Role of Ultrasonography for Anal Incontinence

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5.1 Introduction

Continence depends on several anatomic and physiologic entities: integrity of the anal sphincters, pelvic floor function, rectal distensibility, anorectal sensation, anorectal reflexes, intact nervous system, mental functions, stool consistency and colonic transit. Deficiency of one or more of these factors can lead to anal incontinence (AI) [1]. AI is more frequent in women (females:males = 3:1) and it is estimated that about 40% of women over 70 years old are affected. Evaluation of the pelvic floor is generally clinical, but in the last two decades, the use of ultrasound has become a mainstream diagnostic tool in the investigation of female pelvic organ prolapse, urinary and fecal incontinence and other defecation disorders, providing an immediate objective confirmation of clinical examination findings [2]. Both AI and urinary incontinence are major health problems. They can be particularly embarrassing and affect 2–24% of community-dwelling adults, with 1–2% experiencing a significant impact on daily activities [3].

Tests to diagnose AI include anorectal manometry, electromyography, dynamic proctography, colon motility test, and endoanal ultrasonography (EAUS).

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Different kinds of AI are diagnosed through different basic anorectal function tests: they help to discriminate between the bowel dysfunction related to spinal cord injuries and sphincter lesions [4]. Preoperative EAUS is a useful tool for the assessment of anal sphincter injury in patients with rectal prolapse [5]. Sphincter defects after delivery are classified according to the classification of obstetrical anal sphincter injuries (OASIS) [6], and EAUS was recommended by the sixth International Consultation on Incontinence (ICI, Tokyo 2017) [7] as the gold standard technique for assessment of anal sphincter integrity.

This chapter will focus on the ultrasound technique, normal ultrasound anatomy of the anal canal and the evaluation of anal sphincter injury.

5.2 Ultrasound Technique

Ultrasound is a useful and flexible modality in medical imaging, and often provides an additional or unique characterization of tissues, compared with other modalities such as conventional radiography or computed tomography. Ultrasound uses high-frequency sound waves. Sound is a mechanical form of energy generated by vibrations. While audible waves lie between 20 and 20,000 Hz, ultrasound uses greater frequencies, between 1 and 30 MHz. Increasing the frequency improves image resolution but decreases the penetration of waves through tissue. Sound waves do not exist in a vacuum, and their propagation in gases is poor because the molecules are widely separated [8]. The transducer creates the sound waves and receives those reflected by the tissues, which are displayed on an ultrasound screen as scale of grey values (B mode). Ultrasound is composed by five main components: the transducer crystal, the matching layers, damping material, the transducer case, and the electric cable. The images are displayed in a sector, vector, linear, or curved linear format.

EAUS is performed by a mechanical 360-degree rotating transducer with 9–16 MHz frequencies and high resolution. New probes allow for 3D automatic acquisition of the images. A 3D cube is formed by 300 transaxial 2D images over a distance of 60 mm with a distance of 0.2–0.3 mm between two adjacent images. Using 3D, the images can be visualized in the axial, coronal and sagittal planes and any other reconstructed oblique plane.

The patient may be placed in a dorsal lithotomy, prone or, more commonly, left lateral position. The anterior wall of the anal canal is at 12 o'clock and the posterior aspect is inferior at 6 o'clock. Laxative enemas may be sufficient for anorectal ultrasound. Endorectal ultrasound (ERUS) is performed by filling a balloon at the tip of the rigid probe to create an acoustic interface in direct contact between the rectum and the transducer. The transducer is inserted through a rectoscope to assess the entire length of the rectum up to 20 cm.

On the ultrasound screen the image is oriented with the anterior side at 12 o'clock, left lateral at 3 o'clock, posterior at 6 o'clock and right lateral at 9 o'clock position. The EAUS images are collected from the upper aspect of the puborectalis (PR) muscle to the anal margin. The probe is aligned with median raphe. EAUS may be also performed by linear electronic, high frequency transducer. This probe has the advantage of allowing the assessment of vascularity by color doppler and elasticity of the tissue by elastography.

