Abdelzaher *et al. Egypt J Radiol Nucl Med (2024) 55:96*
https://doi.org/10.1186/s43055-024-01270-7

Egyptian Journal of Radiology and Nuclear Medicine

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3D endoanal ultrasound versus external phased array MRI in detection and evaluation of anal sphincteric lesions

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Abstract

Background The anal sphincteric complex is formed by internal and external sphincters making two partially overlapping tubes around the anal canal. Anal sphincteric lesions represent a spectrum of entities with different patients' presentations and surgical managements. Endoanal ultrasound has an increasing role in detection and evaluation of anal sphincteric lesions as compared to MRI of the anal canal. The aim of this work was to compare between the 3D EAUA and external phased array MRI in detection and evaluation of anal sphincteric lesions.

Results There is almost perfect agreement of 97.92% ($K_w = 0.972$) between 3D EAUS and external phased array MRI in the detection of the internal anal sphincter lesions and fair agreement of 66.67% ($K_w = 0.37$) in the detection of the external anal sphincteric lesions.

Conclusions 3D EAUS and external phased array MRI are comparable imaging techniques in the detection of the internal anal sphincter lesions, while the MRI could detect more external sphincteric lesions than EAUS.

Keywords Anal sphincters, Anal sphincteric lesions, Endoanal ultrasound, MRI anal canal

Background

The anal canal is the most caudal segment of the gastrointestinal tract and surrounded by two layers of sphincters engaged in defecatory process; the inner layer is the internal anal sphincter (IAS), and the outer layer is the external anal sphincter (EAS) [1]. Many pathological lesions can affect the anal canal sphincters. The most common anal canal pathology is perianal fistula by which the anal sphincters are usually breached in most of its types [2]. Traumatic anal canal conditions or surgical interventions can lead to anal sphincteric injuries which in turns lead to sphincteric weakness and fecal incontinence, identification of such injuries is crucial for selection of best therapeutic option for patients with continence problems [3]. Change of muscle thickness of anal sphincteric complex manifested either by muscle atrophy or muscle thickening as seen in hypertrophic myopathy of the IAS can result in defecatory problems as fecal incontinence or constipation, respectively [3]. Many neoplastic conditions can involve the anal sphincteric complex and are either primarily from the anorectum or secondarily from anal canal metastasis or surrounding pelvic organs malignancies [4]. MRI has become the preferred technique for assessment of the anal sphincter complex due to its great soft-tissue resolution and multiplanar capability. MRI with an endoanal coil was initially established as an accurate approach for anal canal evaluation due to its high accuracy in assessing the site and extent of anal fistulas, sphincter tears, and local extent of tumors [4]. However, the endoanal coils are not widely available. Currently, MRI with external phased array coils

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is a widely accepted method for assessing the anal canal [4]. Endoanal ultrasound (EAUS) is generally considered a valuable substitute for imaging anal canal anatomy. It is relatively inexpensive and does not require any patient preparation, allowing for rapid evaluation and imaging of the anal sphincters without the need for waiting lists [5]. The aim of this study is to compare 3D EAUS and external phased array MRI in the detection and evaluation of anal sphincteric lesions.

Methods

This study was a prospective cross-sectional analytical study, approved by the local research Ethical Committee (code: MD-135-2021) conducted at a tertiary healthcare university hospital during the period between January 2021 and March 2023. Informed consent was gained from all patients.

Patients' selection

This study included 48 patients referred from the General Surgery departments and National cancer institute for the pelvic floor imaging unit at the diagnostic radiology department, Cairo University Hospital, for MRI and EAUS examinations. Inclusion criteria were patients with perianal discharge suspected to have perianal fistula, stool or flatus incontinence suspected to have sphincteric injury, and patients with low rectal/anal neoplastic lesions. Exclusion criteria were patients with contraindications to MRI examination as those with cardiac pacemaker.

Clinical data were collected by reviewing medical records whenever possible as well as by direct patient interviewing about anal symptoms (perianal discharge, pain, fecal incontinence, constipation, defecatory complaints), in addition to history of surgical interventions and vaginal delivery for female patients.

Magnetic resonance imaging examination

A 1.5 Tesla MRI machine was employed (Philips, Achieva, the Netherlands) using circular surface (Sense-XL-Torso body) coil. All MRI examinations were done in the supine position, headfirst on the examination couch. Sagittal single-shot fast spin-echo (SSFSE) images were acquired first to show the axis of the anal canal, followed by imaging planes of anal sphincter complex aligned to the anal canal; oblique coronal and axial images aligned parallel and orthogonal to the anal canal. T2-weighted images of the anal canal in the axial, coronal and sagittal planes (TR: 3000–5000 ms, TE: 100 ms), field of view (FOV): 260 mm, slice thickness: 4 mm, interslice gap: 0.5 mm, and matrix: 200 × 200. T1-weighted images of the anal canal in the axial plane (TR: 500 ms, TE: 10 ms), FOV: 260 mm, slice thickness: 4 mm, interslice gap: 0.5 mm, and matrix: 200 × 200. STIR (short tau inversion recovery) images of the anal canal were also acquired in the axial and coronal planes (TR: 5000 ms, TE: 170 ms), inversion time 150 ms, FOV: 260 mm, slice thickness 4 mm, gap 0.5 mm, matrix 200 × 200.

MR images interpretation

MR images were interpreted by two radiologists in the same setting: (H.A and A.A.) with 13 and 8 years of experience, respectively. The final diagnosis was reached in consensus. Both of them were blinded to the results of the ultrasound. Anal sphincteric lesions were classified into: (A) *fistula*: The sphincteric interruption is identified as a fluid filled or fibrotic tract eliciting high T2/STIR or low T2/STIR, respectively, traversing through only the IAS only (intersphincteric fistula) or both IAS and EAS (trans-sphincteric) [2]. (B) *Sphincteric injury:* involving the IAS, EAS, or both anal sphincters can be either (i) *defect*: identified as discontinuity of muscle fibers or (ii) *scar*: identified by replacement of muscle by low signal scar tissue [3]. (C) *Atrophy*: identified by thinning out or fat replacement of the muscle. Atrophy of the IAS is defined if the muscle thickness measures less than 2 mm. There is no specific criterion for diagnosis of EAS atrophy by MRI [3]. (D) *Hypertrophic myopathy of the IAS:* thickening and lengthening of the IAS which appears as intermediate T2 signal muscle ring, considered hypertrophied when it measures more than 5 mm in thickness [6]. (E) *Neoplastic lesion*: mass lesion of intermediate/high T2 and intermediate/low T1 signal intensities, invading the sphincteric layer [1].

