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ORIGINAL ARTICLE

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Anal endosonography: a survey of equipment, technique and diagnostic criteria adopted in nine Italian centers

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Abstract Background Anal endosonography (AES) has become an essential part of the pre-operative diagnostic workup in both organic and functional anal diseases. **Methods** Nine Italian centres with an average volume activity of >10 exams/week each were surveyed with the aim of determining the concordance with respect to indications for the procedure and interpretation of the results. **Results** Overall, anal sepsis, faecal incontinence and anorectal tumours were the more common indications for AES while anal pain was not always considered an indication. All centres use the same diagnostic criteria for simple and complicated perirectal sepsis and sphincteric defects, but adopt different classifications for stage 1 and stage 2 anal tumours. Participants agreed in that lymph-node staging by AES is less precise than tumour staging, especially after chemoradiation therapy. **Conclusions** A list of recommendations and guidelines based on the groups's experience has been produced for those radiologists and coloproctologists interested in the use of AES and accreditation of their centres.

Key words Anal endosonography • Anorectal sepsis • Anorectal neoplasms

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Introduction

Since its introduction in 1989 [1–5], anal endosonography (AES) has become an essential part of the pre-operative diagnostic work up in many anal diseases such as fistulae [6, 7], sphincter defects [8–11] and anorectal tumours [12–17]. For anal fistulae, in particular, AES has been favourably compared with more expensive techniques such as magnetic resonance imaging (MRI) [18–21]. New technical improvements to AES include contrast-enhanced imaging [22–25] and three-dimensional imaging [26–33] that, although still in need of validation, seem to increase the accuracy of the exam, allowing a more appropriate management of anal diseases. The transperineal and the transvaginal approaches [34–39] are also considered attractive and to some extent effective alternatives, especially in such cases when anal or rectal strictures and/or pain prevent the insertion of the mechanical anal probe.

Accuracy of ultrasound scanning largely depends upon the examiner's experience, so that an incorrect acquisition or interpretation of the images obtained may bear worrying consequences. Over the last decade indications to anal and rectal endosonography have greatly widened and in Italy the number of examiners has grown accordingly, to fulfil the increased requests. The National Committee for Ultrasound in Coloproctology, on behalf of the Imaging Working Group of the Italian Society of Colorectal Surgery, surveyed nine qualified Italian research centres for all the technical aspects of anal ultrasonography, including indications and diagnostic criteria, in order to standardise the quality of endoanal ultrasound education.

Methods

After a three-year survey period (January 2002-February 2005) a total of 9 Italian centres (in 8 cities) performing anorectal endosonography >10-times per week were selected on the basis of the criteria indicated by the joint SICCR-SIUMB Committee (Table 3). Out of them, all but one had been performing anorectal endosonography >6-times per week.

The centres were sent, by electronic mail, a questionnaire prepared by the chairman (VP) investigating the indications for AES, the equipment used, the preparation and positioning of patients, scanning technique and criteria for the endosonographic diagnosis of the most common anal and rectal diseases. The average time span to which the collected data regarding indications for AES was referred was two years (range 1 to 5). Written answers were possible in a free-style mode (open answers).

Results

All centres completed the questionnaire. Sepsis, faecal incontinence and anorectal tumours were the more common indications for anal endosonography, while rectocele, mucosal prolapse and endometriosis represented less common indications (Table 1).

All centres use a Bruel and Kjaer Medical ultrasound scanner (Denmark): a Leopard model is used in 3 centres, a Falcon in 3 centres and a Panter in the remaining 3 centres. The rotating endoprobe type 1850 and type 3050 are the most commonly used. The endoprobe is equipped with a multifrequency 7–10 MHz transducer (focus, 1.5–4 cm) that provides 360° axial scanning of the anal canal and rectum. For anal imaging, the tip of the probe is protected by a plastic cone of 1.7 cm outer diameter while a latex balloon is used for rectal examination. The cone and the balloon are filled with degassed water for acoustic coupling.

