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Role of endoanal ultrasound in the assessment of perianal fistula in correlation with MRI fistulography

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Abstract

Background: Perianal fistula is a considered as chronic recurrent inflammatory condition that requires proper surgical treatment and may require repeated intervention. Therefore, adequate pre-operative radiological diagnosis plays a critical role.

In this study, we aimed at comparing the role of endoanal ultrasonography with MRI fistulography in evaluating the primary fistula's tract, internal opening, secondary extensions, and complications of the perianal fistula.

Results: The study was carried over 108 males (90%) and 12 females (10%) presenting with clinically diagnosed perianal fistula. Ultrasound was found superior to MRI in the localization of the internal opening with estimated K value (0.44), *P* value (0.001). Regarding the type of fistula, ultrasound was found in agreement with MRI in 112 cases (93.3%) with estimated K value of about (0.7). Ultrasound was found equally effective as MRI in the detection of complication with estimated agreement K value of about 1. Regarding assessment of the secondary extensions, the agreement between the two modalities was about 50% with estimated k value of about 0.65. Conversely, MRI was found superior to ultrasound in the characterization of the fibrotic tracts.

Conclusions: Both EAUS and MRI have a crucial role in the evaluation and detection of perianal fistulas. EAUS was preferable to MRI in the localization of the internal opening; ,conversely, in the evaluation of extra-sphincteric fistulas and fibrotic tracts characterization MRI was preferable to EAUS.

Keywords: Endoanal ultrasound, Perianal fistula, MRI fistulography

Background

Perianal fistula is an abnormal perianal tract that connects two epithelialized surfaces, Most often the anal canal and the perianal skin [1].

Preoperative radiological evaluation of perianal fistulas is critical for selecting the most appropriate surgical approach and hence informing the patient about the type of surgery and potential consequences; it is also helpful in lowering the rates of postoperative recurrence due to missed pathology [2].

Magnetic resonance (MR) is multi-planar imaging with a high degree of soft tissue characterization. The ability of MR imaging to show the extensions related to primary tract is its main benefit which may provide a great road map prior to surgery from a morphological standpoint [3].

Endoanal ultrasound (EAUS) is a useful tool for representing the anal canal normal anatomy. It is also simple, inexpensive, available, less taxing on the patient, and has a good diagnostic accuracy. It provides quick evaluation, simple to use, painless, and does not necessitate patient preparation [4].

Endoanal ultrasound also gives excellent imaging of the internal and external sphincters, intersphincteric plane,

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the position of the internal opening, rectal wall, and muscle mobility, all of which are important for the surgical approaches to limit the risk of incontinence [5].

Many studies had adopted similar comparative study between endoanal ultrasound and MRI as in the diagnosis of perianal fistula, some of them showed that ultrasound is superior to MRI in localization of internal opening, others show that MRI is superior to ultrasound.

The main aim of this study is to compare the role of endoanal ultrasound with MRI fistulography in evaluating the primary fistula's tract, internal opening, secondary extensions, and complications of the perianal fistula.

Methods

This study was a prospective study, approved by the ethics committee at our institute during the period from august 2019 to august 2021. The findings were correlated with operative findings (considered as the standard reference).

Patients

It included 120 patients who were referred from the anorectal surgery department and subjected to endoanal ultrasound and MRI fistulography prior to surgery.

Inclusion criteria

Patient presented with clinically diagnosed perianal fistula.

Exclusion criteria

Patients that didn't proceed to operative intervention thus lacked operative confirmation of the findings, patient with general contraindications to MRI examination as (claustrophobic patients, those with cardiac pacemaker or metallic foreign body in their eye or aneurysm clips in their brain). About 20 patients were excluded.

Procedure

Informed consent was obtained from the all patients before they were subjected to the following.

History taking

Detailed history taking was obtained; every patient had to answer several questions as the following:

- Symptoms of perianal discharge, pain, discomfort.
- Possible risk factors as recent operation or previous perianal fistula.

Endoanal ultrasound

Technique EAUS was performed by bK medial systems scanner 1202 (BK, Herlev, Denmark) with a model 2052 transducer equipped with automated multifrequency crystals (11.9 MHz), with 360 mechanical rotation, Fractional bandwith 96.2 % and stainless steel reflector. All patients were evaluated in the lateral decubitus position. The transducer is inserted within the anal canal after being coated with a condom and properly lubricated. No bowel preparation or sedation were required.

The transducer was advanced till the U-shaped sling of the puborectalis, then automatically withdrawn to the superficial perianal plane.

The transducer was positioned so that the anterior aspect of the anal canal is superior on the screen at the 12-o'clock position; the left aspect at 3 o'clock, the posterior aspect at 6 o'clock, and the right aspect at 9 o'clock. Three scan planes were acquired:

1. The deep plane represents the anal canal's upper third, where the hyperechoic puborectalis muscle has a distinctive U-shaped sling appearance.
2. The iso to hyperechoic external anal sphincter (EAS) and inner hypoechoic internal anal sphincter (IAS), as well as the transverse perineal muscle marks the intermediate plane.
3. The hyperechoic layer of the subcutaneous section of the external anal sphincter marks the superficial plane, which represented the lower extremity of the anal canal.

