The role of 360° ultrasound in anal incontinence

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ABSTRACT

Fecal incontinence (FI) is a condition that affects 5-15% of the population with important medical and psychosocial implications. A 360° endoanal ultrasound (EAUS) is an accurate method with a sensitivity and specificity that ranges from 83 to 100%. A precise diagnosis of the different causes that lead to FI can be established and warrants the planning of correct treatment. This review intends to describe the study method of EAUS, the ultrasonographic anatomy, and the most common sphincter lesions. This is illustrated with multiple examples of EAUS with their respective schemes to describe and show the normality of the anal sphincter by ultrasound.

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El rol del ultrasonido 360° en la incontinencia anal

RESUMEN

La incontinencia fecal es una condición que afecta al 5 al 15% de la población y conlleva importantes implicaciones médicas y psicosociales. El ultrasonido endoanal de 360° es un método preciso con una sensibilidad y especificidad en el rango de 83 a 100%. Este método permite establecer un diagnóstico correcto de las diferentes causas que producen la incontinencia y así planear un tratamiento adecuado. El propósito de esta revisión es describir el método del estudio, la anatomía ultrasonográfica del ano y las lesiones esfinterianas más comunes. Lo anterior se ilustra con múltiples ejemplos de USEA con sus respectivos esquemas para describir y mostrar la normalidad del esfínter anal por ultrasonido.

INTRODUCTION

Fecal incontinence (FI) is the partial or total incapacity to voluntary control gas and stool expulsion. It is a frequent entity that affects women and men of all ages with significant impairment in the quality of life, and considerable socioeconomic and psychological impact. FI has been called the “silent affliction” and can affect 5-15% of the general population with increasing incidence in the elderly. Patients are reluctant and embarrassed by this condition and are not aware of the possible treatments; only 15-45% of them will seek medical attention1-3.

A 360° endoanal ultrasound (EAUS) has been very useful in the evaluation of FI, being a sensitive tool to study the sphincter complex as well as its lesions and should be used as the primary examination to detect anal lesions with high sensitivity and specificity of almost 100% for both4,5.

In this article, a short overview of FI, its causes and related pathology are revised as well as the technique and method of the 360° EAUS; the ultrasonographic anatomy of the normal anal canal and the characteristic findings of the most frequent pathologies are described.

The diagnosis of FI is founded on anal inspection, digital rectal examination and anorectal manometry. In comparison with EUAS, digital rectal examination detected only major sphincter defects with a sensitivity of 82% and a low specificity of 32%6.

EAUS

EAUS was one of the first imaging techniques that could demonstrate the anal sphincter’s anatomy and is actually, along with manometry, a part of the diagnostic tools to assess, with precision, the structural damage of the sphincter. Both are essential for therapeutic decision-making7.

EAUS allows the evaluation of the sphincter morphology while anorectal manometry evaluates the sphincter function. A good correlation has been observed between these two techniques in partial or complete ruptures of the anal sphincter and thinning of the internal anal sphincter (IAS), obtaining decreased maximal resting pressure when manometry was performed8,9.

CAUSES OF FI

Causes of FI are multifactorial. Obstetric injuries are the most common causes of structural acquired abnormalities followed by anorectal surgeries, rectal prolapse, and direct trauma.

In women, perineal tears are originated during childbirth vaginal deliveries. These lesions are classified in four degrees: in the first-degree tear, only the skin and/or vaginal mucosa are involved. In the second degree, the perineum and perineal muscles are affected but not the sphincters. The third and fourth degrees correspond to severe perineal laceration and are called obstetric anal sphincter injuries (OASIS) and are present in up to 11% of vaginal deliveries. In the third degree,
The role of 360° ultrasound in obstetrics

V. Barois: The role of 360° ultrasound

153

the perineum and the anal sphincter complex are involved in different grades. The fourth-degree tear affects the perineum, both sphincters and the anorectal mucosa10-12.

Sphincter tears can be underdiagnosed at the time of delivery and can lead to severe complications and sequelae, including FI even 20 or 30 years after. EAUS diagnosis of anal sphincter tears after childbirth and before reconstruction of OASIS is superior to clinical evaluation and reduces the possibility of FI13-15. In men, the main cause of FI is anorectal surgery16.

Other causes of FI are functional and affect both sexes in the same percentage. Functional FI may be related to conditions such as chronic diarrhea, irritable and inflammatory bowel disease, radiation proctitis, malabsorption, hypersecretory tumors, fecal impaction, physical disabilities, and psychiatric disorders.

Neurological conditions can also be associated with FI including pudendal neuropathy that can be related with obstetric injury in women, spinal surgery, multiple sclerosis, dementia, and central nervous system disorders. Finally, congenital malformations such as imperforate anus, cloacal defect, or spina bifida can also be associated with different degrees of anal incontinence17.