Table 1 Indications for anal endosonography (AES), for 9 Italian centres surveyed between January 2002 and February 2005. Values in parentheses are total absolute numbers of procedures performed

Indication	Center								
	Milan (957)	Padua (893)	Rome I (950)	Treviso (556)	Legnano (906)	Rome II (1101)	Cuneo (616)	Catania (151)	Palermo (534)
Anal sepsis/fistula	399	364	411	219	352	548	162	61	165
	41.6%	40.7%	43.3%	39.3%	38.8%	49.7%	26.3%	40.3%	30.9%
Fecal incontinence	198	214	202	72	98	237	38	20	118
	20.6%	23.9%	21.3%	12.9%	10.8%	21.5%	6.2%	13.2%	22.1%
Tumours									
Rectal	52	209	247	197	226	149	146	11	43
	5.4%	23.4%	26.0%	35.4%	24.9%	13.5%	23.7%	7.2%	8.05%
Anal	24	63	34	13	10	26	12	0	4
	2.5%	7.0%	3.6%	2.9%	1.1%	2.3%	1.9%		0.74%
Rectocele/ m. prolapse/ Obstructed defecation	80	0	15	25	206	39	98	18	98
	8.3%		1.6%	4.4%	22.7%	3.5%	15.9%	11.9%	18.3%
Endometriosis	12	4	10	18	12	19	24	0	0
	1.2%	0.4%	1.1%	3.2%	1.3%	1.7%	3.9%		
Congenital conditions	1	0	0	0	2	0	5	0	0
	0.1%				0.2%		0.8%		
Pain	69	0	31	12.	118	71	3	20	47
	7.2%		3.3%	2.1%	13.0%	6.4%	0.5%	13.2%	8.8%
Asymptomatic sphincter defect	0	0	0	0	0	0		0	0
Other	14	39	38	0	0	12	124	21	59
	1.4%	4.6%	4.55%			1.0%	20.12%	13.9%	11.0%

Both are covered with a lubricated condom prior to the examination. The probe is gently inserted through the anus and images are taken as the probe is slowly withdrawn. All centres store all images on a hard disk and print some images on paper. Three-dimensional (3D) ultrasound equipment is available in 5 centres (55.5%), which routinely use reconstructed 3D images for more detailed diagnosis. When coupled with an axial self-moving endoprobe, 3D reconstruction allows a correct measurement of the longitudinal extension of an anal lesion or a sphincteric defect.

A 150 ml disposable enema 2–3 hours before the exam is considered mandatory for rectal ultrasonography by all centres and useful when examining the anal canal only by 4 centres. Oral bowel preparation is rarely performed. Patients are usually examined in the left lateral (Sim's) position as it allows a thorough clinical inspection and digital examination. Anoscopy or rigid rectoscopy can also be easily performed in this position if necessary. For rectal examination, all centres use the left lateral position. For anal ultrasonography, one centre only adopts the prone position, as proposed by Frudinger et al. [43], as this position may help identifying alterations of symmetric structures (such as deep and superficial transverse muscles) and seems to enhance the outer aspect of the external anal sphincter.

Regarding image display, all centres refer to the so-called anal clock, i.e. the view of the anal region as it appears with the patient in lithotomy position where the anterior perineum is at 12 o'clock and the anal cleft is at 6 o'clock; 3 and 9 o'clock refer to the left lateral and right lateral aspects, respectively. This orientation corresponds to the surgeon's view of the perianal region. Axial MR images are also oriented in the same way.

Hydrogen peroxide-enhancement is deemed useful by all centres for studying anal fistulae. The technique is rather simple: once the external opening has been identified, up to 4 ml hydrogen peroxide is injected into the track using an 18-gauge plastic catheter; gas bubbles created along the main and accessory tracks are visualised as an intense hyperechoic signal shadowing the surrounding structures.