3D EAUS

All examinations were performed by a single radiologist (A.A.) using a bK Flex Focus ultrasound scanner 1202 (BK, Herlev, Denmark) with a model 2052 probe equipped with automated multifrequency crystals (6–16 MHz), with 360° mechanical rotation, fractional band with 96.2% and stainless-steel reflector with field depth up to 8 cm. No patient preparation is required. All patients were examined in the left lateral decubitus position. The probe was applied within the anal canal after being concealed by a condom and adequately lubricated. It was introduced till the U-shaped sling of the puborectalis appeared. This probe automatically acquires images down to the superficial perianal level without altering its position along the anal canal. The correct position of the transducer was as follows: the anterior aspect of the anal canal at the 12 O'clock position, its posterior aspect at 6 O'clock, its right aspect at 9 O'clock and its left aspect at 3 O'clock. Three anal canal scan levels were marked as illustrated in Fig. 1. (A) The upper anal canal level marked by hyperechoic puborectalis muscle which has a unique

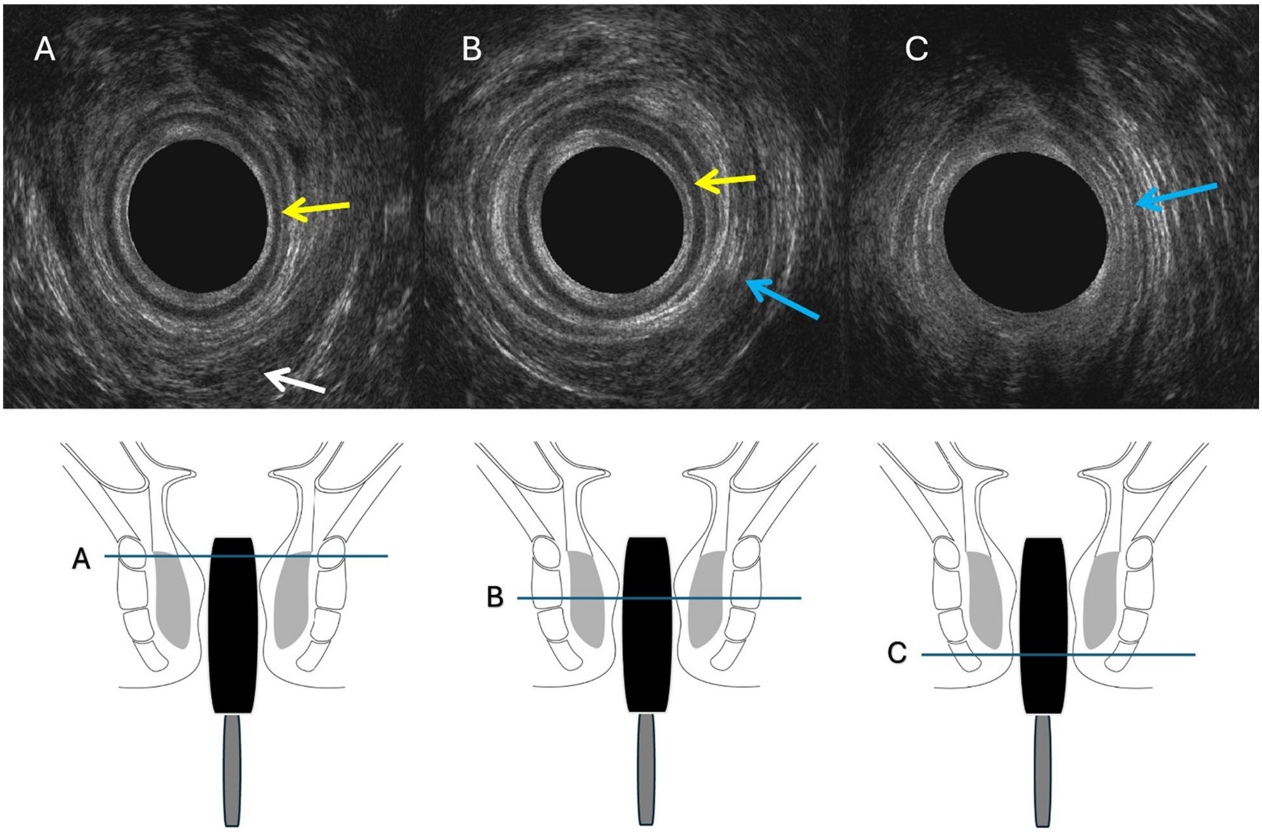

Fig. 1 Illustration of the anal canal levels and corresponding EAUS images **a** at the upper level, **b** at the mid-level, **c** at the low level. White arrow refers to the puborectalis muscle. Yellow arrows refer to IAS. Blue arrows refer to EAS

U-shaped sling appearance. (B) The middle canal level marked by complete rings of iso- to hyperechoic EAS and inner hypoechoic IAS. (C) The lower canal level marked by the subcutaneous part of the EAS and absence of IAS.

Post-processing and image analysis of EAUS

Ultrasound images were interpreted in the same setting by two different radiologists (H.E. and A.S.) with 15 and 9 years of experience, respectively. The final diagnosis was reached in consensus. Both of them were blinded to the results of the MRI. The ultrasound images were visualized by using B.K 3D viewer software version 7.0.0.519 for 3D images processing.

Anal sphincteric lesions were classified similarly classified into: (A) *Fistula:* sphincteric interruption was identified as a hypoechoic tract traversing through only the IAS (intersphincteric type) or both IAS and IAS (trans-sphincteric type) [5]. (B) *Sphincteric injury*: involving the IAS, EAS, or both anal sphincters (i) *defect*: identified as discontinuity of muscle fibers or (ii) *scar*: identified by replacement of muscle by hypoechoic scar [7]. (C) *Atrophy*: identified by thinning out or fat replacement of the muscle. Atrophy of the IAS is defined if the muscle thickness measures less than 2 mm. there is no specific criterion for diagnosis of EAS atrophy by EAUS [7]. (D) *Hypertrophic myopathy of the IAS:* thickening and lengthening of the IAS which appears as thick hypoechoic ring. It is considered hypertrophied when it measures more than 5 mm in thickness [6]. (E) *Neoplastic lesion*: hypoechoic mass lesion invading the sphincteric layer [8].