Post processing and image analysis Ultrasound was performed by two radiologists (the first with 10 years of experience and the second with 6 years of experience) in the same setting and the final diagnosis was reached by their agreement (in consensus). Both radiologists were blinded to the results of the MRI.

Further 3D processing of the images was done using B.K 3D viewer software version 7.0.0.519.

The primary tract appears as a hypoechoic tract/band passing adjacent or through to the external sphincter. Its internal opening is identified as the site of the interruption of the hypoechogenic texture of the internal sphincter (Fig. 1).

The anatomy of the fistula was identified considering:

- The primary tract.
- Location of the fistula in relation to the sphincters.
- The clock position of the internal opening.
- Secondary extensions and complications (abscess or collections).

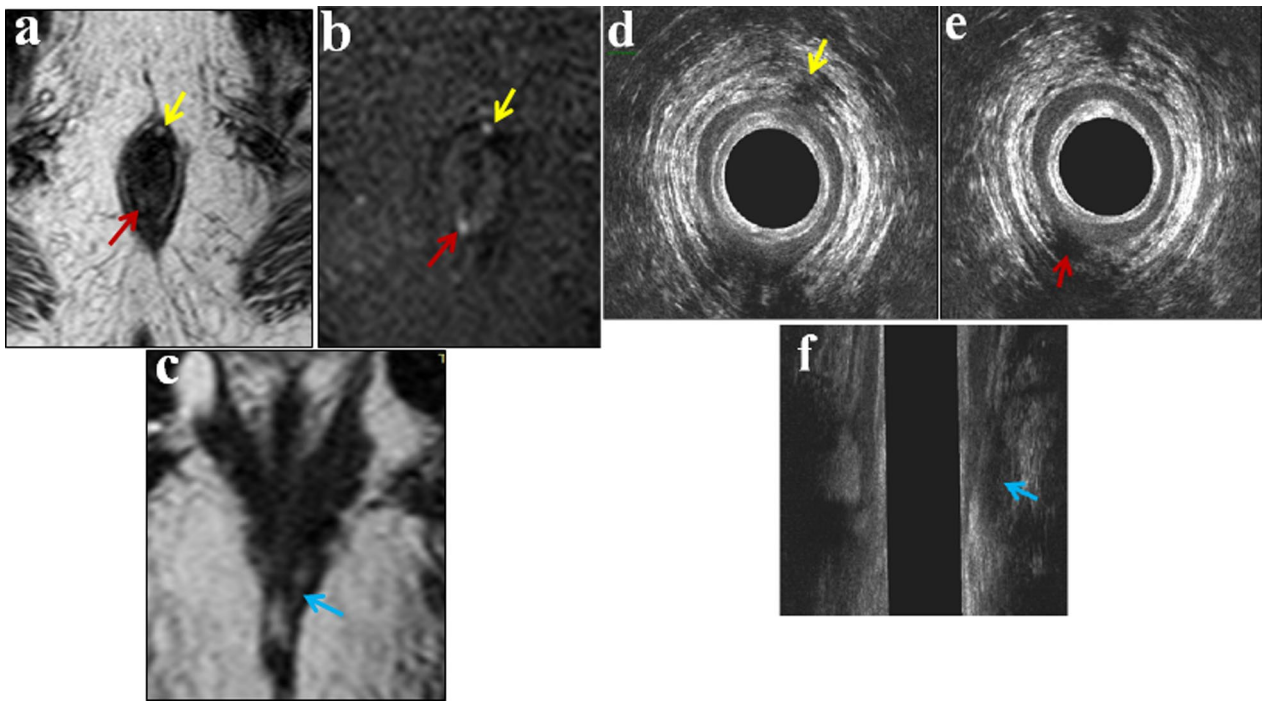

Fig. 1 **a**, **b** MRI axial T2 and STIR WI images showing two fluid filled intersphincteric fistulous tracts eliciting high signal and abutting the internal sphincter at 1 o'clock (yellow arrows) and 6–7 o'clock (red arrows). **c** Coronal T2 MRI WI images showing left intersphincteric fluid filled fistulous tract (blue arrow). **d** Ultrasound images show a hypoechoic fistulous tract seen within the left anterior intersphincteric space abutting the internal anal sphincter (internal opening) opposite 1 o'clock (yellow arrow). **e** Another hypoechoic fistulous tract seen within the right posterior intersphincteric space abutting the internal sphincter opposite 6–7 o'clock (Red arrow). **(f)** Ultrasound coronal images show left short intersphincteric fistulous tract breaching the internal sphincter at the level of the superficial portion of the external sphincter (blue arrow)

MRI examination

MRI was performed using 1.5 Tesla magnet scanners by two devices (Intera and Achieva, Philips medical system). All patients were examined in the supine position using a phased array surface coil. Total study time ranged from 20 to 30 minutes. No sedation was used.

MRI protocol

Different MRI techniques have been utilised in the imaging of perianal fistula. All provide multiplanar high resolution images of the perianal region in surgically relevant planes. Thus, the most important aspect of image acquisition is related to obtaining axial and coronal oblique images, which are orthogonal and parallel to the anal canal as the anal canal is oriented at an angle of about 45o anteriorly in the sagittal plane. To achieve such orthogonal orientation of the anal canal, sagittal fast spin-echo (FSE) T2W sequences should be performed as a localiser scan, providing an overview of the pelvis and displaying the correct axis of imaging. Imaging were done in coronal, axial and sagittal projections using T1 and T2 and T2 STIR sequence parameters, with a field of vision (FOV) of 450, a 4 mm slice thickness, a 196x256 matrix, and 2 mm interslice gap. To delineate the anal canal and separate the mucosal walls, a small enema tip was used for distension of the lower rectum, air was administered through this enema tip (however it was not applicable in all patients).