In terms of diagnostic criteria, all centres agree on the following endosonographic features of anal diseases:

- A sphincteric defect corresponds to replacement of normal muscle fibres with scar tissue and fibrosis. However, given the different echogenic texture present in the normal internal anal sphincter (IAS) and external anal sphincter (EAS), a defect can appear alternatively as a hyperechoic break in a hypoechoic ring (IAS defect) or a relatively hypoechoic area in a hyperechoic ring (EAS defect) (Fig. 1). Birth-related anoperineal tears are classified on a clinical basis and scored from 0 to 4 as follows: grade 0 corresponds to an intact perineum; a first-degree tear is the involvement of the vaginal mucosa and skin; in a second-degree tear the perineal body is also involved; the third-degree tear is divided into three types (*type a*, when less than 50% of the thickness of the EAS is damaged; *type b*, when more than 50% of the thickness of the EAS is disrupted; and *type c*, when the IAS is also involved); in the fourth-degree tear, the lesion is extended to the anal mucosa [9–11]. Ultrasonography is used to confirm the diagnosis in third- and fourth-degree tears.
- A neoplastic tissue usually appears as a hypoechoic lesion disrupting the normal 5-layer sonographic structure of the rectal wall or invading the sphincteric anal complex. For rectal cancer T-staging, all centres refer to the TNM classification of Hildebrandt and Feifel [12], while for anal cancer T-staging 6 centres refer to Tarantino and Bernstein's classification [16], 2 centres to Bartram and Burnett's [2] and 1 to TNM [17] (Table 2). For N-staging, all centres agree that the most important sonographic features of possibly involved nodes are

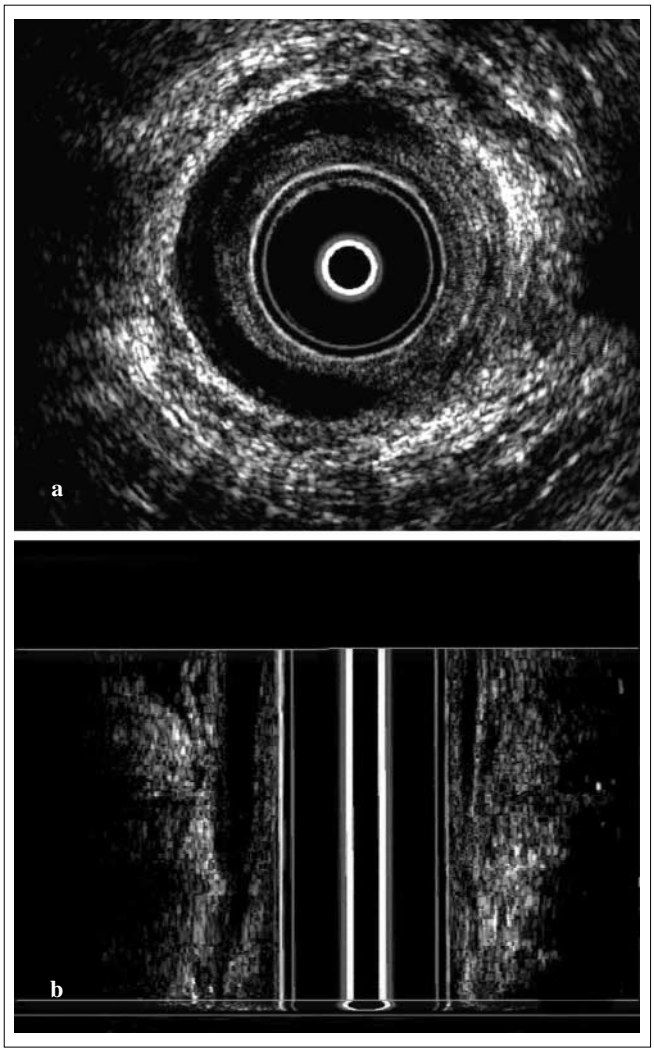

Fig. 1a, b *Endosonograms of an internal anal sphincter defect*. **a** Transverse 2D view shows a 2-o'clock to 5-o'clock interruption of the internal anal sphincter. **b** Longitudinal projection (frontal section) of the anal canal: the cephalad-caudal extension of the sphincteric defect is more clearly seen

Table 2 Differences among three staging systems for anal cancer adopted by 9 Italian centres. Both Bartram and Burnett's and Taratino and Bernstein's systems refer to depth of tumour invasion, while TNM refers to tumour size