Additional imaging diagnostic techniques, available only in specialized centers, are three-dimensional EAUS (3D EAUS) and magnetic resonance imaging (MRI), with multiplane high spatial resolution and high diagnostic accuracy. Reconstructions with 3D EAUS can improve the evidence of sphincter defects acquiring axial, longitudinal, and coronal images which facilitate the measurement of the length of the anal sphincters with a correlation between axial and longitudinal extension of the lesions. Volume measurement has been unsatisfactory with a low reproducibility and is not a reliable tool for the diagnosis of sphincter atrophy18.

Comparable results were obtained for the detection of external anal sphincter (EAS) defects with 3D EAUS and endoanal MRI: the thickness, length, and area of EAS sphincter showed a poor correlation between these modalities. However, endoanal MRI is a more accurate method for assessing atrophy of the EAS19. The margins of the EAS are more difficult to delimitate with ultrasound, due to heterogeneous echogenicity. MRI was previously considered superior in detecting EAS injuries. With the advance of sonographic technology and higher frequency transducers (10-15 MHz), the definition of the different tissues has improved and actually there is no significant difference between endoanal MRI and EAUS in depicting EAS defects when performed by a trained operator20,21. Both MRI and EAUS have good reliability for measuring all sphincter components, whereas EAUS is more reliable for IAS measurements22. In a study comparing EAUS and endoanal MRI, the results were similar for EAS defects diagnosis but inaccurate for IAS defects with MRI imaging23.

Ultrasound-based elastography is a non-invasive measurement that evaluates the stiffness of the tissues. A study from Sweden used this technique to evaluate the tissue properties of the anal sphincters after anorectal surgery, finding more hardness in the striated muscle
than in the IAS, a smooth muscle with no additional information comparing with gray scale EAUS\textsuperscript{24}.

Anal imaging as well as pelvic organ prolapse can also be evaluated combining endoanal, transvaginal, and transperineal ultrasonography. However, the description of these techniques is beyond the scope of the article\textsuperscript{15,25}.

Ultrasound quality is highly operator dependent and a learning curve is necessary to avoid interpretative errors. Anatomy and pathology understanding are essential in the interpretation of anal disorders.

**EAUS METHOD AND TECHNIQUE**

A detailed clinical history should be obtained before any examination, emphasizing in women the obstetrical history (vaginal deliveries, use of forceps, perineal lacerations, etc.). In every patient, previous surgery or any other anorectal pathology should be investigated.

It is also important to consider the type of incontinence: urge incontinence is the need to defecate, usually associated with a weak EAS. Passive incontinence occurs when the patient does not have any sensation and is mostly related with a lesion or weakness of the IAS\textsuperscript{15,26}.

In our unit, we perform EAUS using a HI-VISION Preirus ultrasound platform, to obtain high spatial resolution cross-sectional images on the different levels of the anal canal. Furthermore, a 5-10 MHz, 360° radial array rotating probe is utilized. The study has a duration of 10-15 min.

The examination is similar to a routine digital exploration and is performed without sedation. It is usually painless and well accepted by patients. The patient is asked to clean the lower rectum with an enema, 2 h before the appointment. The examination is made with the patient on the left lateral decubitus position. The ultrasound probe is covered with a latex condom and is inserted under real-time visualization through the anal canal approximately 4-5 cm to the level of the anorectal junction which is delimited by the puborectalis muscle (PRM). It is then slowly withdrawn to the distal end, to assess the length and width of the anal canal, the thickness of the sphincters, and to rule out any defects or the presence of scar tissue.

**ULTRASOUND ANATOMY OF THE ANAL CANAL**

With EAUS, the whole anal sphincter can be visualized and examined with a high sensitivity degree, good discrimination of the IAS and EAS, assessing their length, width, and the presence of any defect or structural abnormalities that can reveal the cause of the anal sphincter dysfunction.

The length of the surgical anal canal from the anorectal ring to the anal verge has an average length of 4.4 cm in men and 4.9 cm in women\textsuperscript{26}. Women have a shorter anterior EAS than men, which occupies, respectively, 30 and 38\% of the anal canal length\textsuperscript{27}. It is divided in upper, mid, and lower segments. The upper segment is delimited by the “U”-shaped PRM; the middle segment is demarcated by the complete ring formed by the external sphincter; and the lower segment starts at the...
Concentric layers of different echogenicity correspond to the different structures. The first visible hyperechoic ring adjacent to the transducer corresponds to the submucosa. The IAS surrounds the submucosa. It is a smooth muscle in continuity with the muscularis propria of the rectum. It corresponds to the homogeneous hypoechoic circular structure with a thickness of 1.5-3 mm. The EAS, a striated muscle, is thicker and arises from the PRM and the levator ani; it encircles the internal sphincter and has a mixed echogenicity. Between the two sphincters are the fibroelastic stroma of the intersphincteric space. In some patients, to delimitate a ring with hypoechoic dots.
corresponding to the longitudinal muscle bundles\textsuperscript{29,30} (Figs. 1 and 2).

