IV.4. Fecal Incontinence: Endoanal Ultrasonography and MR Imaging

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Introduction

To assess fecal incontinence, the physician can use different sources of information such as medical history, physical examination, a set of anorectal functional tests, and imaging techniques [1, 2]. Imaging techniques used in the diagnostic workup of patients with fecal incontinence comprise endoanal ultrasonography (EAUS), endoanal magnetic resonance (MR) imaging, external phased array MR imaging, and defecography. As this chapter focuses on demonstrating the anatomy and pathology of the anal sphincter complex, defecography will be left aside, as this technique is primarily performed in fecal incontinent patients to visualize an intussusception [3–5].

EAUS is the first imaging technique used for assessing anal sphincter pathology in patients with fecal incontinence. Before the introduction of this technique, fecal incontinence was primarily ascribed to neurogenic dysfunction, but EAUS elucidated that structural damage of the anal sphincter complex plays a crucial role in the development of fecal incontinence complaints [6–8]. EAUS is an endoluminal technique that yields images of high-contrast resolution [9]. Different layers of the anal sphincter complex can be discriminated because of tissue-dependent reflection. Some layers are low reflective (hyporeflective; darker) and other layers are high reflective (hyperreflective; brighter).

MR imaging in patients with fecal incontinence can be performed with an endoanal coil, which was introduced in the mid 1990s, or an external phased array coil [10–12]. Inherent to MR imaging are multiplanar capabilities and high contrast resolution images enabling accurate demonstration of the multilayer construction of the anal sphincter complex. Different structures can be distinguished by differences in signal intensity. Some structures produce low-intensity (hypointense) signals (e.g., external anal sphincter and other striated muscles) whereas other structures produce high-intensity (hyperintense) signals (e.g., internal anal sphincter; fat) at T2-weighted images. The use of an endoanal coil results in images of higher spatial resolution than when an external phased array coil is used although the field of view is limited. The latter is not a disadvantage in patients with fecal incontinence but might be a limitation for imaging of perianal fistulas, especially in patients with perianal Crohn's disease in which fistulas are often complex and can extend outside the field of view of endoluminal coils [13].

Techniques

Endoanal Ultrasonography

Endoanal ultrasonography is generally performed with a two-dimensional (2-D) ultrasound scanner with a 7 or 10 MHz rotating endoprobe covered by a water-filled hard sonolucent cone, providing a 360° axial view of the anal canal. No specific patient preparation is required before starting the examination. Patients can be examined in the following positions: left lateral, prone, or the lithotomy position. Performing the examination in the prone or lithotomy positions is preferable in women, as in the left lateral position, the structures at the anterior part of the anal

sphincter complex are deformed, impairing accurate diagnosis. The endoprobe is covered with a condom lubricated and subsequently introduced into the anus to the level of the anorectal verge and slowly withdrawn. Images are obtained at the proximal, middle, and distal levels in the anal canal.

Besides 2-D EAUS, three-dimensional (3-D) EAUS is also available. The advantage of 3-D EAUS over 2-D EAUS is the possibility of multiplanar imaging of the anal canal, which enables demonstration of anal sphincter pathology along the length of the anal canal [14].

MR Imaging

MR imaging is generally performed at a 1.0 or 1.5 T MR unit with a dedicated endoanal coil or an external phased array coil. For MR imaging, a number of strategies can be used; here, general instructions are provided. Bowel preparation is not needed, but asking patients to fast 4 h prior the examination is necessary to reduce artifacts from bowel peristalsis. Further, asking patients to empty their bladder before starting the examination is also recommendable to prevent motion artifacts due to discomfort from a distended bladder. Bowel relaxants (one milliliter of butyl scopolamine bromide (Buscopan, 20 mg/ml; Boehringer Ingelheim, Germany) or one milligram of glucagon hydrochloride (Glucagen, Bagsvaerd, Denmark) can be injected intramuscularly just before imaging to reduce peristalsis. When an endoanal coil is used, the coil should be covered with a condom and lubricated. Lubricant produces high signal intensity nearby the coil and therefore the amount of lubricant should be limited. The endoanal coil is inserted in the anal canal in a left lateral position. After endoanal coil positioning, the patients are turned in the supine position. Supportive pads are necessary to stabilize the position of the endoanal coil. If an external phased array coil is used, the patients should be placed in the supine position with the pelvis centered at the proximal end of a posterior phased array coil in the feet-first position. An external phased array coil is placed anteriorly.