	Classification system		
	Bartram and Burnett [2]	Tarantino and Bernstein [16]	TNM [17]
Centres, n	2	6	1
Stage			
T 1	Internal sphincter	Mucosa/submucosa	≤2 cm
T 2	External sphincter	a) Internal sphincter b) External sphincter	>2 cm but <5 cm
T3	Perianal tissue	Perianal tissue	≥5 cm
T4	Pelvic organs	Pelvic organs	Any size invading adjacent organs

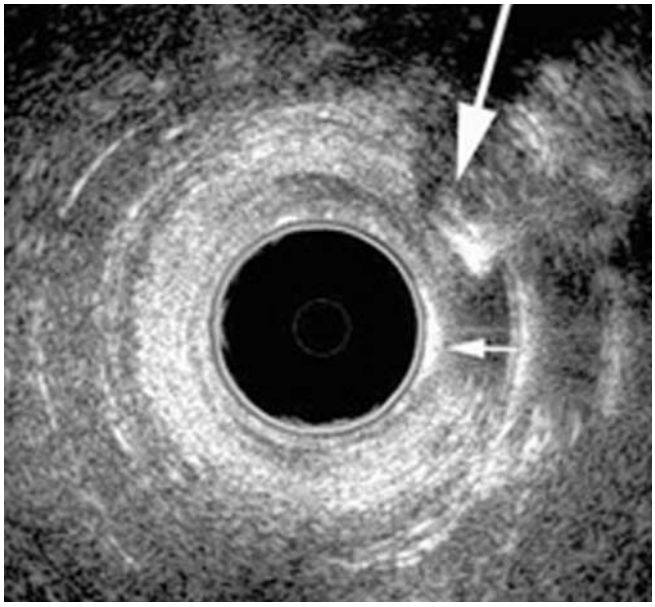

Fig. 2 Injection of hydrogen peroxide through the external opening of the fistula. The abscess (*large arrow*) and the anal canal (*small arrow*) are observed

round shape, hypoechoic appearance and reduced sonic attenuation coefficient. The size of the lymph node is also important: the risk of nodal involvement is less than 20% if the lymph node is smaller than 4 mm and the figure increases to 50%–70% if the node is greater than 5 mm.

- An abscess appears as a hypoechoic mass containing bright echogenic dots (air bubbles). Both fistulous tracks and abscesses turn brilliantly hyperechoic after injection of hydrogen peroxide. The contrast medium also shows the main track routing towards the lumen of the anal canal (Fig. 2) and points out possible secondary tracks. According to Cho's criteria [46] the internal opening may appear as: (a) a root-like budding where the intersphincteric track meets the IAS, (b) a hypoechoic budding associated with an IAS defect; (c) a subepithelial breach connected to the intersphincteric collection through an IAS defect. Fistulae are classified according to Parks' classification [47]. Infection of the apocrine glands located around the anus or perineum, i.e. suppurative hydradenitis (HS), has no connection with the anal canal and involves only the skin and subcutaneous tissue. In this case, endoanal ultrasonography usually shows superficial areas of mixed echogenicity, usually hypoechoic when a collection is present and small shallow abscesses and fistulae that do not make contact with the sphincteric complex.

After the examination, all centres give patients a detailed descriptive report, together with some relevant pictures. The report includes the patient's name and age, the date of the exam, a summary of the equipment used, the patient's position, the image orientation, the scanning planes (upper, middle and lower anal canal), the average measures of both IAS and EAS, and a detailed description of all abnormalities. For a sphinteric defect, the site is identified with the anal clock rule, its circumferential extension is reported in degrees, while its longitudinal extension is expressed in millimetres. For abscesses and fistulae, the location of the internal opening, the route of the primary track, and the presence of secondary tracks are noted. For rectal cancer, the distance from the anal verge, its position and an accurate T-staging as well as lymph-node status are thoroughly reported by all centres. For anal tumours, T-stage and measurements of the mass are accurately reported. These measurements are useful for quantification of the disease and for comparison during follow-up visits.