To avoid confusion in the localization of lesions when the patient is explored subsequently in a different position, we do not use the hours of the clock to classify the findings and instead divide the cross-sectional image in four compartments: anterior, posterior, right, and left. The right of the patient will always be, like in other cross-sectional techniques, on the left side of the screen and the left side of the patient on the right of the screen (Fig. 3).

ULTRASOUND FINDINGS IN FI

EAUS can localize and measure defects, demonstrate thinning of the sphincters or scar tissue which could eventually be repaired surgically, and will not be detected by digital examination\textsuperscript{31}.

Obstetrical ruptures are usually anterior, the EAS being the first sphincter injured during expulsion with loss of the circumferential integrity and of the mixed hyperechoic echogenicity, substituted by low levels and heterogeneous echoes representing scar tissue. EAUS should be performed after OASIS to guide early repair and/or to plan subsequent deliveries. An EAS rupture can be single or associated with a tear of the IAS, easier to detect, showing a complete interruption of the hypoechoic ring with thickening of the retracted tear muscle\textsuperscript{32} (Figs. 4 and 5).
Figure 5. Sixty-three-year-old women with incontinence: rupture of the anterior quadrants of the internal anal sphincter: IAS (arrows head) with intact external anal sphincter: EAS (arrows), *intersphincteric space: ISS.

Figure 6. A 34-year-old male with four previous anal surgeries for fissures and fistulae, with persistent secretion. The anal sphincters cannot be depicted on the left quadrant, replaced by hypoechoic fibrous scar tissue: edges of the internal anal sphincter (IAS): arrowheads. Edges of the external anal sphincter (EAS): arrows.

Figure 7. Recent anal surgery and subsequent passive incontinence in a 28-year-old female: disruption of the left quadrants of the internal anal sphincter (IAS): arrows and integrity of the external anal sphincter (EAS): arrowheads.

Figure 8. A 53-year-old woman with incontinence. The internal anal sphincter (IAS) is intact but very thin measuring < 2 mm thickness (arrows); the borders of the external anal sphincter (EAS) are replaced by fat tissue and difficult to define.

Figure 9. Rectal prolapse of the upper segment of the anal canal in a 69-year-old female with occasional incontinence. There is an asymmetric submucosal layer thickening in the union of the anterior quadrants, associated with a rupture of the internal anal sphincter (IAS): arrowhead. Puborectalis muscle (PRM): *

After surgical procedures for hemorrhoidectomy, fistulae, or sphincterotomy for anal fissures, the IAS will be the first sphincter disrupted and can be associated with a rupture of the EAS. These lesions can be multiple and found anywhere in the anal circumference and length (Figs. 6 and 7).

The IAS is accurately defined by EAUS: normal thickness in adult’s ranges from 2 to 4 mm.

An IAS that measures < 1.8 mm is abnormal in patients older than 50 years. This has been
related to primary degeneration of the IAS and associated with passive incontinence\textsuperscript{35}.

Thinning of the external sphincter can also be reliably identified with EAUS. In case of atrophy, this muscle could be very thin and difficult to individualize, the muscle fibers being replaced by fat\textsuperscript{36}. In elderly women, mixed echogenicity and increase of the IAS diameter and thickness are concomitant with a thinner EAS. This is a normal age-related change and should not be misinterpreted (Fig. 8)\textsuperscript{18}.

At older ages, there is increased IAS thickness and decreased EAS thickness. Diagnosis of external sphincter atrophy, on the basis of sphincter thinning, requires that one distinguish between abnormal thinning and age-related differences.

In elderly women, incontinence associated with diarrhea can also be the consequence of a rectal prolapse: an asymmetrical appearance of the anal sphincter or heterogeneous thickening of the anal submucosa can be observed with EAUS. Prolapse can be concomitant with a solitary rectal ulcer and a sphincter tear\textsuperscript{31,37} (Fig. 9).

New treatment options are available for patients with FI unmanageable with other medical treatments: use of bulking agents made with dextramer microspheres in stabilized hyaluronic acid or silicone elastomer which can be injected in the intersphincteric or submucosal rectum spaces to increase anal resting pressure. This procedure showed better results when performed under ultrasound guidance\textsuperscript{1,38,39} (Fig. 10a and b).

**CONCLUSIONS**

A 360° EAUS is a quick and easy procedure. It plays an important role in the diagnosis of FI. It should always be performed as a first diagnostic tool and by trained operators to avoid diagnostic errors. Precise demonstration of anatomical lesions of anal sphincters and their extension can be obtained as well as in aging degeneration processes. A 360° EAUS is essential to make therapeutic decisions.
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