Elastography is a newer technique that exploits the fact that a pathological process alters the elastic properties of the involved tissue. Endoscopic ultrasound elastography enables highly accurate discrimination of colorectal adenocarcinomas from adenomas, while inflammatory bowel disease phenotypes can be distinguished based on strain ratio calculation [9]. Its role in AI is still under investigation.

5.3 Normal Ultrasound Anatomy

The anal canal is 2–4 cm in length. The inner circular fibers of the muscularis propria of the rectal wall become the internal anal sphincter (IAS) muscle within the anal canal. This is a smooth muscle and is visualized as a dark, hypoechoic ring. More externally, there is a hyperechoic layer that represents the longitudinal muscle (LM), in continuity with the longitudinal fibers of the muscularis propria of the rectal wall. The LM extends through the anal canal into the intersphincteric space and implants into the external anal sphincter (EAS) muscle. Deeper to that layer, the EAS is visualized as a mixed echogenic ring, larger but less distinct than the IAS [10].

EAUS can identify at least six layers in the middle third of anal canal: the inner layer is the hyperechoic interface with the plastic cap; the second layer is the hypoechoic mucosa; the third layer is the hyperechoic subepithelial tissue; the fourth layer is the hypoechoic IAS; the fifth is the hyperechoic LM, and the outer layer has mixed echogenicity [11].

In the upper third of the anal canal, the PR muscle is visualized which appears as a U-shaped hyperechoic structure. This muscle is part of the levator ani muscle (LA) and it is contiguous to the EAS.

In the lower third of the anal canal, the IAS is no longer visualized and only the subcutaneous part of the EAS can be seen (Fig. 5.1).

In the axial plane, normal measurements of the IAS range from 1.5 to 4 mm in thickness and those of the EAS range from 7.7 to 8.6 mm. In the coronal plane the anterior length of the EAS is between 12 and 15 mm in women and between 2 and 3 cm in men (Fig. 5.2).

5.4 Ultrasound in Anal Incontinence

In patients with AI, EAUS identifies if there is a combined lesion of the IAS and EAS, and of the PR, or if the lesion involves just one muscle. Number, circumferential (radial angle in degrees or in hours of the clock) and longitudinal (proximal, distal, or full length) extension of the defect, presence of scarring, differences in echogenicity and thickness of the sphincters, and other local alterations must be carefully assessed and always be described. However, finding a sphincter defect does not necessarily mean that it is the cause of AI. EAUS is able to detect