If intravenous contrast is used, suppression of background fat with SPIR (spectral presaturation with inversion recovery).Images post contrast are obtained in axial and coronal planes with FOV of 350, 1 mm slice thickness and 0.48 mm interslice gap. Such parameters are those used in elkasr alainy that we apply for all patient (Table 1).

Table 1 Parameters of sequences used in MRI scans of anal fistulas

Parameter	T2WI	T2WI	STIR	STIR	T1WI	T2WI	T1 post contrast	T1 post contrast
Scanning plane	Axial	Sagittal	Axial	Coronal	Axial	Coronal	Axial	Coronal
TR/TE (msec)	3600/96	3600/98	3600/96	4000/62	3600/96	4000/62	3.50/1.41	3.50/1.41
FOV (mm)	450	450	450	450	450	450	350	350
Slice thickness (mm)	4	4	4	4	4	4	1.0	1.0
Slice spacing (mm)	2	2	2	2	2	2	0.48	0.48
Matrix	196 × 256	196 × 256	196 × 256	196 × 256	196 × 256	196 × 256	512 × 512	512 × 512

MRI images interpretation

The MR images were evaluated by two radiologists (the first with 10 years of experience and the second with 6 years of experience) in the same setting and the final diagnosis was reached by their agreement (in consensus). Both radiologists were blinded to the results of the ultrasound. The anatomy of the fistula was identified considering:

- The primary tracts: were classified as fluid-filled if they had low signal intensity on T1 weighted images and high signal intensity on T2 and STIR images, and as fibrotic if they elicit low signal intensity on all three weighted images. Inflamed granulation tissue in the walls of abscess and fistulas enhances whereas chronic fistulas usually do not.
- Location of the fistula in relation to the sphincters.
- The clock position of the internal opening.
- Secondary extensions and complications (abscess or collections) seen eliciting low T1, high T2 and STIR signal with post contrast enhancement in case of abscess.

Surgical producers

The operative technique is chosen according to the fistula tract and its relation to the anal sphincter. The surgical techniques are as follows:

Fistulectomy and fistulotomy

Fistulectomy is recommended for low anal fistulas, as the success rate is high with this procedure and with minimal risk of incontinence. A tract is cannulated and excised in to leave the wound to heal by secondary intention or closed primarily.

Seton drainage

Placement of a seton drain is another frequently employed technique in anal fistula surgery. The material used is either a strong braided non-resorbable suture or a plastic (vessel loop, etc.) suture thread.

Anodermal advancement flap

Another option for covering the inner fistula cavity is the use of anodermal flaps. Advancement flaps consist of mucosa, submucosa, and part of the internal sphincter. The flap is lifted, edge of the flap containing internal opening. The underlying fistulous tract is excised up to the level of the internal sphincter. Here, the tract is transfixed. The flap is then advanced and sutured to close the internal defect. The outer part of the track can be curetted.

Statistical analysis

The statistical tool SPSS (Statistical Package for the Social Sciences) version 26 was used to code and enter the data (IBM Corp., Armonk, NY, USA).In quantitative data, the mean, standard deviation, minimum, and maximum were used to summarise the data, while categorical data was summarised using frequency (count) and relative frequency (%). Cohen test was used to assess the agreement between EAUS and MR and expressed as k values. Cohen suggested the Kappa result be interpreted as follows: values ≤ 0 as indicating no agreement and 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement. A statistically significant *P* value was less than 0.05.

Results

The study included one hundred and eight male patients (90%) and twelve female patients (10%) presenting clinically with perianal fistula. Their age ranging from 13 to 70 years (mean = 42). Twenty patients (16.7%) presented with history of previous anal operations and four patient (3.3%) present with history of trauma as co-morbidity.

Regarding the type of fistula, surgical analysis revealed the presence of intersphincteric fistula in 72 cases,