After AES, the surveyed centres perform further diagnostic workups in particular situations:

- *Perianal sepsis and fistula*. The majority of participants consider fistulography [48] and pelvic computed tomography (CT) insufficiently accurate for clinical use. In fact, while fistulography (X-ray contrast radiography), which has been used for many years, is unable to show the anatomic relationship of the fistulous track with the anal sphincters and levator ani muscle, CT does not distinguish the sphincter muscle planes from fibrotic reaction or active inflammatory tissue. Although the use of hydrogen peroxide has made the identification of

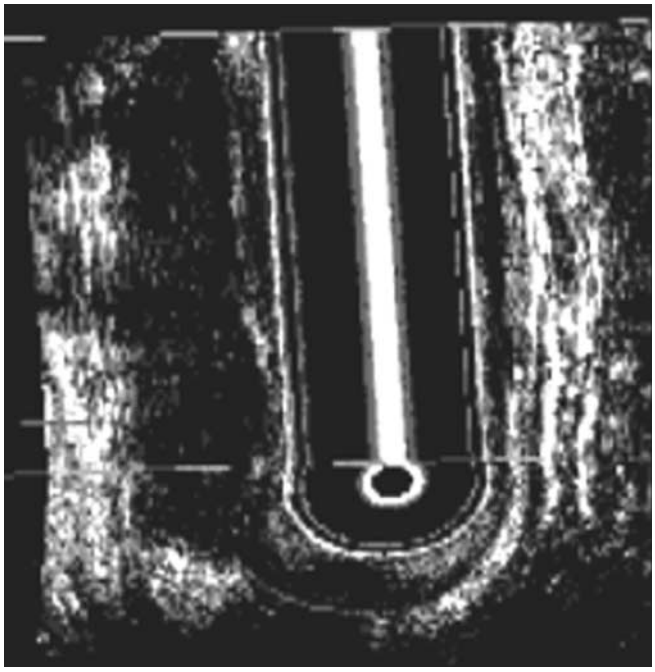

Fig. 3 3D endosonogram of an anal carcinoma. Longitudinal view. The margin of infiltration is clearly seen

the fistulous track and its internal opening much easier, MRI is thought to be significantly more accurate in identifying secondary extensions and distant collections, especially in the supralevator space and ischioanal fossa as well as in the superficial tissues. As an attractive alternative to MRI in case of severe anal stenosis or pain that do not allow the insertion of the probe and also in case of repeated surgical procedures in the perianal region, transperineal sonography (TPS) may also be considered.

- *Fecal incontinence*. AES is considered an unsurpassed method for evaluating anal sphincter anatomy, although the external boundaries of the EAS are sometimes difficult to follow. The echogenic characteristic of the sphincter itself and the interface with adjacent tissue are possible explanations. Today AES remains the most sensitive technique for detecting occult sphincter defects; however, initial results suggest that endoanal and even phased array external MRI could be as accurate, if more in some cases. Apart from sphincter studies, in case of faecal incontinence due to faecal impaction or chronic diarrhoea, transit time studies (using radiopaque markers) and defecography remain important parts of the diagnostic pathway [49, 50].
- *Neoplasm*. Anorectal endosonography is unanimously considered the exam of choice for T-staging rectal and anal cancers, as it accurately shows the tumour penetration through the layers of the bowel wall. AES also allows the detection of suspect lymph-nodes in the mesorectum. Moreover, the introduction of 3D facilities has dramatically improved the demonstration of the upper limit of the tumour (Fig. 3) at the anorectal junction where the ampulla bends backward, so that it is now easier to discriminate between tumoral and normal tissue [26, 27, 32, 33]. Overall, AES provides an excellent axial resolution of less than 0.1 mm and a lateral resolution of 0.8 mm in the focal zone, thus resulting in a voxel size of 0.2 mm^3. In comparison, the best resolution by means of MRI with an endoanal coil has a voxel size of at least 0.6 mm^3. Another advantage of 3D-AES is that it requires approximately 2 min to scan the entire length of the anal canal, by far faster than MRI. CT and MRI are nevertheless important in the assessment of pelvic and distant involvement.

Discussion

The primary aim of this survey was to determine the concordance among various centres across Italy with respect to indications and interpretation of AES in common anal problems such as trauma, infection and malignancy. In addition, in order to standardize the quality of endoanal education, a list of recommendations regarding sonographic accreditation for Italian centres and use of ultrasonography in certain anorectal disorders has also been produced, based on the centres' collective experience.