The optimal sequence for evaluating anal sphincter anatomy and pathology with endoanal or external phased array MR imaging has not been established. Generally, T2-weighted turbo spin-echo sequences can be used as basic sequence. At a 1.5 T MR unit, patients can be scanned using scan parameters within the following ranges: TR 2,500–3,500 ms, TE 70–90 ms, echo train length 10, field of view 10x10 cm (axial) and 16x16 cm (coronal), imaging matrix 256x512, 3-mm slice thickness, 0.3-mm interslice gap, and 2 excitations. Scan parameters should be optimized for the MR imaging system and endoanal coil or external phased array coil used to obtain optimal contrast resolution. Fat suppression techniques are not valuable in T2-weighted imaging in fecal incontinence. The use of T1-weighted sequences is not advisable, as its superiority above T2-weighted sequences has not been established. Phase-encoding direction should be adjusted to prevent artifacts in the anterior part of the anal sphincter complex. Axial images with slice orientation perpendicular to the anal sphincter and endoanal coil should be made. Further coronal images and, if desired, sagittal images with slice orientation parallel to the anal sphincter and endoanal coil should be obtained.

Normal Anatomy

The anal sphincter complex is comprised of different muscular layers and is enclosed by the fat-containing ischioanal space [9]. The most inner part of the anal sphincter complex is the internal anal sphincter (IAS), a smooth, circular muscle that is the terminal continuation of the circular rectal muscle. The striated external anal sphincter (EAS) is the outermost muscle of the distal anal sphincter complex and encircles the IAS. The space between the IAS and EAS, the intersphincteric space, contains fat and the longitudinal muscle. The latter is the continuation of the longitudinal muscle of the rectum. The puborectal muscle, a striated, sling-like muscle, is closely aligned to the deep part of the EAS and forms the upper outer part of the anal sphincter complex. The striated levator ani muscle is the cranial continuation of the puborectal muscle.

At EAUS, the IAS is visible as a clearly defined ring of low reflectivity (Figs. IV.39 and 40). The EAS is inseparable from the sling-like puborectal muscle and appears as an intact ring. In men, the EAS is recognizable as a ring of low reflectivity (Fig. IV.39), and in women, the EAS is mainly hyperreflective, making recognition sometimes more difficult (Fig. 40). The longitudinal muscle is a layer of variable reflectivity (Fig. IV.39).

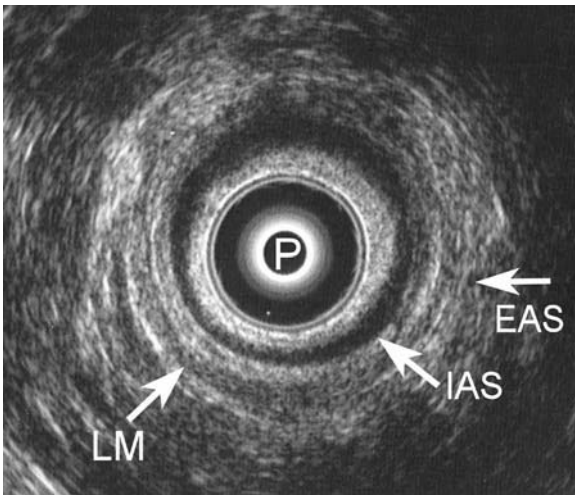


Fig. IV.39. Two-dimensional axial endoanal ultrasonography image obtained in the mid anal canal demonstrating normal male anatomy. *EAS* external anal sphincter, *IAS* internal anal sphincter, *LM* longitudinal muscle, *P* endoanal probe

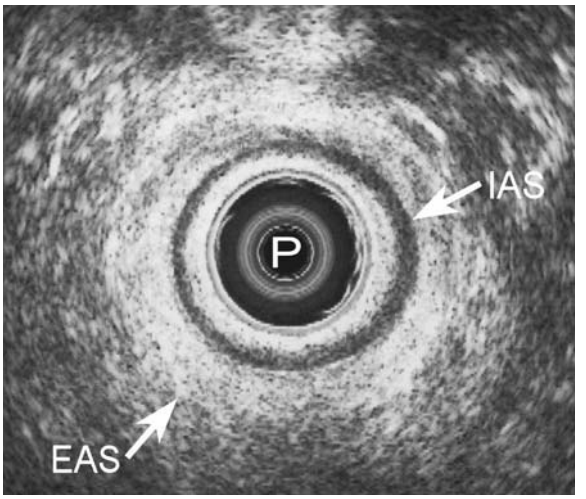


Fig. IV.40. Two-dimensional axial endoanal ultrasonography image of the mid anal canal showing normal female anatomy. The external anal sphincter is visible as a mainly hyperreflective ring (compare to Fig. IV.39). *EAS* external anal sphincter, *IAS* internal anal sphincter, *P* endoanal probe

At MR imaging on T2-weighted images, the IAS and EAS are recognizable in the axial plane as a clearly defined ring of relatively hyperintense signal intensity and relatively hypointense signal intensity, respectively (Fig. IV.41). In the coronal plane, the relation between the EAS and the puborectal muscle can be easily appreciated in contrast to the axial plane in which this is more difficult (Figs. IV.42). The hypointense longitudinal muscle often has a beaded appearance in the axial plane (Fig. IV.44). The amount of fat in the intersphincteric space is variable and may not be discernible. The puborectal muscle and levator ani have a signal intensity comparable to the EAS: relatively hypointense (Figs. IV.42 and 43).