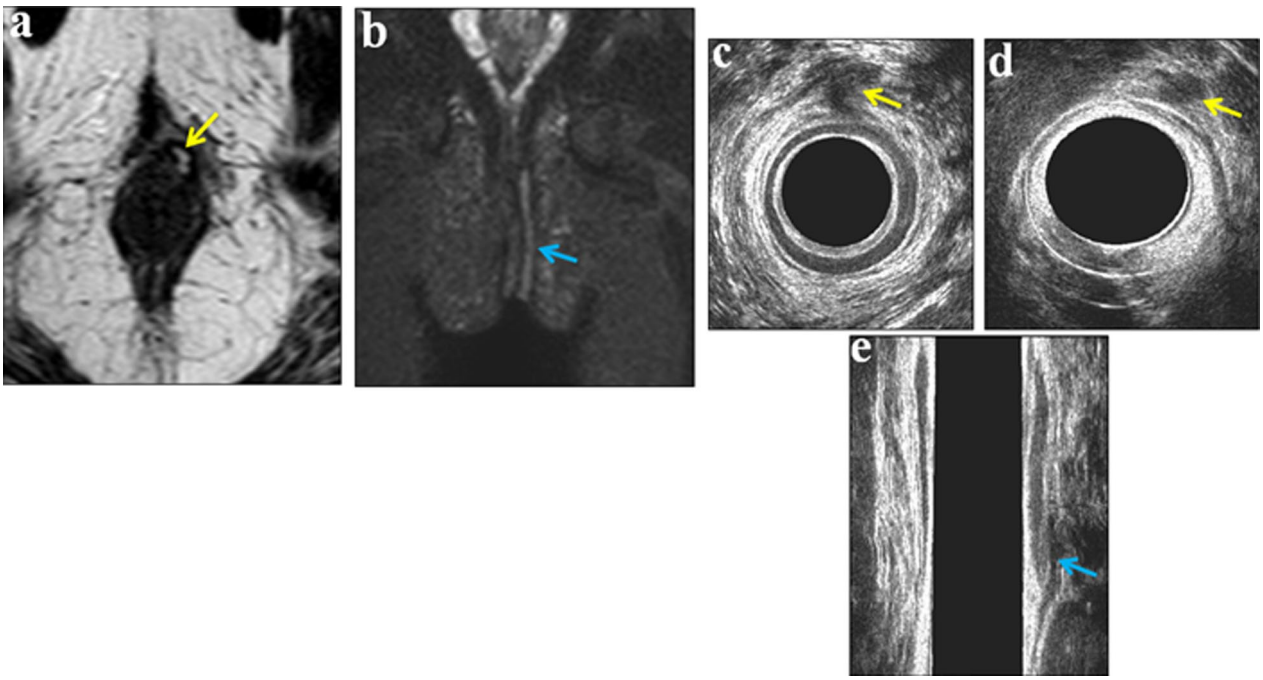

Fig. 2 **a** MRI axial T2 WI images showing left perianal region trans-sphincteric fistulous tract breaching the deep part of the external anal sphincter opposite 1 o'clock (yellow arrow). **b** MRI coronal STIR WI images showing high signal trans-sphincteric fistulous tract ending just below the inferior margin of the left puborectalis (blue arrow). **c**, **d** ultrasound axial images show left hypoechoic trans-sphincteric fistulous tract breaching the subcutaneous and deep portions of the left external anal sphincter at 12–1 o'clock (yellow arrows). **e** Post reconstruction ultrasound coronal images show left trans-sphincteric fistulous tract breaching the deep and superficial portions of the external sphincter (blue arrow)

trans-sphincteric fistula in 44 cases and extra-sphincteric fistula in 4 cases, the analysis of the radiological examination showed the presence of inter-sphincteric fistula in 72 cases by ultrasound versus 72 cases by MRI, trans-sphincteric fistula in 40 cases by ultrasound versus 44 cases by MRI and extra-sphincteric fistula in 4 cases by MRI and no fistula was detected in 8 patients by ultrasound (Figs. 2, 3). Ultrasound overall agreed with MRI in the diagnosis of 112 cases (93.3%) with estimated K value of about (0.7) (Table 2).

Regarding assessment of the primary tract, there was no significant difference between the two modalities being identified in 112 cases (93.3%) by ultrasound compared to 120 cases by MRI. The agreement between the two modalities was 93.3% (chart in Fig. 4).

Regarding assessment of the internal opening, ultrasound was superior to MRI being identified in 112 cases (93.3%) by ultrasound (which was confirmed by surgery) compared to 96 cases (80%) by MRI and was not detected in 8 cases (7%) by ultrasound. The agreement between the two modalities was (85.7%) with estimated K value of about 0.44 with statistically significant *P* value (0.001) (Table 3).

Regarding assessment of the secondary extensions, surgical analysis revealed the presence of secondary branches in 8 cases. Radiological analysis revealed that they were detected in 4 cases (3.3%) by ultrasound compared to 8 (6.6%) cases by MRI with no extensions detected in 116 cases (96.6%) by ultrasound compared to 112 cases (93.4%) by MRI (Fig. 5). The agreement between the two modalities was about 50% with estimated k value of about 0.65 with significant *P* value 0.001 (Table 4).

Regarding the assessment of complications, collections were detected in 36 cases (30%) by each modality which was confirmed by surgery (Fig. 6), while no

(See figure on next page.)

Fig. 3 **a**, **b** MRI axial and coronal T2 WI showing fluid filled left low anterior intersphincteric fistulous tract with fibrotic wall seen breaching the internal anal sphincter at the level of the superficial part of the external sphincter opposite1 o'clock (red arrows). **c**, **d** Ultrasound axial images show hypoechoic fistulous tract seen within the left anterior intersphincteric space breaching the internal sphincter (internal opening) opposite 1 o'clock (yellow arrows). **e** Post reconstruction coronal ultrasound images show left hypoechoic low intersphincteric fistulous tract breaching the internal sphincter at the level of the superficial part of the external sphincter (blue arrow)