Affection was classified based on the parts involved of the anal sphincter: IAS lesions group and EAS lesions groups. We considered the intersphincteric fistula belonging only into the internal anal sphincter group because its fistulous track breaches only the internal sphincter while the trans-sphincteric fistula belonging into the two groups because its fistulous tracks breaches both sphincters.

MRI was considered the standard of reference in cases of perianal fistulae. Among the rest of the lesions, we compared both imaging modalities with no reference.

Statistical methods

Data were analyzed to determine the effectiveness of using endoanal ultrasound compared to MRI in diagnosing IAS and EAS lesions. Data analysis was done by IBM® SPSS® v28. Normality of the age variable was checked by Kolmogorov–Smirnov test. Categorical data were summarized as frequencies and relative frequencies. The overall agreement between the MRI and endoanal ultrasound was assessed using weighted kappa (K_w) scores, while for each diagnosis, the agreement between MRI and US was assessed using unweighted kappa (κ) scores. Kappa statistics were interpreted as: slight agreement: 0.00–0.20, fair agreement: 0.21–0.40, moderate agreement: 0.41–0.60, substantial agreement: 0.61–0.80, or almost perfect agreement: 0.81–1.00 [9].

Results

Forty-eight patients were included the study, 33 (69%) males and 15 (31%) females, with mean age of 38.8 ± 12.3 years (range: 20–65 years). Twenty-five (52%) patients complained from perianal discharge, 18 (37.5%) patients presented with incontinence, while 4 (8.3%) patients complained from bleeding per rectum and 1 (2.1%) patient was presenting with constipation. Based on MRI findings, most of the study participants (62.5%) had both IAS and EAS affected. The IAS was more commonly affected, while affection of EAS alone represented 4.2% of all patients (Table 1).

There was variation regarding the lesions involving the sphincters. The commonest lesion detected among the IAS lesions was perianal fistula (41.7%) followed by scar (25%). In the EAS, the commonest lesion was scarring (33.3%) followed by the fistula (14.6%), while in one-third of the patients their external sphincter was not affected. Other lesions found involving either sphincters were defect, neoplastic lesion (low rectal cancer), or atrophy. None of the patients included had hypertrophic myopathy of the IAS or anal canal cancer.

Regarding the agreement between the MRI and EAUS for each lesion in both anal sphincters (Table 2), almost perfect agreement was found in fistula and neoplasm detection for both anal sphincters and the IAS atrophy. For IAS, we found moderate agreement between MRI and EAUS in defect detection. However, for EAS, we found moderate agreement between MRI and EAUS in scar detection.

Comparing IAS involvement by fistula examined by EAUS and MRI; 28 (58.3%) cases were found uninvolved, and 19 (39.6%) cases were found to be involved by the tract on either method of investigation (matched findings) (Figs. 2, 3 and 4). Meanwhile, MRI detected the interruption of the IAS by a fistula in 1 case (2.1%) that was missed on EAUS. By applying sensitivity and specificity statistical tests, EAUS as a method of investigation was found to be 95% sensitive and 100% specific test in IAS involvement by fistula.

Matching the EAS involvement by fistula between EAUS and MRI; 41 (85.4%) cases were uninvolved, and 6 (12.5%) cases were found to be involved by both methods of investigation (matched findings) (Fig. 3). Meanwhile, MRI detected the interruption of by the fistula in 1 (2.1%) case which was missed using EAUS. By applying sensitivity and specificity statistical tests, EAUS was found to be 85.7% sensitive and 100% specific in EAS involvement by fistula. According to Park's classification of the perianal fistulae, the agreement between 3D EAUS and MRI in detection of the type of the fistula was 97.9% ($K = 0.957$).

Analysis of both IAS and EAS injuries (scar/defect) detected by EAUS and MRI is summarized in Table 3.

Table 1 Type of the affected sphincter and type of the lesion in each sphincter based on MRI

		Frequency (n = 48)	Percent %
Sphincter affected	Both anal sphincters	30	62.5
	Internal anal sphincter only	16	33.3
	External anal sphincter only	2	4.2
Lesion in internal anal sphincter	Fistula	20	41.7
	Scar	12	25
	Defect	7	14.6
	Neoplastic	4	8.3
	Atrophy	3	6.3
	No lesion	2	4.2
Lesion in external anal sphincter	Scar	16	33.3
	Fistula	7	14.6
	Neoplastic	4	8.3
	Atrophy	3	6.3
	Defect	2	4.2
	No lesion	16	33.3

Table 2 Agreement and disagreement between MRI and US for each lesion in internal and external anal sphincters

	Agree				Disagree		K	P-value
	Present		Absent					
	Number	%	Number	%	Number	%		
Internal anal sphincter								
Fistula detection	19	39.6	28	58.3	1	2.1	0.957	< 0.001
Scar detection	0	0	36	75	12	25	0	
Neoplasm detection	4	8.3	44	91.7	0	0.0	1	< 0.001
Defect detection	7	14.6	29	60	12	25.4	0.413	< 0.001
Atrophy detection	3	6.3	45	93.8	0	0	1	< 0.001
External anal sphincter								
Fistula detection	6	12.5	41	85.4	1	2.1	0.911	< 0.001
Scar detection	6	12.5	32	66.7	10	20.8	0.444	< 0.001
Neoplasm detection	4	8.3	44	91.7	0	0.0	1	< 0.001
Defect detection	0	0	46	95.8	2	4.2	0	
Atrophy detection	0	0	45	93.8	3	6.3	0	

EAUS and MRI similarly detected the involvement of IAS in 19 cases suggesting almost perfect agreement ($K_w = 1$) (p-value < 0.001) between both modalities (Figs. 4 and 5). However, comparing the detection of injuries involving the EAS, MRI was superior, identifying injuries in 18 patients while EAUS only detected 6 cases with a fair agreement between both investigations ($K_w = 0.385$) (p-value = 0.001) (Figs. 4, 5 and 6).

Overall agreement regarding the identification of sphincteric lesion involving IAS and EAS using EAUS and MRI is illustrated in Table 4. Almost perfect agreement of 97.92% in detecting the IAS lesions on both modalities ($K_w = 0.972$) (p-value < 0.001). However, there was an overall fair agreement of 66.67% between both investigations ($K_w = 0.37$) (p-value = 0.001) in detecting EAS lesions, where MRI was found superior in detecting EAS involvement by scars, defects, fistula and identifying atrophy (Fig. 6).