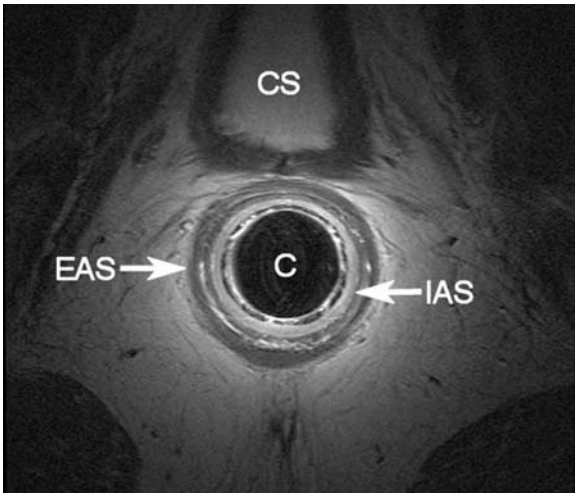


Fig. IV.41. Axial endoanal T2- weighted fast spin-echo MR image obtained in the mid anal canal visualizing normal anatomy and normal continuity of both the external and internal anal sphincter ring in a male patient. *EAS* external anal sphincter, *IAS* internal anal sphincter, *CS* corpus spongiosum, *C* endoanal coil

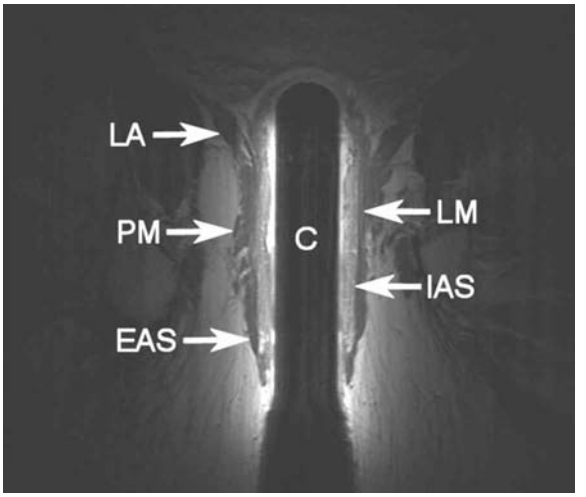


Fig. IV.42. Endoanal T2- weighted fast spin-echo MR image demonstrating normal anatomy in the coronal plane in a 68-year-old man. *EAS* external anal sphincter, *IAS* internal anal sphincter, *LM* longitudinal muscle, *PM* puborectal muscle, *LA* levator ani, *C* endoanal coil

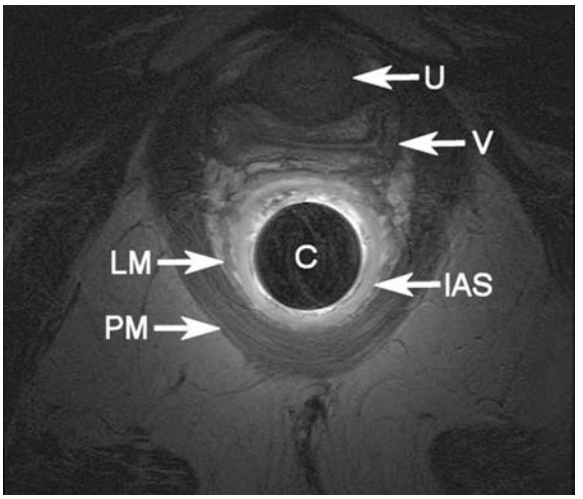


Fig. IV.43. Axial endoanal T2- weighted fast spin-echo MR image obtained through the upper part of the anal sphincter complex showing the normal sling-like configuration of the puborectal muscle in a female patient. *IAS* internal anal sphincter, *LM* longitudinal muscle, *PM* puborectal muscle, *V* vagina, *U* urethra, *C* endoanal coil