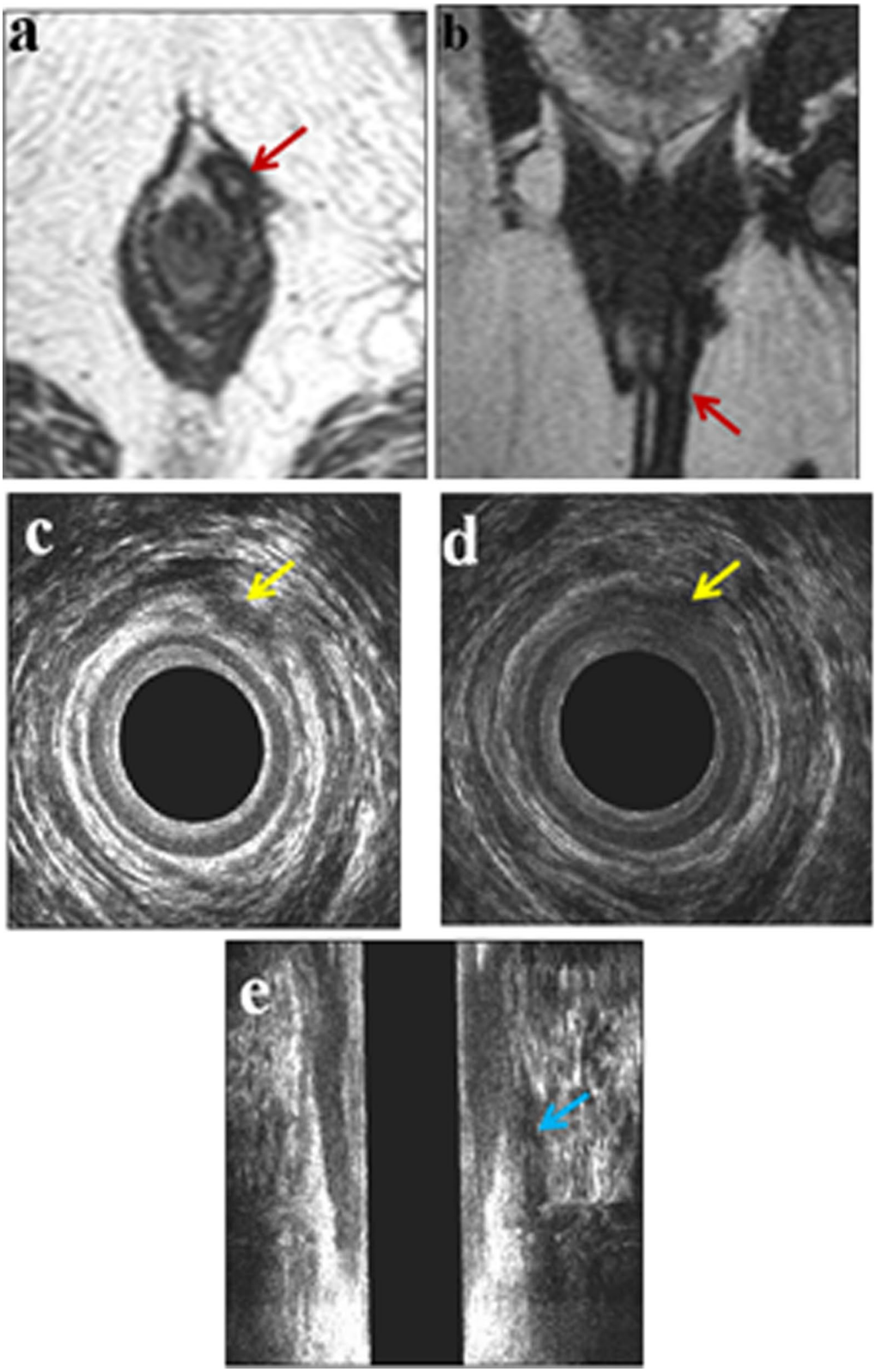

Fig. 3 (See legend on previous page.)

Table 2 Illustrates the agreement between MRI and US in detecting the location of the fistula

		MRI: relation to sphincter				Total	Weighted Kappa
		No relation	Inter-sphincteric	Trans-sphincteric	Extra-sphincteric		
US: Relation to sphincter	No relation	0	0	4	4	8	0.706
		0%	0.0%	9.1%	100.0%	6.7%	
	Inter-sphinctiric	0	72	0	0	72	
		0%	100.0%	0.0%	0.0%	60.0%	
	Trans-sphenctiric	0	0_a	40	0	40	
		0%	0.0%	90.9%	0.0%	33.3%	
	Extra-sphinctiric	0	0	0	0	0	
		0%	0.0%	0.0%	0.0%	0.0%	
Total		0	72	44	4	120	
			100.0%	100.0%	100.0%	100.0%	

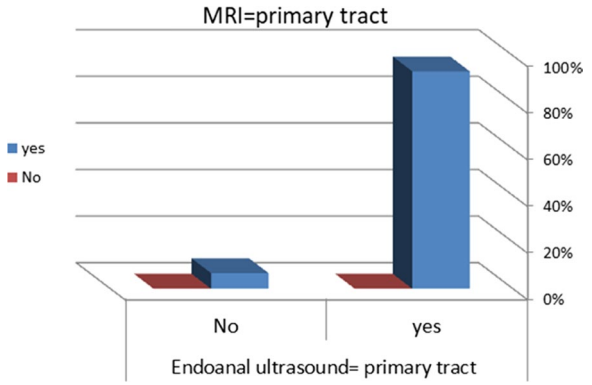

Fig. 4 Chart showing comparative study between endoanal ultrasound and MRI in the detection of the primary tract

collections were detected in 84 cases (70%) with estimated k value of about 1 and non-significant *P* value 0.06 (Table 5).