Anal endosonography in Italy is most frequently used to detect anal sphincter defects, to classify anal fistulas and perianal abscess and to stage anorectal tumours. Less certain is the role of this technique in the diagnosis of functional disorders such as obstructed defecation and rectal prolapse. In fact, only a few centres indicated that it is useful for assessing rectal prolapse and haemorrhoids.

All centres surveyed showed high uniformity in the equipment used and in conduction of the examination. From the technical point of view, the major limitations when performing anal endosonography result from: (1) incomplete coupling of the probe at the level of the anal verge that produces artefacts which may hide superficial abscesses, fistulae and inflammation of the skin; and (2) a tight anal stricture or a hypertonic IAS preventing introduction of the probe through the anus. In these two cases, a large amount of gel or a stand-off to achieve better coupling and perineal sonography using a convex or linear probe probe, respectively, should be considered.

Although a 3D system for axial image reconstruction was not available in all centres, the general opinion of participants agrees with that of Christensen et al. [33] and suggests that this new technique does improve the diagnostic confidence in terms of visualization of tumour spread and detection of regional lymph nodes. More precisely, 3D endosonography allows better discrimination of upper tumour limit and invasion depth. In addition, compared to 2D endosonography, a 3D system is able to show a consid-

erably higher number of lymph nodes, thus improving T-staging. Accurate inspection of the iliac vessels and their associated lymph nodes by color Doppler examination is also considered necessary for complete staging.

Similarly, there is uniformity over the use of hydrogen peroxide-enhanced sonography in the preoperative assessment of fistula-in-ano: this technique is considered to help spotting out the internal opening and secondary extensions (particularly horseshoe tracks).

When considering the problem of image interpretation in the various disease states, Cho's criteria [46] for identification of the internal opening of the sinus track are used by the majority of centres, while all centres in case of perineal tear refer to the four-degree score of post-partum anoperineal sphincteric defects. Conversely, in T-staging anal cancer, only 66.7% of centres refer to the classification proposed by Tarantino and Bernstein [16]. This may represent a problem when comparing data in multicenter studies, as for instance a T1 anal cancer indicates integrity of the IAS in Tarantino and Bernstein's classification and invasion through the AS in Bartram and Burnett's classification.

Some questions remain unaddressed. AES is pretty accurate in determining the presence of neoplastic tissue, which usually appears as a hypoechoic area disrupting the normal structure of the bowel wall, but accuracy decreases when determining the depth of invasion as also peritumoural inflammation appears hypoechoic. For this reason, T1 cancers may be overstaged as T2. Understaging of a lesion usually represents a failure to detect microscopic foci of cancer infiltration, mainly due to technical limits of resolution of the sonographic system [51].

Finally, endoanal ultrasonography is less accurate in detecting local recurrence and in N-staging [15, 52, 53]. The detection of local recurrence by sonography alone is sometimes made difficult by post-operative or post-radiation inflammatory changes and fine needle biopsy is often indicated in these cases to obtain a definite diagnosis. Figures of N-staging accuracy, on the other hand, do not differ from those encountered in the literature, as endosonography allows a morphologic evaluation of perirectal lymph-nodes in the mesorectum, and malignancy can only be suspected but not proven sonographically.

When considering other imaging modalities for the diagnosis of fistulae and anal abscess, MRI with external phased array coils, although more expensive, is currently considered the method of choice for identifying secondary tracks and collections in the supralevator and ischiorectal spaces. According to some authors [39], however, TPS using a regular 3.5 MHz convex probe gives comparable results while anal endosonography, in experienced hands, may occasionally give better results, allowing real-time evidence of active inflammation and sepsis. In fact, application of gentle pressure with the tip of the probe may help detect air bubbles moving within the track or the collection.

In case of anal sphincter injury, from vaginal delivery, accidental trauma or iatrogenic causes, AES is regarded as the most accurate means for morphological mapping and therapeutical planning. Recently, however, MRI of the anal sphincter (using an internal coil with different pulse sequences and contrast enhancement following intravenous gadopentetate dimeglumine) has been proven to be even more effective in showing sphincter atrophy or scar.