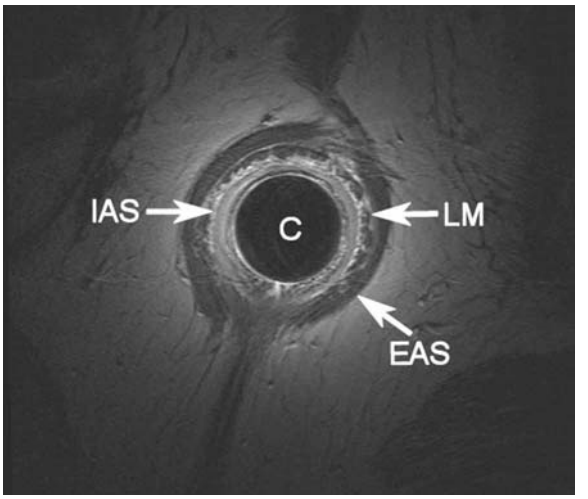
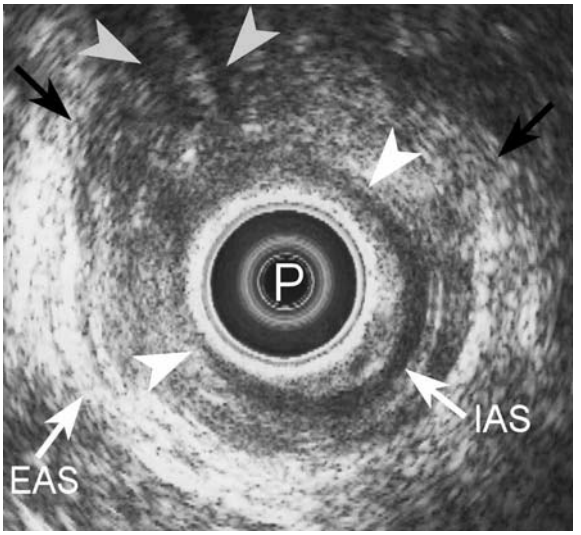


Fig. IV.44. Endoanal T2- weighted fast spin-echo MR image demonstrating the beaded appearance of the longitudinal muscle in the axial plane at the lower edge of the anal sphincter complex in a male patient. *EAS* external anal sphincter, *IAS* internal anal sphincter, *LM* longitudinal muscle, *C* endoanal coil

Anal Sphincter Complex Lesions

In fecal incontinent patients, EAUS and MR imaging focus mainly on visualizing the IAS and EAS, as damage of these two muscles proved to be a major cause of fecal incontinence [7, 8, 15–19]. IAS and EAS lesions are comprised of defects, scar tissue, and muscle volume anomalies.



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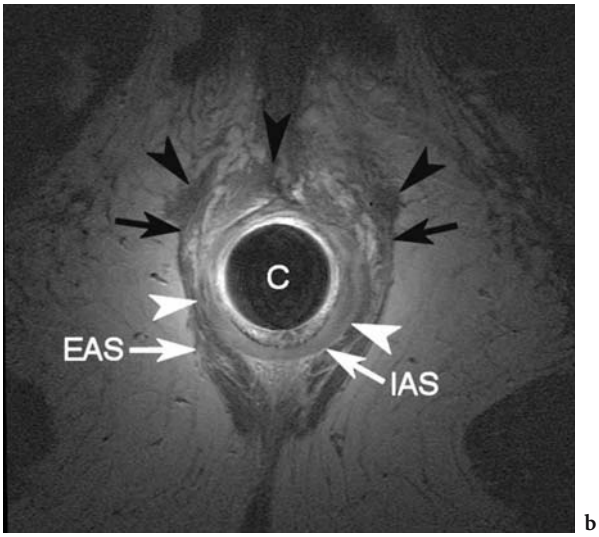

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Fig. IV.45. Complex lesion in a 31-year-old woman with fecal incontinence after a complicated vaginal delivery in the past. Two-dimensional axial endoanal ultrasonography image (**a**) demonstrates a defect (10–2 o'clock; *black arrows*) and scar tissue (*grey arrowheads*) of the external anal sphincter (EAS). Further, a defect (8–2 o'clock; *white arrowheads*) of the internal anal sphincter (IAS) is visualized. Axial endoanal T2- weighted fast spin-echo MR image (**b**) shows a defect (10–2 o'clock; *black arrows*) and scar tissue (*black arrowheads*) of the EAS. Also, severe thinning and scar tissue of the IAS is demonstrated (8–4 o'clock; *white arrowheads*). *P* endoanal probe, *C* endoanal coil

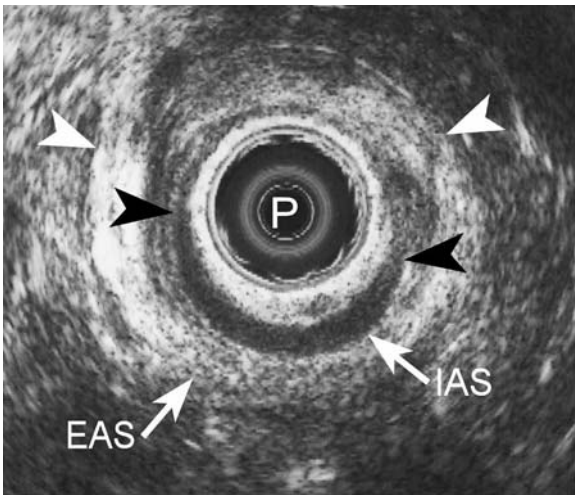


Fig. IV.46. Two-dimensional endoanal ultrasonographic image showing a defect of the internal (9–3 o'clock; *black arrowheads*) and external anal sphincter (10–2 o'clock; *white arrowheads*) at the anterior part of the anal sphincter complex in a 35-year-old woman with fecal incontinence complaints and a complicated vaginal delivery in the past. *EAS* external anal sphincter, *IAS* internal anal sphincter, *P* endoanal probe