MRI was found superior to endoanal ultrasound in the characterization of the fibrotic tracts or those with fibrotic walls as they generally appear hypoechoic in ultrasound similar to the fluid filled tracts. Sixteen fibrotic fistulae and eight fluid filled fistulae with fibrotic wall were identified by MRI with failure of fibrosis characterization by ultrasound (Table 6).

Discussion

Perianal fistula is a chronic inflammatory condition defined as an abnormal perianal tract that connects two epithelial surfaces, usually the anal canal and the perianal skin. This condition is often highly recurrent and may require repeated surgical treatments. Therefore, adequate pre-operative diagnosis is crucial for the success of surgery and should include localization of the internal opening, primary tract, secondary extensions and possible complications [6].

Different imaging modalities have been employed in the diagnosis of perianal fistula. Currently, the most common used modalities are endoanal ultrasound and MRI fistulography [7].

EAUS is a safe and economical technique that can also be used in patients who cannot undergo MRI because of claustrophobia, obesity, or metallic implants (such as pacemakers [8].

In the recent years, many reports on anal fistula diagnosis have been published, also comparing endoanal ultrasound to MRI.

Our study showed that ultrasound was superior to MRI in the localization of the internal opening being, such results were in close harmony with Ahmed et al. [9] and Ratto et al. [10] studies which reported ultrasound accuracy of about 88.3% and 91% respectively (being 93.3% in our study), while our study showed

(See figure on next page.)

Fig. 5 **a**, **b**, **c** MRI axial and coronal T2 WI images showing left anterior intersphincteric fluid filled fistulous tract with fibrotic wall (yellow arrows) seen ending cranially with small intersphincteric collection abutting the internal sphincter at 12–2 o'clock (blue arrows). **d** A side branch of high STIR signal is seen arising from the intersphincteric collection abutting the left aspect of the rectum. **e**, **f**, **h** Axial and post reconstruction coronal ultrasound images show left anterior intersphincteric hypoechoic fistulous tract (yellow arrow) seen ending with left intersphincteric collection showing internal echogenic foci /air (abscess) breaching the internal sphincter at 12–2 o'clock (blue arrow). **g** Ultrasound axial image show hypoechoic side branch arise from the intersphincteric collection and runs posteriorly (red arrow)