Discussion

MRI has become the preferred the radiological investigation for evaluation of the anal sphincter complex because of its multiplanar capability and high soft-tissue resolution [4]. EAUS is also a valuable tool for the assessment of patients with various anal conditions, it has many advantages: ease of use, cost-effectiveness, and rapid evaluation. The new advent of three-dimensional (3D) ultrasound with post-processing capability in the form of volume rendering has further increased the accuracy of this technique [10].

Our study revealed almost perfect agreement between the EAUS and MRI in the detection of the fistulae involving the IAS as well as the EAS with $K = 0.957$ and $K = 0.911$, respectively. In the recent years, many studies investigating the imaging of perianal fistula compared EAUS and MRI regarding their ability to distinguish the type of fistula according to Parks or St James's University classification. However, our objective was different; we were more concerned of comparing EAUS and MRI in terms of detection of the part of the anal sphincter affected by the fistulous tract, Our study revealed that the agreement between 3D EAUS and MRI in detection of the type of the fistula according to Park's classification was 97.9% ($K = 0.957$), this result agreed with Alabiso et al. study [5] which reported the agreement between the EAUS and MRI in detection of the type of the fistula about 97% while our results were higher than Sayed et al., study [11] which reported that the agreement between these imaging modalities about ($K = 0.7$).

One of the fistulous tracts examined in our study could not be assessed by EAUS while the MRI could detect and classify it as a trans-sphincteric type, our explanation in this case was due to the associated extensive scar tissue involving the IAS and EAS resulting from repeated prior surgical interventions, masking the visualization of the tract's course by ultrasound.

We found perfect agreement between the EAUS and MRI in detection of the injuries of the internal sphincter and only a fair agreement in the injuries of the external sphincter with $K = 1$ and $K = 0.385$, respectively. Although there have been studies assessing the correlation of EAUS with endoanal MRI examination in diagnosis of sphincter injuries, there have been no studies comparing MRI with body coil and 3D EAUS imaging modalities except, to the best of our knowledge, Kirss et al. [12] published in 2019 evaluating the correlation of

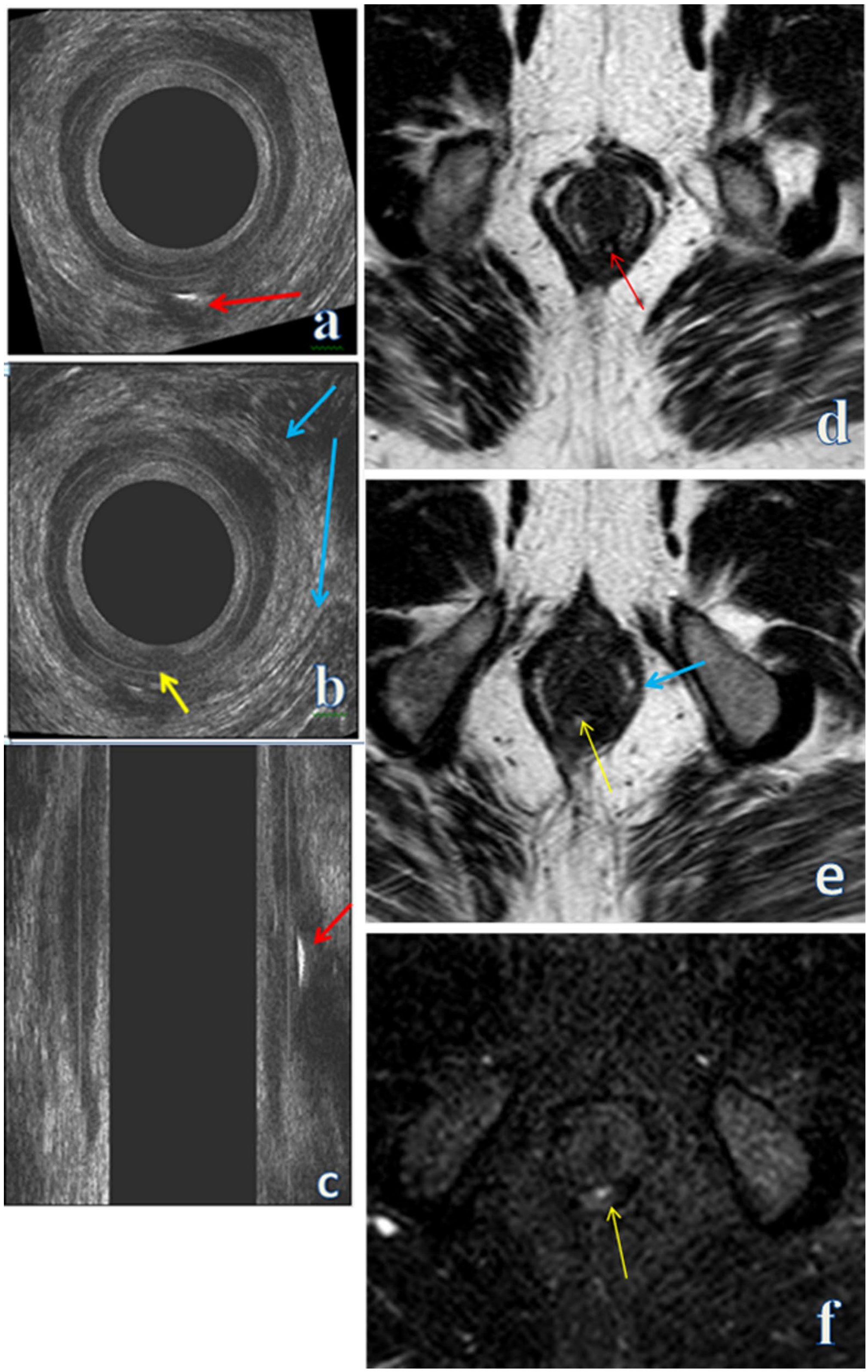

Fig. 2 **a**, **b** axial and **c** sagittal reconstructed EAUS images show intersphincteric hypoechoic fistulous track (red arrows) showing internal echogenic air loculi and abutting IAS at 6 O'clock (yellow arrow). **d**, **e** axial T2 WI and **f** axial STIR WI MRI images show fluid filled intersphincteric fistula, eliciting high T2/STIR SI (red arrow),abutting IAS at 6 O'clock (yellow arrows). Blue arrows refer to EAS in **b** EAUS and **e** MRI images