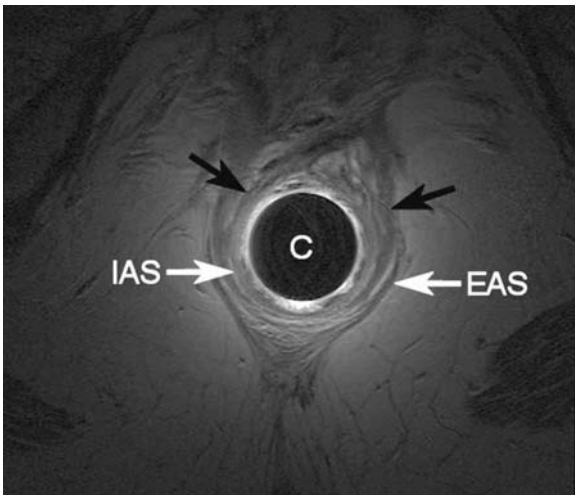


Fig. IV.47. Scar tissue and a defect of the internal (IAS) and external anal sphincter (EAS) (10–2 o'clock; *black arrows*) and diffuse thinning of the IAS and EAS ring at axial endoanal T2-weighted fast spin-echo MR imaging in a 67-year-old woman with fecal incontinence and a complicated vaginal delivery in the past. *C* endoanal coil

Defects and Scar Tissue

Defects of the IAS and EAS are defined at EAUS as an interruption of the fibrillar echotexture (Figs. IV.45a and 46) and at MR imaging as a discontinuity of the muscle ring (Figs. IV.45b and 47) [9, 10, 20]. Defects of the IAS and EAS can be isolated or may be accompanied by each other. Isolated IAS defects are mostly due to prior anorectal surgery whereas isolated EAS defects and combined IAS and EAS defects have generally an obstetric origin. Defects following obstetric trauma are frequently located at the anterior part of the anal sphincter complex (Figs. IV.45, 46, and 47) [7, 16, 19]. Healing of defects is accompanied by the formation of granulation tissue, which leads to scar tissue. Scar tissue is recognized at EAUS by loss of the normal architecture, with an area of amorphous texture that usually has low reflectiveness (Fig. IV.45a) [9, 20]. At MR imaging, scar tissue is visible as a hypointense deformation of the normal pattern of the muscle layer due to replacement of muscle cells by fibrous tissue (Figs. IV.45b and 47) [10].

To describe the extent of defects and/or scar tissue in the axial plane, we advocate reading in hours from a clock face or reporting of regions (e.g., right anterolateral, left posterior). In both cases, the physician should refer to the patient in the classic lithotomy position. The longitudinal extent can be indicated by the level of the anal canal (EAUS: proximal, middle, and distal) or in millimeter distance from the lower edge of the EAS (MR imaging).

Muscle Volume Anomalies

IAS thickness increases and EAS thickness decreases with age [21, 22]. These age-related effects should be differentiated from pathological thinning or thickening of both anal sphincter muscles. Thickness of the IAS can be defined accurately in millimeters at both EAUS and MR imaging, as the boundaries of the IAS are clearly visualized, resulting in an accurate delineation (Figs. IV.39–41). Generally, IAS thickness in adults is considered to be normal when it ranges from 2 to 4 mm, irrespective of patient age. Abnormal thickening (>4 mm) of the IAS can be found in patients with solitary rectal ulcer syndrome, and abnormal thinning (<2 mm) in patients with idiopathic degeneration [23, 24]. The above-mentioned range for normal IAS thickness and cutoff values for pathological thickening or thinning of the IAS apply only for endoluminal imaging, as

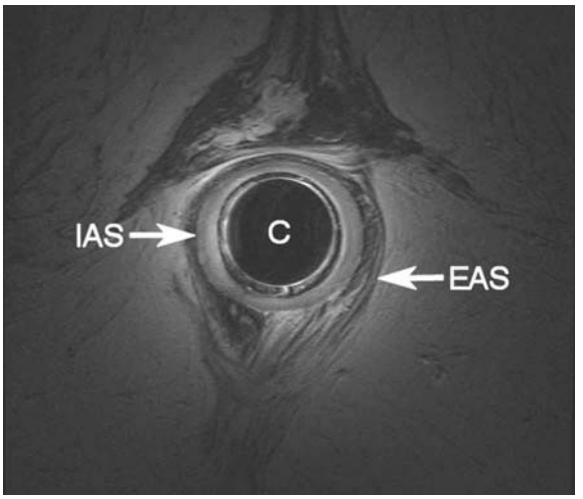
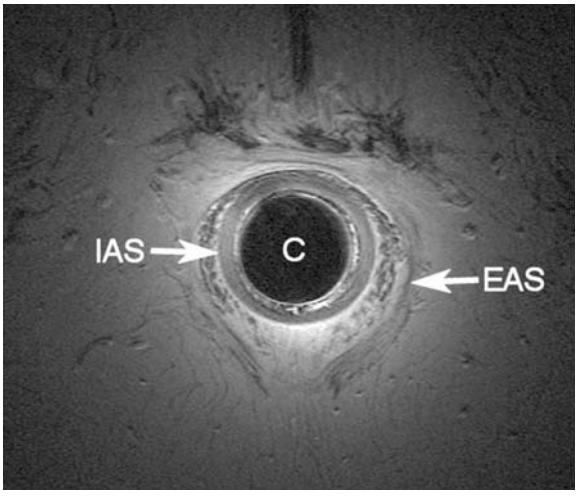