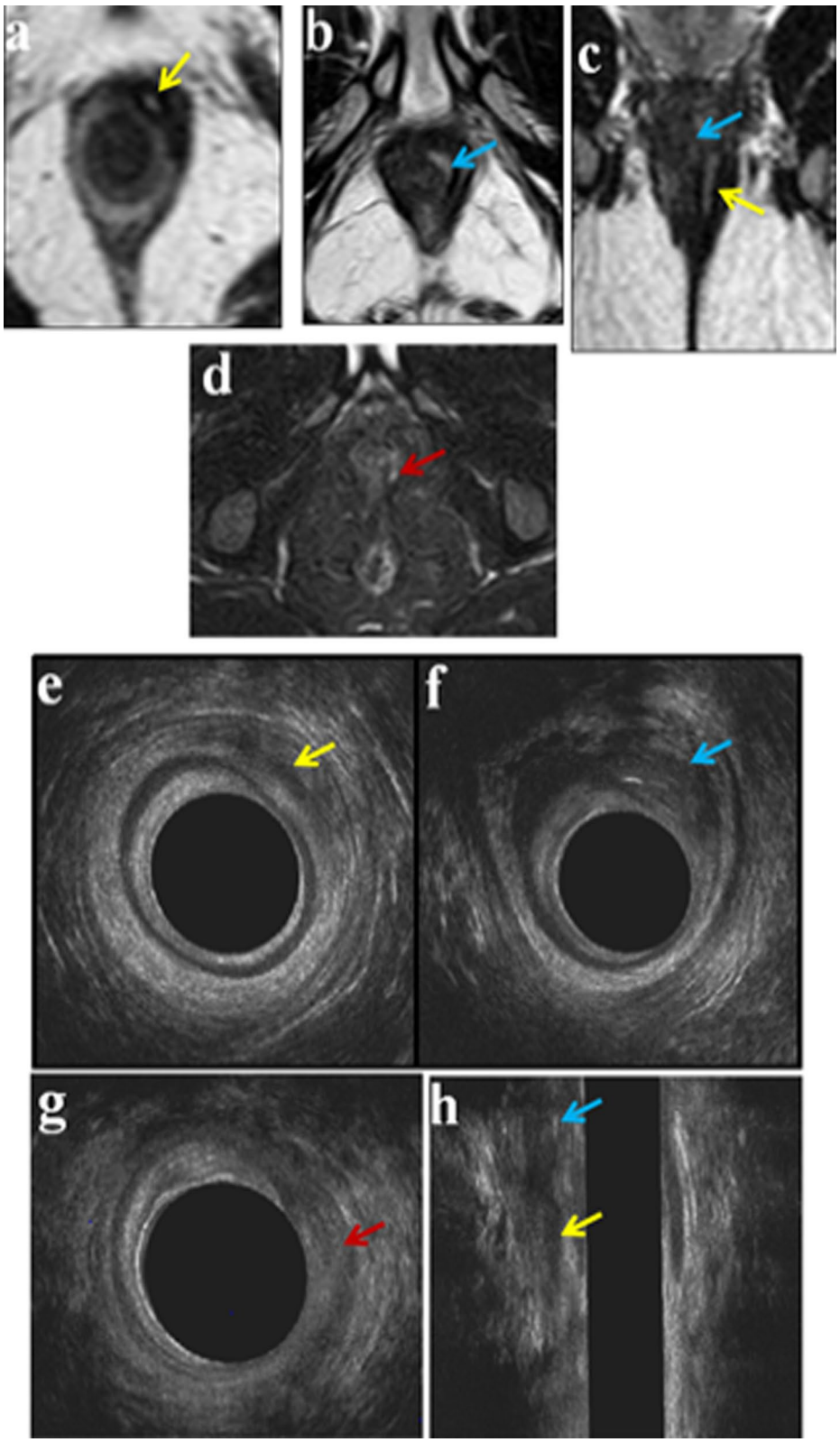

Fig. 5 (See legend on previous page.)

Table 3 Comparative study between endoanal ultrasound and MRI in detection of the internal opening

	Internal opening (MRI)				Cohen's kappa coefficient	*P* value
	Yes		No			
	Count	%	Count	%		
Internal opening (endoanal ultrasound)						
Yes	96	100.0	16	66.7	0.444	< 0.001
No	0	0.0	8	33.3		

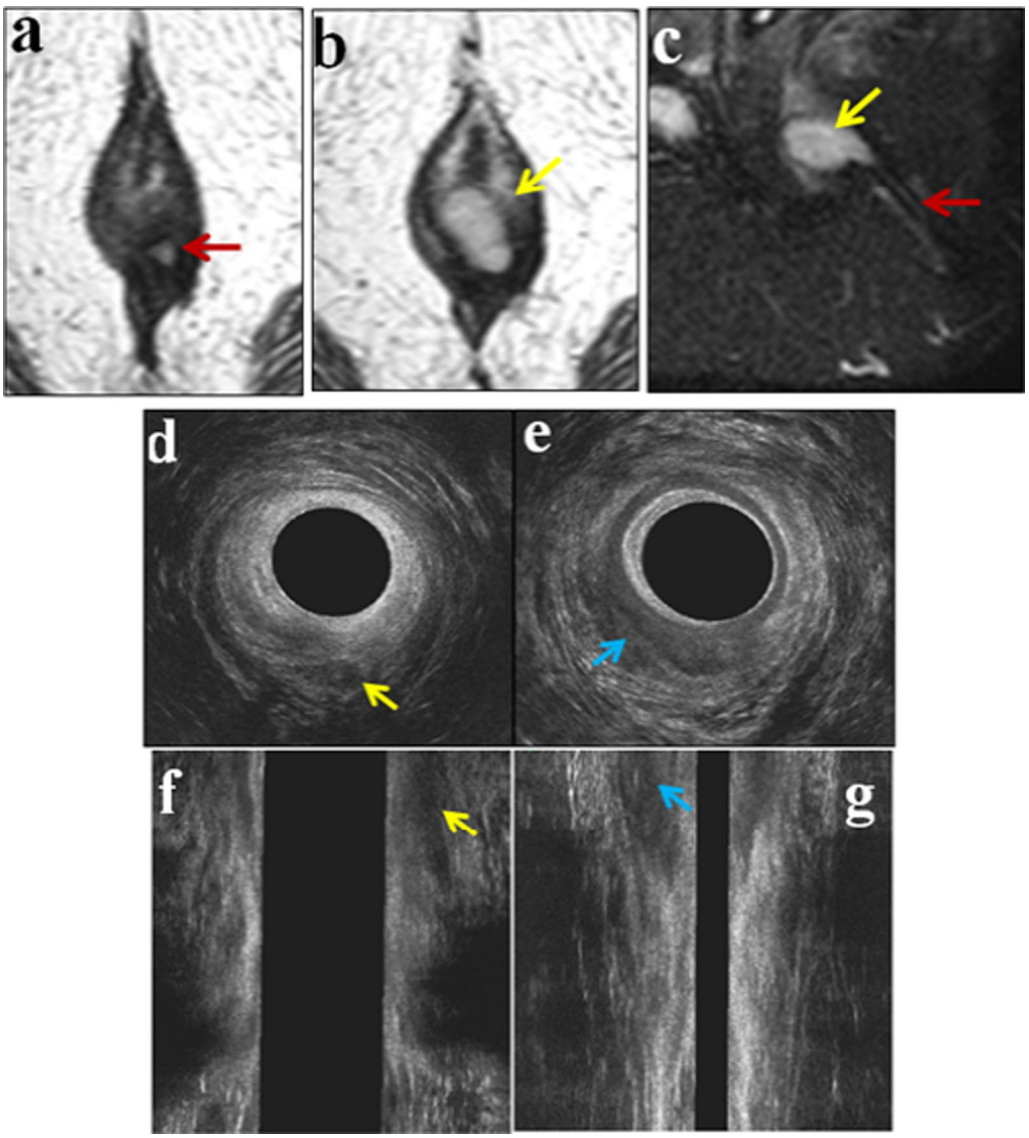

Fig. 6 **a**, **b**, **c** MRI axial T2 and sagittal STIR WI images show left posterior high trans-sphincteric fistulous tract (red arrows) seen crossing the midline at the level of deep portion of external anal sphincter ending in right inter-sphincteric collection between 6–9 o'clock eliciting high T2&STIR signal (yellow arrows). **d**, **f** ultrasound axial and post reconstruction coronal images show left posterior high trans-sphincteric hypoechoic fistulous tract (yellow arrows) seen breaching the deep portion of the external anal sphincter and ending in right posterior and midline hypoechoic collection **e**, **g** with internal echogenic foci between 6–9 o'clock (blue arrows) at the level of the right puborectalis muscle