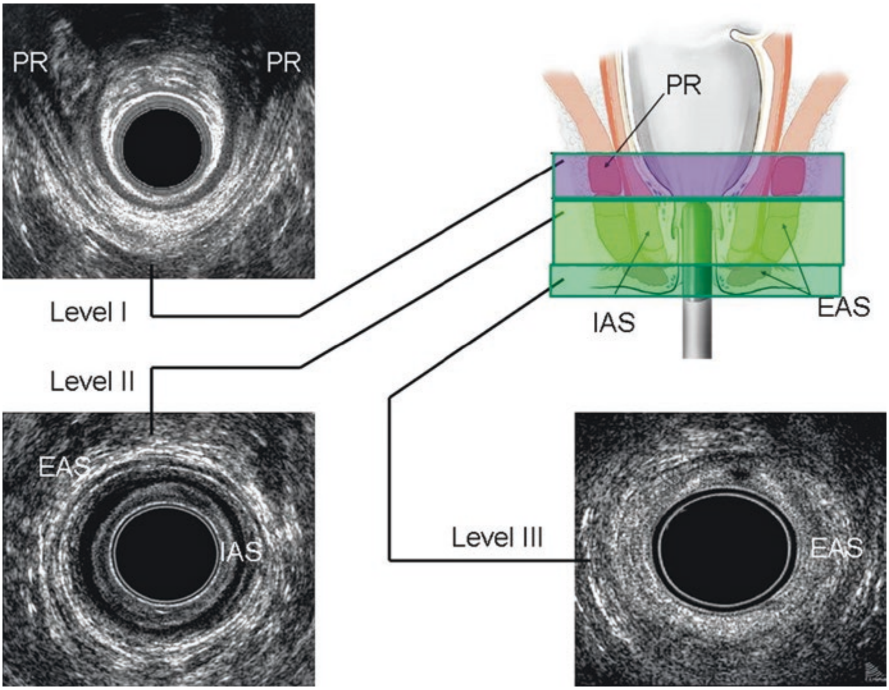

Fig. 5.1 Normal ultrasonographic anatomy of the anal canal. *EAS*, external anal sphincter; *IAS*, internal anal sphincter; *PR*, puborectalis muscle

sphincteric occult tears, which are reported in up 33% of primiparous females after vaginal deliveries [12].

There are different scores to classify the extent of sphincter damage by EAUS. Stark's score defines the severity of sphincter lesions with a range from 0 (no defect) to 16 (defect ≥180° involving the whole length and depth of both sphincters) [13]. During the examination it is important to distinguish between natural gaps (hypoechoic areas with smooth, regular edges, occurring in the upper part of the anal canal) and sphincter ruptures (mixed echogenicity due to scarring, with irregular edges and loss of symmetry) occurring at the upper anterior part of the anal canal [14].

5.5 Internal Anal Sphincter Lesions

IAS injuries can be caused by obstetric and iatrogenic (hemorrhoidectomy, mucoprolapsectomy, sphincterotomy) traumas, persistent manual dilatation [15] or fistulectomy.

Injuries of the IAS are displayed as hyperechoic breaks in the normally hypoechoic ring. Incontinence related to a single IAS injury has a typical pattern of thickening of the remaining muscle due to retraction phenomenon ("halfmoon"

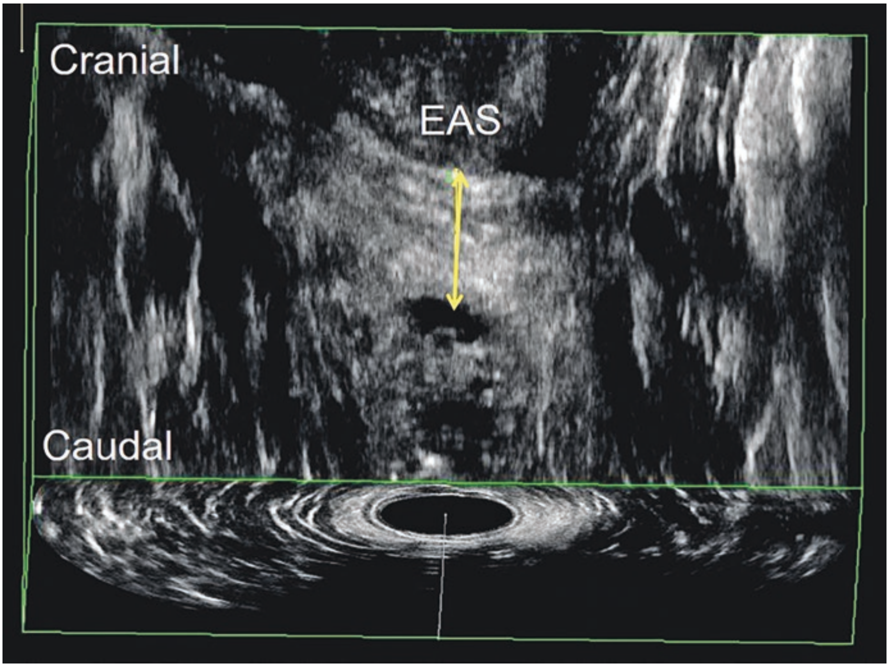

Fig. 5.2 Measurement of the external sphincter (*EAS*) by 3D endoanal ultrasound. This woman showed a normal thickness of 14 mm