Fig. IV.48. Axial endoanal T2- weighted fast spin-echo MR image showing mild thinning of the external anal sphincter (EAS) muscle and diffuse replacement of EAS muscle by fat in a 68-year-old woman with fecal incontinence and diabetic mellitus. *IAS* internal anal sphincter, *C* endoanal coil

they have not yet been established at external phased array MR imaging.

Measuring the thickness of the EAS is difficult at 2-D EAUS, as the boundaries of the EAS are heterogeneous and therefore more complicated to define. EAS thickness can more easily be determined at MR imaging, as the demarcation of the EAS to the surrounding tissues is clearer. In healthy subjects, the average thickness of the EAS at endoanal MR imaging is approximately 4 mm [22]. Beets-Tan et al. reported that sphincter measurement with external phased array MR imaging is as reliable as that with endoanal MR imaging [25]. A previous study in four men and five nulliparous women showed an excellent correlation between EAS thickness measurements at 3-D EAUS and endoanal MR imaging [26]. Although EAS thickness measurements can accurately be made at 3-D EAUS and MR imaging, the role of these linear measurements is limited [27]. A recent study showed no significant difference in EAS thickness measurements between patients with and without EAS atrophy [28].

EAS atrophy, thinning of the EAS muscle, or diffuse replacement of the EAS muscle by fat is a common pathological muscle volume anomaly in patients with fecal incontinence [10, 28–30]. Atrophy of the EAS results from damage of the pudendal nerve, the principal nerve innervating the anorectum [31]. Demonstration of EAS atrophy is difficult at 2-D EAUS as firstly, fatty infiltration cannot be distinguished from normal muscle tissue; and secondly, the boundaries of the EAS are hard to determine (Figs. IV.39 and 40). EAS atrophy can easily be defined at MR imaging, as the delineation of the greater part of the EAS to the surrounding tissues is clear, and fat results in a hyperintense signal and is therefore easily recognized within the hypointense EAS [10] (Figs. IV.48 and 49). Important risk factors for pudendal



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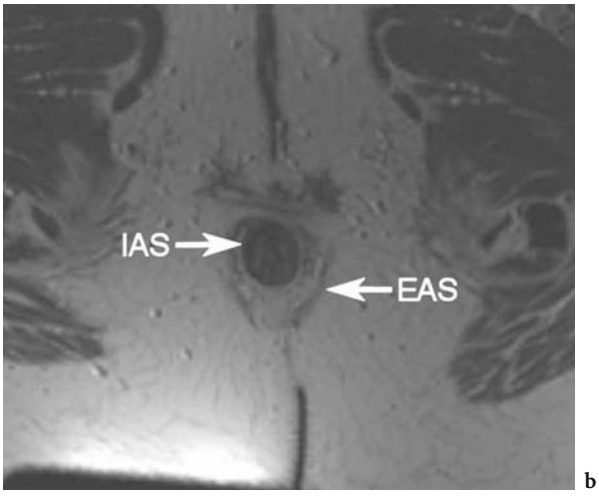

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Fig. IV.49. Axial endoanal T2- weighted fast spin-echo MR image (**a**) and axial external phased array T2- weighted fast spin-echo MR image (**b**) showing severe thinning of the external anal sphincter (EAS) muscle and diffuse replacement of EAS muscle by fat in a 69-year-old woman with fecal incontinence and no risk factors for pudendal nerve damage in the past. *IAS* internal anal sphincter, *C* endoanal coil

nerve damage comprise obstetric details in women (i.e., high-birth-weight infant, a long second stage of labor, forceps delivery), neurological disorders (cerebral, spinal, local disorder), straining for chronic constipation, diabetes mellitus, or simply the neuropathy of aging [31]. Depicting EAS atrophy is of importance in patients with fecal incontinence, as a previous study demonstrated – as did some physiological studies [32–34] – that atrophy of the EAS due to pudendal nerve damage is a negative predictor for the outcome of surgery of an EAS defect (anterior anal sphincter repair) [35]. The authors of that study have shown that outcome of anterior anal sphincter repair was significantly better in patients without EAS atrophy compared with those patients with EAS atrophy.

