating fistula in ano, particularly in determining the location, identifying internal and external openings, and assessing related anatomical features. Despite this strong agreement, systematic differences were noted between the two imaging methods, especially in fistula length and the distance from the anal verge, with MRI consistently providing higher measurements—an aspect that may influence clinical interpretation. Additionally, MRI demonstrated slightly higher sensitivity in detecting complex anatomical features such as supra-sphincteric involvement and side branching when compared with ultrasonography.

Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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