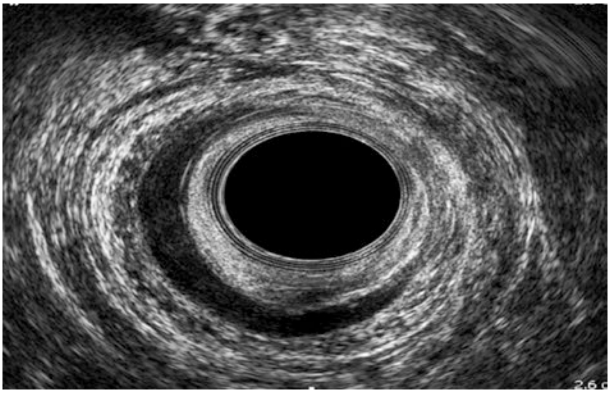

Fig. 5.3 Lesion of the internal anal sphincter

sign) (Fig. 5.3). IAS lesions after hemorrhoidectomy appear as multiple defects in the positions of the hemorrhoidal plexus. AI related to OASIS is often associated with defects of both the EAS and IAS, rarely the IAS alone. Although IAS thickness increases with age, a thickness greater than 4 mm may be a sign of myopathy [16, 17].

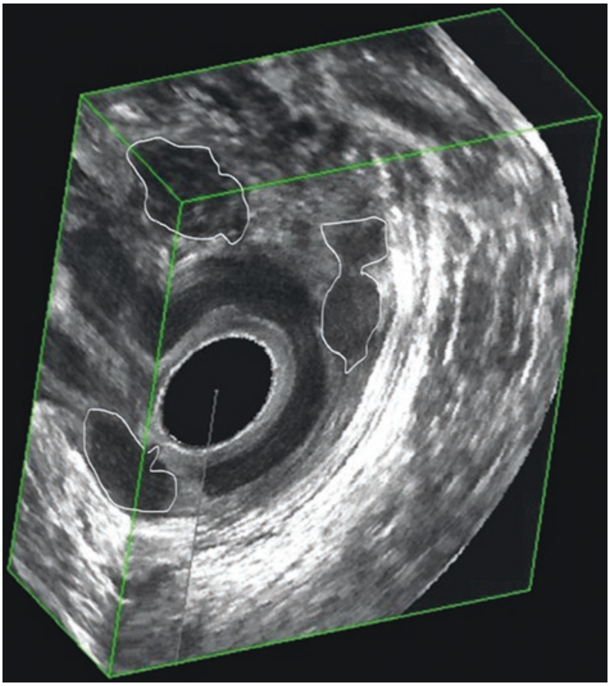

Fig. 5.4 Placement of a prosthesis in the intersphincteric space in severe anal incontinence

EAUS is also used intraoperatively for the correct positioning of injectable substances or prostheses for the treatment of AI and to evaluate, postoperatively, their dislocation in patients with recurrence (Fig. 5.4). EAUS is also helpful to quantify how much IAS can be divided during fistulotomy for intersphincteric fistulas [18].

5.6 External Anal Sphincter Lesions

OASIS are due to pelvic traumas during delivery, and they increase the risk of developing AI either immediately following childbirth or later in life. Their prevalence is underestimated. EAUS performed 60 days after delivery is considered the gold standard modality for the diagnosis of OASIS. It is able to detect between 4% and 8.5% of sphincter defects in multiparous women and 27–35% of injuries in primiparous women [19].

OASIS can be classified into four grades of severity, and they always involve the sphincters anterior to a horizontal line through the mid canal. In most cases, there is a single break of the anterior part of the EAS (<50% of EAS thickness = OASIS 3a; or >50%/full thickness = OASIS 3b). A combined defect of the EAS and IAS is defined as OASIS 3c. In grade 4 OASIS, the anal mucosa is also disrupted (Fig. 5.5). Ultrasonographically, a lesion of the transverse perineal muscles appears as an