In contrast to EAS atrophy, pathological thickening of the EAS is seldom discussed in the literature, and its clinical value is not well established.

Comparative and Reproducibility Studies

Endoanal Ultrasonography versus Endoanal MR Imaging

Several studies investigated the diagnostic accuracy of 2-D EAUS and endoanal MR imaging in assessing anal sphincter integrity. Both EAUS and endoanal MR imaging have been validated physiologically, histologically, and intraoperatively as accurate tools in mapping internal and EAS defects [36–42]. Some studies compared these competitive techniques for demonstrating IAS and EAS pathology. Malouf and colleagues evaluated prospectively 2-D EAUS and endoanal MR imaging in 52 patients with fecal incontinence and reported that both techniques are comparable in diagnosing EAS defects [43]. Further, they suggested the inferiority of endoanal MR imaging in demonstrating IAS defects. Another study compared retrospectively 2-D EAUS and endoanal MR imaging to surgery in 22 patients with fecal incontinence and found MR imaging to be the most accurate technique for depicting IAS and EAS defects [20]. The reported results of those studies vary. Some of the variability can be attributed to differences in study design, patient population, and level of experience of readers. The current consensus is that both techniques can be used for demonstrating defects of the anal sphincter complex [30].

As explained before, depiction of EAS atrophy at 2-D EAUS is difficult. By contrast, the diagnostic accuracy of endoanal MR imaging for the diagnosis of EAS atrophy has been thoroughly investigated, and all studies reported that EAS atrophy can be accurately demonstrated with endoanal MR imaging [20, 27, 35, 44–47]. Rociu and colleagues compared 2-D EAUS and endoanal MR imaging for the depiction of EAS atrophy and found that EAS atrophy can only be accurately depicted at endoanal MR imaging and not at EAUS [20]. These findings are in concordance with another study evaluating both techniques in 20 women with fecal incontinence due to obstetric trauma [35]. Williams et al. found that patients with a thin IAS (<2 mm) and/or a poorly defined EAS at EAUS were more likely to have EAS atrophy and endoanal MR imaging should be considered to determine whether the sphincter is grossly atrophic [47]. Accurate assessment of EAS atrophy at endoanal MR imaging can be made by quantitative measurements of the area of remaining EAS and of the percentage of fat content of the EAS [35, 44, 47]. A recent study in 18 female patients with fecal incontinence evaluated whether 3-D EAUS measurements could be used to detect EAS atrophy [48]. The authors reported that despite the multiplanar capability, 3-D EAUS was not able to demonstrate EAS atrophy. In clinical practice, there are no "hard" criteria available for the visual diagnosis of EAS atrophy at MR imaging, but a recent study showed a relation between EAS squeeze function parameters obtained at anal manometry and the qualitative assessment of EAS atrophy by radiologists at endoanal MR imaging [28]. We suggest using the following qualitative grading system to assess atrophy at MR imaging: no atrophy (no thinning and no replacement of sphincter muscle by fat) (Fig. IV.41), mild atrophy (<50% thinning and/or replacement of sphincter muscle by fat) (Fig. IV.48), or severe atrophy (≥50% thinning and/or replacement of sphincter muscle by fat) (Fig. IV.49a, b). Although the clinical value of grading EAS atrophy has not been established yet, it might be that grading atrophy has an impact on the outcome of anterior anal sphincter repair. The hypothesis that patients with mild atrophy will fare better after anterior anal sphincter repair than patients with severe EAS atrophy should be analyzed in future studies.

Endoanal MR Imaging versus External Phased Array MR Imaging

Both 2-D EAUS and endoanal MR imaging have been shown, as described above, to be useful in detecting defects of the anal sphincter complex. Nevertheless, both techniques have the drawback that they can mainly be performed only at specialized centers, as a dedicated endoluminal probe or coil is necessary. Additionally, the introduction of the endoluminal device is uncomfortable. These two disadvantages of EAUS and endoanal MR imaging could be overcome with the use of external phased array coils. MR imaging with external phased array coils has already taken a central place in visualizing perineal disease and rectal tumors [49–51]. Previous studies show that external phased array MR imaging is also of great worth for demonstrating anal anatomy [52]. Until recently, the diagnostic value of this MR imaging technique in detecting EAS and IAS defects, as well as demonstrating EAS atrophy in patients with fecal incontinence, has not been established. A recent study in 30 patients with fecal incontinence due to mixed etiologies compared external phased array MR imaging to endoanal MR imaging for the depiction of IAS and EAS defects [12]. The study reported that both techniques did not significantly differ for the depiction of IAS and EAS defects. As endoanal MR imaging showed its superiority over EAUS for demonstrating EAS atrophy, atrophy of the EAS could till recently only be accurately demonstrated at the first technique. However, another recent study reported that external phased array MR imaging and endoanal MR imaging did not significantly differ in their ability to depict EAS atrophy, with good agreement [11].