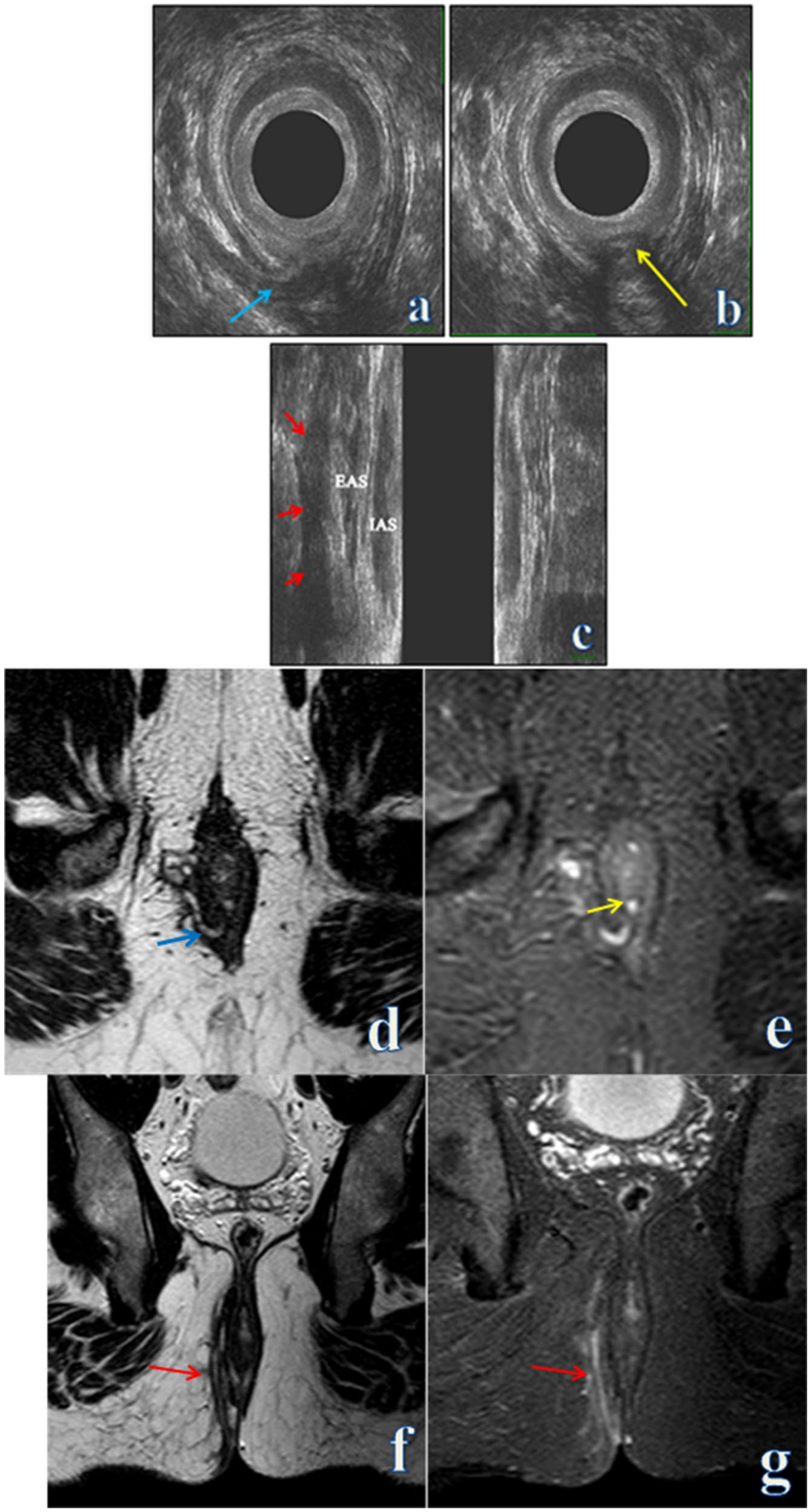

Fig. 3 **a**, **b** axial and **c** coronal reconstructed EAUS images show trans-sphincteric hypoechoic (red arrows) fistulous track, traversing EAS at 7 O'clock (blue arrow) and IAS at 6 O'clock (yellow arrow), **d** axial T2WI, **e** axial STIR, **f** coronal T2WI and **g** coronal STIR MRI images show a right sided fluid filled trans-sphincteric fistula, eliciting high T2/STIR SI (red arrows),traversing EAS at 7 O'clock (blue arrow) and IAS at 6 O'clock (yellow arrow)