Table 4 Comparative study between endoanal ultrasound and MRI in detection of secondary extensions

	Secondary extensions (MRI)				Cohen's kappa coefficient	*P* value
	Yes		No			
	Count	%	Count	%		
Secondary extension (endoanal ultrasound)						
Yes	4	50.0	0	0.0	0.651	< 0.001
No	4	50.0	112	100.0		

Table 5 Comparative study between endoanal ultrasound and MR in detection of complications

	Complication (abscess) (MRI)				Cohen's kappa coefficient	*P* value
	Yes		No			
	Count	%	Count	%		
Complication (collections /abscess) (endoanal ultrasound)						
Yes	36	100.0	0	0.0		< 0.001
No	0	0.0	84	100.0	1	

Table 6 Showing difference between MRI and endoanal ultrasound in the characterization of the fibrotic tracts

	MRI		Endoanal ultrasound	
	Count	%	Count	%
Tract fibrosis				
Yes	24	20.0	0	0.0
No	96	80.0	120	100.0

better results compared to Gustafsson et al. study [11] which reported that corresponding figures by EAUS were 17 cases (74%) "being (93.%) in our study" and by M.R.I 10 cases (43%) "being (80%) in our study" and better than Sudoł-Szopińska et al. study [12] which reported that agreement between the two modalities was about 53% (being 85.7% in our study). Conversely, our study disagreed with Buchanan et al. study [13] which reported that MRI was superior to ultrasound in the localization of the internal opening being diagnosed in 91% cases versus 97% by MRI (In our study, these figures corresponded to 93.3% by ultrasound and 80% by MRI).

Our study was also in agreement with Alabiso et al. study [14] regarding the assessment of the type of fistula which showed agreement between the EAUS and MRI of about 97% (being 93.3% in our study) while our results were better than Iwona Sudoł-Szopińska et al. study which showed overall agreement between the two modalities of about 57% (being 93.3% in our study).

Our study showed that MRI was superior to ultrasound in the detection of the fibrotic tracts which agreed with Sharma et al. study [15].

Regarding the detection of the primary tracts, our study showed better results than Maria Eleonora et al. study being detected in 52% of the cases by ultrasound (93.3% in our study) compared to 58% by MRI (100% in our study).

Our study showed that EUAS was equally effective as MRI in the detection of complications (collections) which disagreed with Alabiso et al. study which reported that MRI was superior to ultrasound in detection of collections being detected in 6% of the cases by ultrasound (being 30% in our study) compared to 16% by MRI (being 30% on our study).

Regarding the detection of secondary extensions, our study showed lower results compared to Iwona Sudoł-Szopińska et al. which reported overall agreement of about 67% agreement between EAUD and MRI (being 50% in our study).

Study limitations

Finally, and as any research or study done before, we acknowledge that our study may have some limitations and shortage. It didn't include as much extra or supras-phincteric fistulae, this made it difficult to draw clear conclusions as to how adequate EAUS was in their detection. In our study, we didn't use H2O2 too (as an enhancing agent in endosonography).Another limitation to our study was lack of analysis of inter-reader agreement as well as lack of post-operative consecutive follow up to rule out missed tracts or recurrence.

Conclusions

Both EAUS and MRI have a crucial role in the evaluation and detection of perianal fistulas. EAUS was preferable to MRI in the localization of the internal opening; conversely, in the evaluation of extra-sphincteric fistulas and fibrotic tracts characterization MRI was preferable to EAUS, hence both MRI and endoanal ultrasound are considered to be complementary to each other for optimal diagnosis of the perianal fistula and reducing the rate of recurrence or missed fistulous tracts.

Abbreviations

EAS: External anal sphincter; EAUS: Endoanal ultrasound; IAS: Internal anal sphincter; MRI: Magnetic resonance imaging.

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Not applicable.

Author contributions

All authors have read and approved the manuscript. (AS), (HE), (HMSE), and (MYAE) contributed equally to this work. AS and HE and MYAE designed research. AS and HE performed research. AS and HMSE analyzed data. AS and HA wrote the paper. All authors read and approved the final manuscript.

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Availability of data and materials

All the datasets used and analysed during this study are available with the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study way approved by the research ethics committee of the Radiology department of the Faculty of medicine Cairo University on 27/8/2019, reference number (MD-172-2019). All patients included in this study gave a written informed consent to participate in the research. If the patient was less than 16 years old, or unconscious at the time of study, written informed consent was given by their parent or legal guardian.

Consent for publication

All patients included in this study gave a written informed consent to publish the data contained in this study. If the patient was less than 16 years old, or unconscious at the time of study, written informed consent was given by their parent or legal guardian.

Competing interests

The authors declare that they have no competing interests.

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