Defecography with vaginal and bladder contrast medium and small bowel opacification is indicated in obstructed defecation and in the diagnostic work-up of pelvic prolapse but, again, TPS and MRI are being used more frequently today since they have proven highly accurate in delineation of disorders such as rectocele, enterocele and rectoanal intussusception with the advantage of not using ionizing radiation.

Finally, addressing the issue of standardization of the quality of endoanal sonography, the Italian Society of Colorectal Surgery (SICCR) has always been at the forefront in the proposal of medical education programmes. Until now, accurate communication between different institutions has not been possible for anal endosonography in Italy because there has been no universally accepted system for describing the conditions of examination, includ-

Table 3 Requirements for accreditation of endoanal sonographic centres, according to the joint committee of the Italian Society of Colorectal Surgery (SICCR) and the Italian Society of Ultrasonology in Medicine and Biology (SIUMB)

Logistics	One 4x4 m^2 diagnostic room in close proximity to supporting departments of general radiology, surgery, laboratory and anesthesiology. A different room dedicated to instrumental disinfection, cleansing, maintenance, patient preparation, and drug administration
Instrumental	A rotating endoprobe with a 10 MHz transducer, providing 360° axial images of the anal canal; ultrasound scanner with image storage and 2D or 3D module reconstruction facilities, color Doppler, equipped with needle biopsy support. A 3.5-MHz convex probe and a 12-MHz linear probe for complementary transperineal approach
Staff	1 trainee physician[a] with no less than 3 years' experience, who holds the first level SICCR/SIUMB certificate in endoanal sonography
	1–2 medical students
	1–2 nurses responsible for patient instruction, bowel preparation, cleaning and maintenance of instruments
Volume of activity	No less than 5-6 exams per week

[a] Radiologist or coloproctologist

Table 4 Suggestions for application of diagnostic imaging algorithm in proctology

Dysfunction or disease	Diagnostic tools
Fecal incontinence	1st AES 2nd TPS 3rd MRI
Obstructed defecation	1st (MR) Defecography 2nd TPS
Pelvic prolapse	1st TPS 2nd MRI of pelvic floor
Anal sepsis	1st AES+TPS 2nd MRI
Tumour	1st AES+TAS 2nd MRI of the abdomen

AES, anal endosonography; *TPS*, transperineal sonography; *MRI*, magnetic resonance imaging; *TAS*, transabdominal sonography

ing the characteristics of the diagnostic room, staff composition, equipment and facilities, and volume activity threshold for those centres asking for sonographic accreditation. As such, a national multidisciplinary committee composed of members of SICCR and the Italian Society of Ultrasonology in Medicine and Biology (SIUMB) has recently been formed. The Committee's effort over the first two months of activity has resulted in the draft of a document describing the standard conditions of anal endosonographic examination in Italy. Adoption of these standards by those centres asking for sonographic accreditation in proctology should be indicated in written form with the following statement: "Anal endosonography: methods and performance conform to the standards recommanded by the joint committee of SICCR and SIUMB".

This article provides an excerpt of these recommendations (Table 3), approved by the multidisciplinary committee, together with an attempted algorithm (Table 4) for the use of diagnostic imaging in proctology.

In conclusion, AES is a valuable exam for the diagnosis of many anal diseases. It is relatively simple to perform, and although requiring dedicated ultrasound probe and scanner, has lower costs with respect to other imaging modalities such as CT and MRI. On the other hand, it is less accurate than MRI and, in inexperienced hands, may be potentially harmful, as the operator's experience seems to be the most relevant factor affecting the accuracy of the diagnosis.

For good results, the clinician wishing to use AES in daily practice should keep in mind the following three main rules: (a) to build up experience after adequate training in a reference centre; (b) to rely only on established diagnostic criteria and classification systems; and (c) to compare US results with the surgical findings.

The present survey has shown a sufficiently uniform standard of performance and diagnostic accuracy among the centres involved. Discrepancies in anal tumour staging classification should be solved by adopting a common staging system.

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