Reproducibility Studies

Error and variation in image interpretation has been described as radiology's "Achilles' heel," and each imaging method must be reasonably reproducible between observers [53]. Gold et al. determined the interobserver agreement of 2-D EAUS for assessing anal sphincter disruption in 51 patients who were referred for EAUS to assess possible sphincter abnormalities [54]. They found very good agreement between observers for detecting IAS and EAS defects. A previous study evaluated the interobserver agreement of endoanal MR imaging and found that interobserver agreement was less than reported for EAUS [55]. The authors of that study found a moderate overall interobserver agreement for the assessment of sphincter integrity and reported that agreement was strongest if the anal sphincters were either both disrupted or both intact. Similar to that study, a weak interobserver agreement of endoanal MR imaging was described for the detection of anal sphincter defects in another reproducibility study of MR imaging [12]. This study evaluated the interobserver agreement of external phased array MR imaging as well, which was poor to fair between different observers. The latter study assessed, besides the between-observers variation, the variation between observations of a single observer for assessing the integrity of the anal sphincter complex, as apparent disagreement between observers may be due to both intra- and interobserver variation. The intraobserver agreement ranged from fair to very good for endoanal MR imaging and external phased array MR imaging, with a stronger intraobserver agreement for each observer familiar with his/her own specific MR imaging technique.

Reported results about the reproducibility of imaging techniques for demonstrating EAS atrophy are sparse in the literature. To our knowledge, only one study evaluated observer reproducibility in assessing EAS atrophy with endoanal MR imaging and external phased array MR imaging [11]. In line with reported results of interobserver agreement for the detection of EAS defects [12, 55], this study found a moderate interobserver agreement of endoanal MR imaging for the detection of EAS atrophy. The reproducibility between observers was moderate to good for external phased array MR imaging. The intraobserver agreement was moderate to very good for endoanal MR imaging and fair to very good for external phased array MR imaging. Also in that study, the reproducibility of observations of a single observer seemed to be related to the experience level of an observer with endoanal MR imaging and external phased array MR imaging, respectively.

The fact that results among radiologists vary considerably for depicting anal sphincter defects and EAS atrophy at MR imaging can be explained by the relatively limited number of manuscripts discussing anal sphincter pathology at MR imaging. This may lead to a higher contribution of personal experience in reading. The latter might also be a consequence of the fact that there are no "hard" criteria available for the visual diagnosis of

EAS atrophy. Training radiologists in interpreting the changes in sphincter morphology that are demonstrated in patients with defects or atrophy of the anal sphincter complex might improve reader performance for both MR imaging techniques.

Role of Imaging Techniques in the Diagnostic Workup

EAUS, endoanal MR imaging, and external phased array MR imaging are competitive techniques in the diagnostic workup of fecal incontinence. They have a central position in assessing pathology of the EAS and IAS muscles, as physical examination is not reliable in detecting EAS and IAS defects [56]. Electromyography is a painful test and precludes an assessment of the structural and functional integrity of the entire sphincter complex [57, 58], and anal manometry is not able to differentiate between sphincter dysfunction due to structural sphincter injury or pudendal nerve damage [59]. Further, pudendal nerve latency testing is not 100% conclusive for demonstrating pudendal nerve damage, as this technique measures only the conduction time of the fastest muscle fibers, and latencies may be normal even in the presence of EAS atrophy [1].

Patients with fecal incontinence are initially treated conservatively, including with dietary measures (fibers, avoidance of foods that cause diarrhea or urgency), medical treatment (antidiarrheal medications, bulking agents), and pelvic floor rehabilitation (electrical stimulation and biofeedback) [1]. If these treatment options have failed, patients with structural damage of the EAS may be considered for surgery (anterior anal sphincter repair). Previous studies report that some patients with an initially good response to anterior anal sphincter repair have shown deterioration of function in the long term due to the coexistence of atrophy of the EAS [60]. No surgical option is available for patients with an isolated disruption of the IAS.

An overview of the literature concerning imaging techniques in patients with fecal incontinence shows that EAUS, endoanal MR imaging, and external phased array MR imaging are all valuable tools in the diagnostic workup of patients with fecal incontinence but that local expertise is the major factor for decisions about the preferred technique. As EAUS is, in contrast to MR imaging, a relatively simple, fast, and inexpensive technique, the present consensus is that EAUS can be used as the primary technique and MR imaging as the second-line technique, depending on availability and observer's experience level. The major advantage of MR imaging above EAUS is the accurate demonstration of EAS atrophy. As described above, EAS atrophy proved to be an indicator for poor outcome of anterior anal sphincter repair. Therefore, to select patients to benefit from anterior anal sphincter repair, besides demonstrating the presence and extent of an EAS defect, the detection of EAS atrophy is also of importance. In these situations, MR imaging is mandatory as a complementary technique to EAUS in the diagnostic workup of fecal incontinence.

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