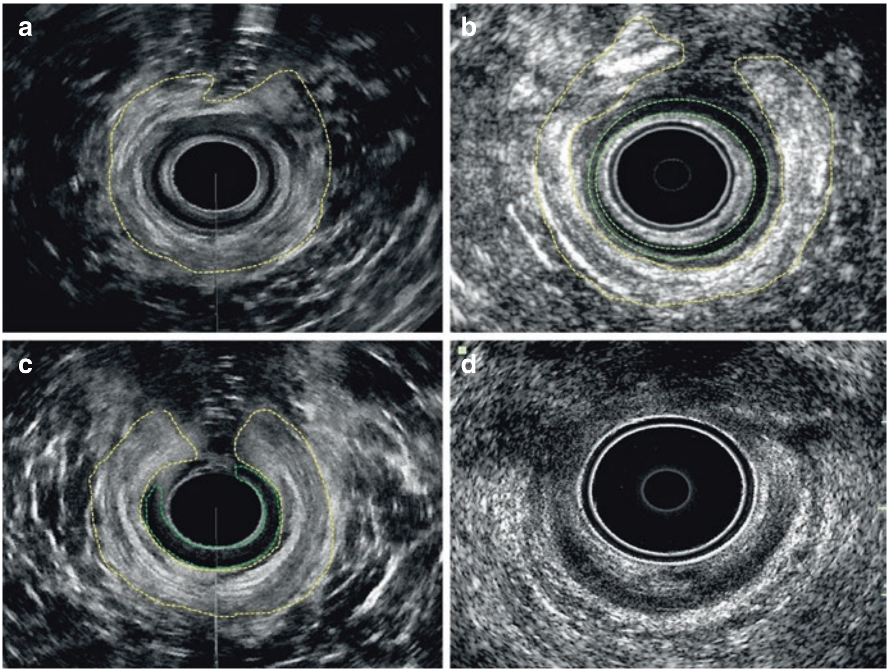

Fig. 5.5 Different grades of obstetric anal sphincter injuries (OASIS) on endoanal ultrasonography: (**a**) OASIS grade 3a; (**b**) OASIS grade 3b; (**c**) OASIS grade 3c; (**d**) OASIS grade 4

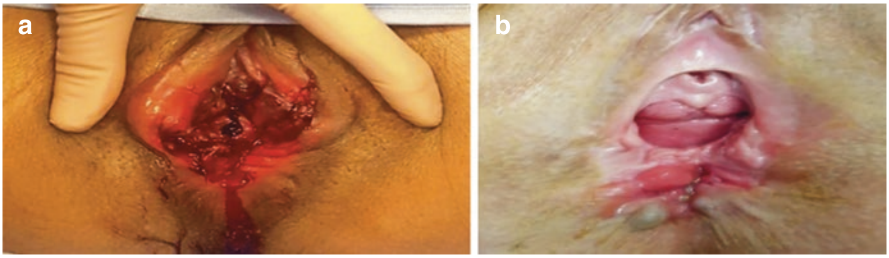

Fig. 5.6 Grade 4 obstetric anal sphincter injury: early lesion (**a**); scarring after 6 months (**b**)

asymmetrical area anterior to the EAS. A combined defect of the sphincter complex in the middle part of the anal canal is visualized as a disruption of regular continuity of both the EAS and IAS. Most injuries extend from 90° to 180°. Lesions of the IAS may show a "rubber band effect", a classical sign of sphincter defect [20]. On ultrasound, EAS lesions appear as a low-intensity defect in the context of the brightest ring of the striated muscle. The poorly defined border of the EAS during tissue regeneration does not allow definition of the degree of atrophy of this muscle (Fig. 5.6). Fat replacement and loss of muscle fibers reduce the definition of the outer interface of the EAS [21]. However, by using volume render mode and