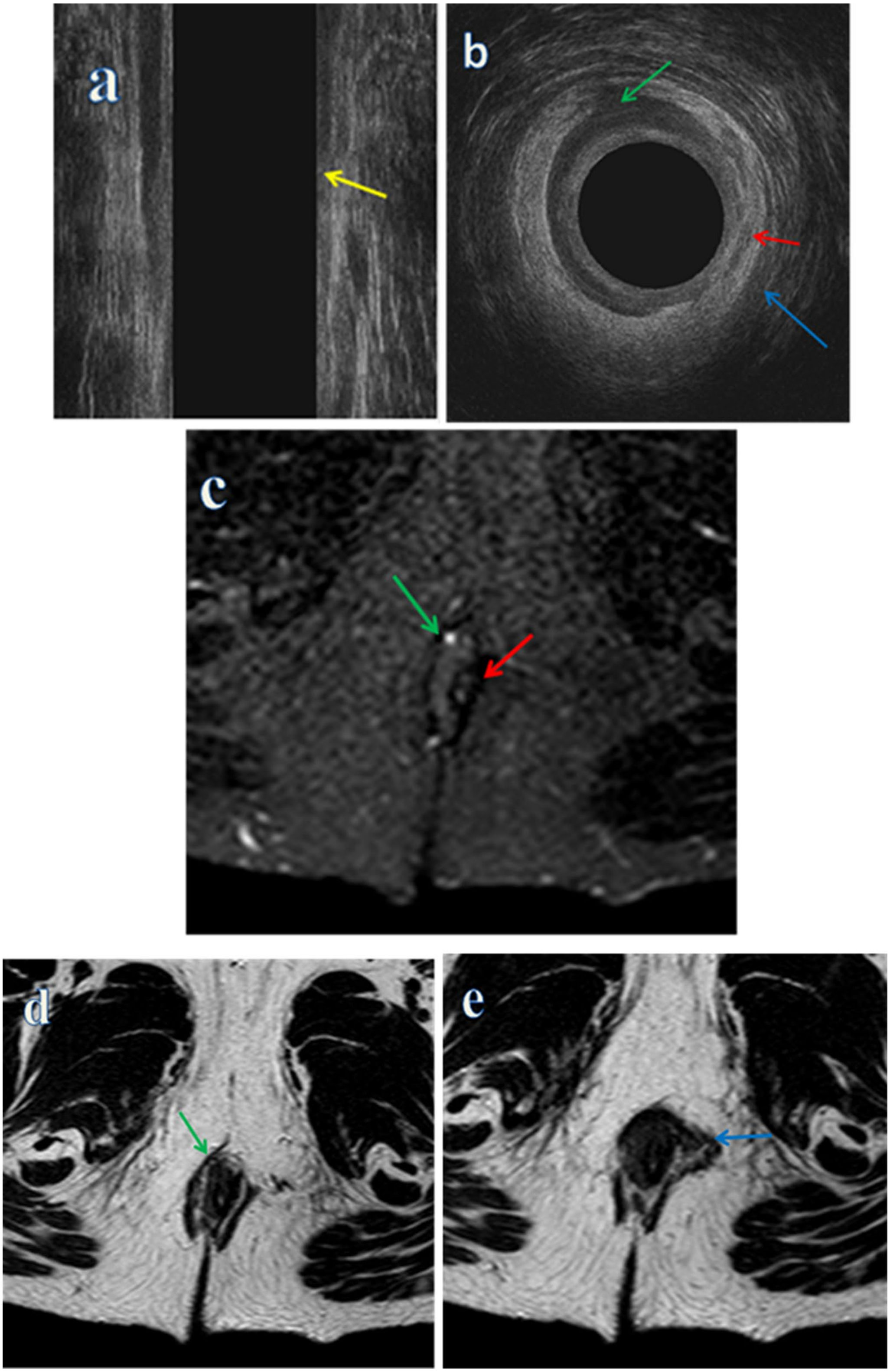

Fig. 4 **a** coronal reconstructed EAUS image shows IAS defect along its lower part (yellow arrow), **b** axial EAUS image shows intersphincteric hypoechoic fistulous track (green arrow) and IAS defect (discontinuity) from 2 to 6 O'clock (red arrow). Intact EAS (blue arrow) by EAUS. Axial **c** STIR WI and **d** T2WI show right intersphincteric fistula, eliciting high T2/STIR SI (green arrows), Axial **c** STIR WI and **e** T2 WI images show internal (red arrow) and external sphincters (blue arrow) dark T2/STIR signal scar tissue

Table 3 Agreement and disagreement between MRI and US for detection of sphincteric injury in internal and external anal sphincters

	Agree				Disagree		K	P-value
	Present		Absent					
	Number	%	Number	%	Number	%		
Internal anal sphincter								
Injury detection	19	39.6	29	0.0	0	0.0	1	< 0.001
External anal sphincter								
Injury detection	6	12.5	30	62.5	12	25	0.385	0.001

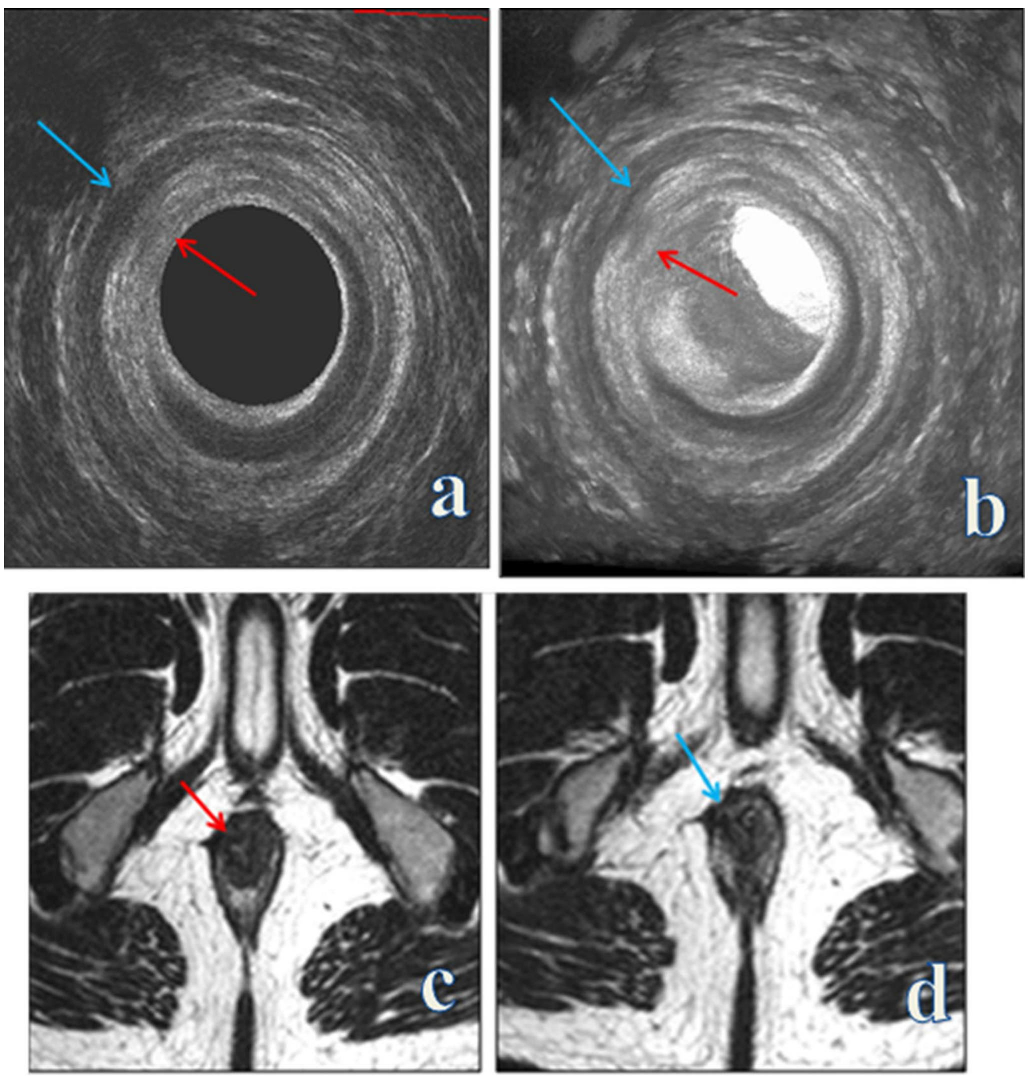

Fig. 5 **a** axial and **b** axial render mode EAUS images show IAS defect from 8/9 to 12 O'clock (red arrows). Intact EAS (blue arrows) by EAUS. **c**, **d** Axial T2 WI MRI images show internal (red arrow) and external anal sphincters (blue arrow) right sided dark T2 signal scar tissue extending from 9 to 12 O'clock

EAUS and external phased array MRI in sphincteric injuries of the IAS and EAS collectively as one unit, showing a moderate interrater reliability ($\kappa = 0.510$) between these imaging modalities in detecting sphincter injuries. This study also found external phased array MRI was superior in detecting EAS injuries compared to EAUS, which is in

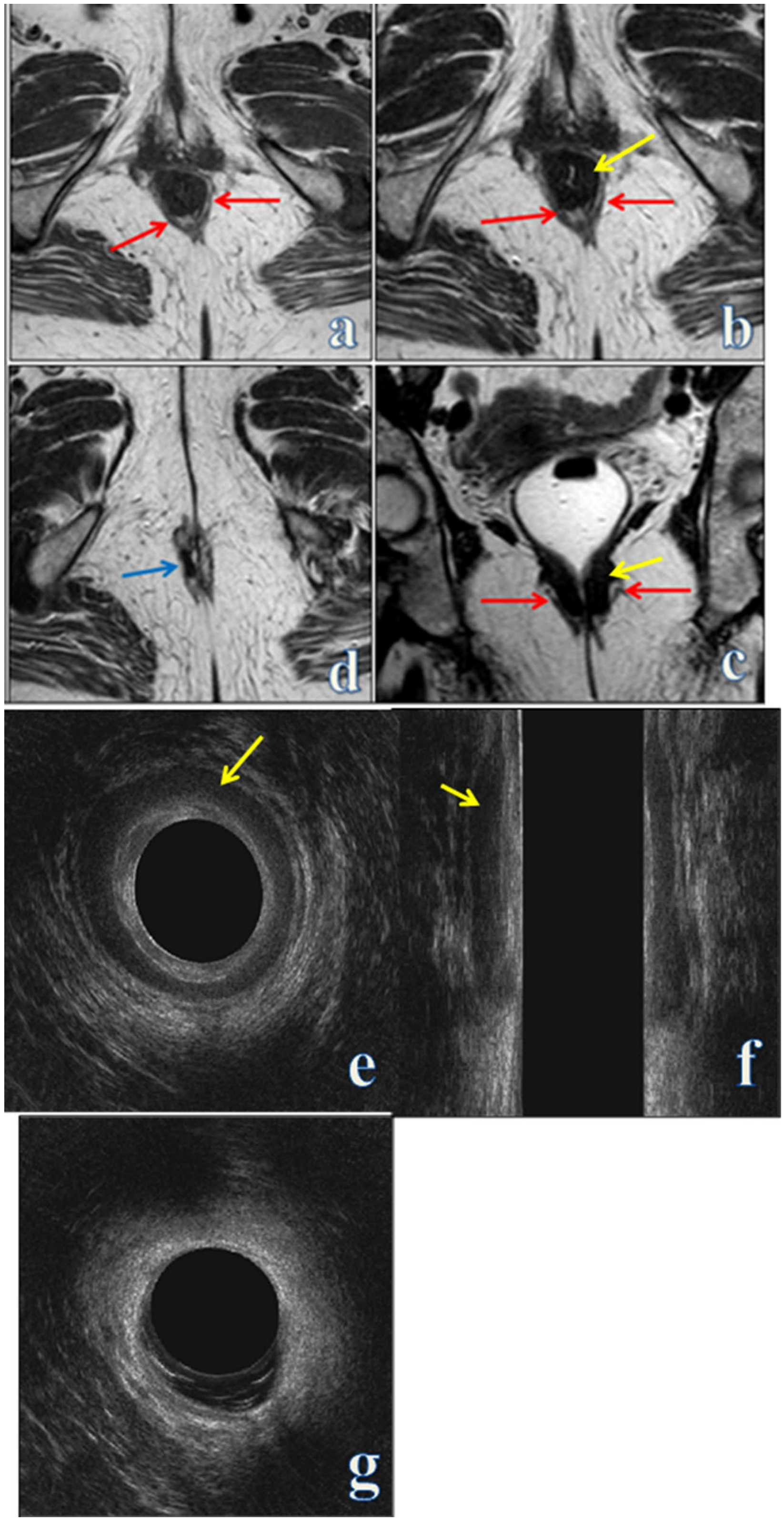

Fig. 6 **a** axial T1and **b**, **d** axial T2WI, **c** coronal T2 WI MRI images show diffuse thinning out/atrophy of EAS (red arrows), **d** axial T2 at lower level shows a right sided EAS dark T2 signal scar at 9 O'clock (blue arrow) **e** axial and **f** coronal reconstructed EAUS images couldn't detect EAS atrophy, **g** axial image at lower level couldn't detect the right sided EAS scar. The IAS (yellow arrows) appears thickened (8 mm) and foreshortened

Table 4 Detection of sphincter lesion in internal and external anal sphincters using Ultrasound and MRI

Internal sphincter lesion by ultrasound			Internal sphincter lesion by MRI			K_w	P-value
Finding	**Number**	**%**	**Finding**	**Number**	**%**		
No lesion	3	6.3	No lesion	2	4.2	0.972	< 0.001
			Fistula*	1	2.1		
Injury	19	39.6	Injury	19	39.6		
Fistula	19	39.6	Fistula	19	39.6		
Neoplastic	4	8.3	Neoplastic	4	8.3		
Atrophy	3	6.3	Atrophy	3	6.3		
External sphincter lesion by ultrasound			**External sphincter lesion by MRI**			**K_w**	**P-value**
Finding	**Number**	**%**	**Finding**	**Number**	**%**		
No lesion	32	66.7	No lesion	16	33.3	0.37	0.001
			Injury*	12	25		
			Fistula*	1	2.1		
			Atrophy*	3	6.3		
Fistula	6	12.5	Fistula	6	12.5		
Injury	6	12.5	Injury	6	12.5		
Neoplastic	4	8.3	Neoplastic	4	8.3		