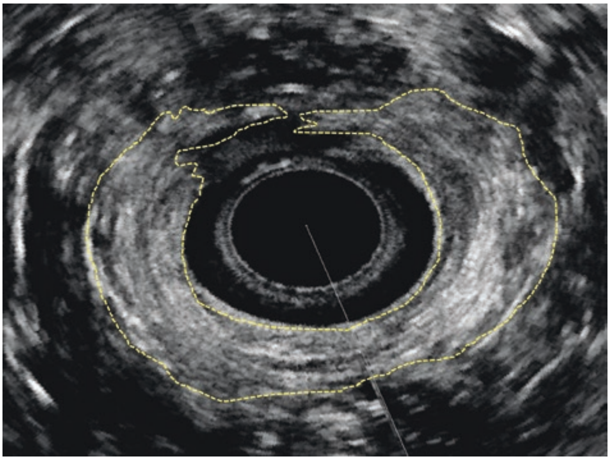

Fig. 5.7 Residual defect of the external anal sphincter and internal anal sphincter after repair of a grade 3c obstetric anal sphincter injury

3D-EAUS, it is possible to evaluate EAS atrophy by enhancing the intensity data of muscular fibers and fat tissue [22].

Many studies have reported good outcomes after immediate primary repair of OASIS, with improved quality of life in women and reduced AI symptoms [23]. Currently, there is no postpartum pathway to evaluate AI associated with obstetric sphincter injuries [24].

Sioutis et al. [24] reported that OASIS were clinically overestimated in 7% of women in whom 3D-EAUS did not demonstrate any damage. Late onset of AI in an elderly population can be related to undiagnosed previous anal sphincter defects after delivery [25].

3D-EAUS is useful to monitor the results after sphincteroplasty and to detect any residual injury, helping the management of subsequent pregnancies (Fig. 5.7). According to Fitzpatrick et al. [26], women experiencing AI after OASIS repair, must be referred for EAUS assessment.

Moreover, EAS thickness was found by Soerensen et al. [27] to be related to recurrence of incontinence symptoms after OASIS repair (Fig. 5.8).

5.7 Puborectalis Muscle Lesions

LA and PR muscles are best investigated by endovaginal ultrasound (EVUS) and transperineal ultrasound (TPUS), because these modalities visualize the attachment of the muscles to the inferior pubic rami. EAUS, which remains the best technique for the assessment of the EAS and IAS, can only show the posterolateral aspect of the PR.

A stretch trauma of the LA is initially associated with hematoma and edema formation; later, the muscle fibers are replaced by scar tissue or fibrosis. By using TPUS, Van de Waarsenburg et al. demonstrated that hematoma appears as a hypo/

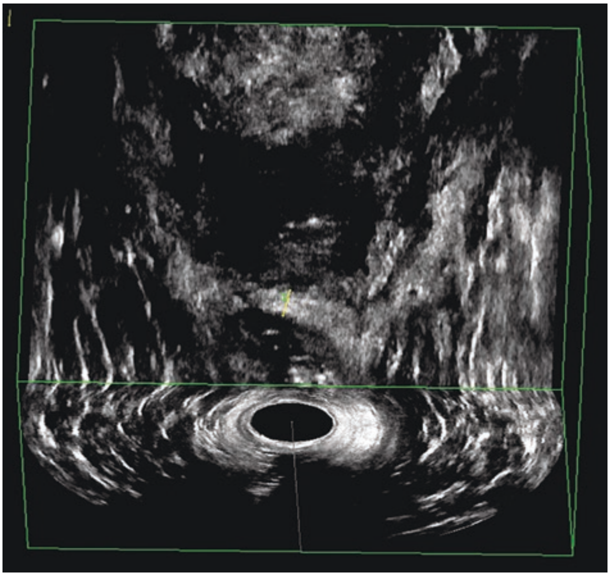

Fig. 5.8 Reduced thickness (4 mm) of the anterior external anal sphincter in a woman with recurring symptoms of anal incontinence after obstetric anal sphincter injury repair

anechoic area in the context of the LA, while scar tissue is visualized as an area of mixed/hyperechogenicity [28].

Lesions of the PR may be visualized by 3D-EAUS as reduced thickness or complete loss of one or both branches of the muscle.

In conclusion, 3D EAUS is the gold standard investigation to evaluate sphincter injuries related to AI [29]. However, it does not provide optimal information regarding EAS atrophy, which is best assessed by endoanal magnetic resonance imaging [30]. EVUS and TPUS provide additional information on pelvic floor muscle and levator hiatus damage [31].

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