*All these lesions were detected by MRI only and completely missed on EAUS

accordance with our results. This can be explained by the inherent heterogeneous echogenicity of the EAS unlike the homogeneously hypoechoic IAS. Accordingly, EAUS may be unable to distinguish between sphincter muscle fibers and scar tissue/defect with confidence [12]. Similarly, Dobben et al. [13] study revealed that there was fair agreement between endoanal MR imaging and EAUS for the detection of external sphincter injuries ($K=0.24$) and Rociu et al. [14] study revealed a fair agreement between endoanal MRI and endoanal US for the detection of the external sphincter injuries ($K=0.38$) both agreeing with our results.

Among our examined cases, EAUS could only detect 6 out of 18 cases of EAS injuries, since all these 6 cases had extensive scarring involving almost the half of sphincter circumference. Our results were discordant with West et al. [15] findings that stated EAUS had fair agreement ($K=0.20$) with endoanal MRI in IAS injuries and had good agreement ($K=0.61$) in EAS injuries, possibly due to the nature of their study participants as they all had history of obstetric injuries.

Regarding the agreement between EAUS and external phased array MRI in detecting the IAS defect and scar, we found it to be fair to slight with a Kappa coefficient of 0.41 and 0, respectively. EAUS could not distinguish between both entities and misinterpreted them, unlike MRI, which was able to differentiate between them. This finding aligns with Dobben et al. [16] findings; however, it is not particularly detrimental since defects and scar require similar management.

Our findings revealed an almost perfect agreement between the EAUS and MRI in the detection of the atrophy of the IAS and a slight agreement in the atrophy of the EAS. To the best of our knowledge, no studies compared between the EAUS and external phased array MRI in the detection of the anal sphincteric atrophy. However, studies have assessed the agreement between the EAUS and endoanal MRI or between the endoanal MRI and external phased MRI in detection of the atrophy of the EAS. Our results showed EAS atrophy detection by MRI in 3 cases presented by fecal incontinence, which were not detected by EAUS, this could possibly be elucidated by the fact that endoanal ultrasound cannot differentiate fatty tissue from muscle tissue and to determine the boundaries of the EAS. These results agree with West et al. [15] that stated the EAUS has no place in detection the EAS atrophy and MRI with endoanal coil is the main imaging modality that should be performed for its detection. These observations contradicted Cazemier et al. [17] study findings that found EAUS and endoanal MRI were comparable in the detection of EAS atrophy. To the best of our knowledge, this is the only study to suggest that EAUS can be used for detection of EAS atrophy, and we could not reproduce their findings.

Only 4 cases included in our study complained of low rectal cancer involving the anal sphincter, with both MRI and 3D EAUS depicted both sphincters were involved with almost perfect agreement. In accordance with our results, Kim [8] stated that the EAUS can accurately determine the depth of penetration of the anal canal cancer into the sphincter complex which it is important as it is closely associated with prognosis of the patients after chemoradiotherapy.

Our study concluded that there was an overall almost perfect agreement between EAUS and external phased array MRI in detection of the IAS lesions ($K_w = 0.972$) (97.92%) and overall fair agreement in detection of the EAS lesions ($K_w = 0.37$) (66.67%), revealed more detectable external sphincter fistulous affection, injuries and exclusively detectable external sphincter atrophy by MRI.

We firmly believe that the detection of more external anal sphincteric lesions by MRI, as opposed to EAUS, holds significant clinical implications. Identifying lesions such as atrophy or injuries in patients presenting with fecal incontinence aids treating physicians in determining the appropriate treatment plan. For example, patients with external sphincter atrophy may benefit from physiotherapy rather than surgical anal sphincter repair, which is more suitable for those with sphincteric injuries but carries a poorer outcome in cases of EAS atrophy. Furthermore, the detection and classification of perianal fistulas by MRI, which may be missed by EAUS, validate patients' clinical symptoms, and facilitate the selection of optimal treatment strategies.

Study limitations

Our study has its limitations. The inevitable selection bias, the small sample size with different sphincteric lesions as well as the lack of correlation with references such as surgical findings in cases of sphincter injuries or histopathology in cases of sphincter atrophy and neoplastic processes, since our main objective was to perform a comparative study between a newly introduced imaging technique (3D EAUS) at our institution compared with the MRI. Our study did not include patients with complex fistulous cases since we were not primarily investigating perianal fistula. Although EAUS can be faster to perform, it is only available at specialized centers and requires experienced radiologists for image interpretation. Additionally, patients with inflammatory anal conditions may not tolerate the EAUS probe, and anal stenotic lesions do not allow for probe insertion. Further validity studies with larger sample size are recommended. Introduction of artificial intelligence in the future research would possibly be of a great value in interpretation of MRI and EAUS images aiding radiologists to make more accurate diagnoses.

Conclusions

3D EAUS and external phased array MRI are comparable in detection of the IAS affection, while MRI is relatively superior in detecting EAS involvement in different sphincteric diseases.

Acknowledgements
Not applicable.

Author contributions
AAA put the idea of the study, participated in the study design and data collection, and performed statistical analysis, ultrasound examination and MRI assessment. MYA contributed to the data collection and clinical assessment of the patients. HMS participated in the study design and ultrasound assessment. ASM participated in ultrasound assessment. MAA contributed to the substantial revision and editing of the manuscript. HMA participated in editing of the manuscript, the study design and MRI assessment. All authors read and approved the final manuscript.

Funding
Not applicable

Availability of data and materials
All the datasets used and analyzed in this study are available with the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Written informed consent was signed by all patients before the examination. The study was approved by the research committee of Faculty of Medicine, Kasr Alainy Hospitals. Cairo University 2021. The reference number provided by the committee was MD-135-2021.

Consent for publication
All patients included in this research were fully conscious and gave written informed consent to publish the data contained within this study.

Competing interests
The authors declare that they have no competing interests.

Received: 16 March 2024 Accepted: 9 May 2024
Published online: 14 May 2024

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