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Endoanal Ultrasound for Anorectal Diseases

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ABSTRACT

In the last decade, the ultrasound has become the tool with the most clinical impact in making decisions for medical specialties and it is considered the stethoscope of the 21st century. In anorectal diseases, endoanal, endorectal, transperineal (translabial) and endovaginal ultrasounds are used to carry out comprehensive patient assessment. The downside of being an operator-dependent study has been solved with the 3D technology of certain equipment. The main indications of the endoanal ultrasound are the assessment of anal fistula and the anal sphincter study in patients with fecal incontinence. Endorectal ultrasound is widely used in the rectal cancer staging. Transperineal and endovaginal studies have been reserved for the study of pelvic floor disorders. The objective of this review is to present the usefulness and indications of ultrasound in coloproctology, as well as to present the most significant images of the most frequently observed pathologies.

Keywords: Anal fistula; Incontinence; Rectal cancer; Rectocele; Constipation

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INTRODUCTION

Endocavitary ultrasound for anal and rectal pathologies was first used in the early 60s for the initial assessment of rectal tumors [1]. However, the images obtained were not of good quality, which caused it to not gain popularity. By the 90s, the St. Marks Hospital's team in England began using a 360° transducer designed for urinary tract pathology (BK Medical, Denmark) in the anorectal area [2].

Initially, the company BK Medical was the spearhead in technology used for the assessment of anorectal pathology; afterwards, Aloka and Hitachi began producing 360° transducers for this area. The high cost of the equipment has been a major constraint in many centers, mainly in developing countries. Attempting to resolve this situation, startup companies emerged with 360° images equipment with relatively low costs, such as Echoson, Accuview and Halo [3].

Most studies around the world are carried out with BK Medical equipment with transducers of 5-16 MHz with a focal distance of 2.8-6.2 cm. The endoanal transducer generically consists of a crystal that rotates 4-6 cycles per second in order to obtain a 360° image. A 6.0-cm long image is captured along the proximal-distal axis for up to 55 seconds by moving the crystals on the extremity of the transducer [4]. Currently, the 3D technology of this company allows to obtain a cube formed by a series of axial images obtained every 0.05mm in an automated manner [5]. The "cube" allows to work with sagittal, coronal or longitudinal cuts, as well as cuts in any other direction required by the doctor [6]. This technology finally allows to minimize operator-dependent errors. Although technically a non-specialist in Coloproctology or even a medical technician may be able to perform it. Sometimes we required to obtain extra images performing unconventional maneuvers, as we will mentioned below, that can only be performed by a specialist [7].

The number of performed studies needed in order to arguably become an expert or to have passed the learning curve has not been established. In a study conducted in Italy by the Italian Society of Coloproctology, was considered that a hospital with "experience" must perform at least 10 studies per week. In the institution of the authors, which is a third level reference service, 30-40 studies are performed per month [8].

It is our policy to conduct the study with the patient in the jack-knife position using a Ritter (Table 1). However, we know that most of the published works suggest performing the study in the Sims' position, especially due to the lack of access to this table. The Sims' position has the major drawback of having the transducer leaning on the left side region, obtaining an asymmetrical image of the sphincter that translates into a false thinning of the internal anal sphincter **(IAS),** which can be misinterpreted as a sphincter lesion [9].

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Table 1: Starck Score. This sphincter defect grading system score 0 for no defects and a score of 16 for a maximal defect.

	score			
Extent of defect	0	1	2	3
External sphincter				
Length of defect	none	Half or less	More than half	Whole
Depth of defect	none	partial	total	————-
Size of defect	none	≤ 90°	91°-180°	≥180 °
Internal sphincter				
Length of defect	none	Half or less	More than half	Whole
Depth of defect	none	partial	total	————-
Size of defect	none	≤ 90°	91°-180°	≥180 °

This study is conducted usually at the doctor's office, it does not require hospitalization, and it is well tolerated by most patients. It is not necessary for the patient to be fasting, and we suggest cleaning the rectum with enemas for the comfort of both the patient and the doctor [10]. Rectal cleaning is essential when performing the endorectal study for tumors or for transrectal or transperineal ultrasound defecography. Although it is not necessary to perform the study under sedation, this has occurred when the study was performed in rectal tumors and in patients with pain without specific diagnosis [11].

For the normal endoanal study, we divide the anal canal in 3 thirds: upper, mid and lower third [12]. In the upper third, we observe the internal anal sphincter and the puborectalis muscle; at this level in addition to assessing the integrity of the entire circumference of the IAS, we must observe symmetry of the puborectalis branches, which are "U"-shaped [13]. In the mid-third, the IAS and external anal sphincter (**EAS**) are observed, and in the lower third only the IAS is observed. The IAS is a hypoechoic ring, and the EAS is a mixed echogenicity ring tending to hyperechogenicity. The mid-third is subdivided in the high and low part, and there is no clear definition on this regard. In the case of women, it is easy to define the upper area: at this level, the EAS is not closed, forming a gap (Figure 1) [2,14-17].

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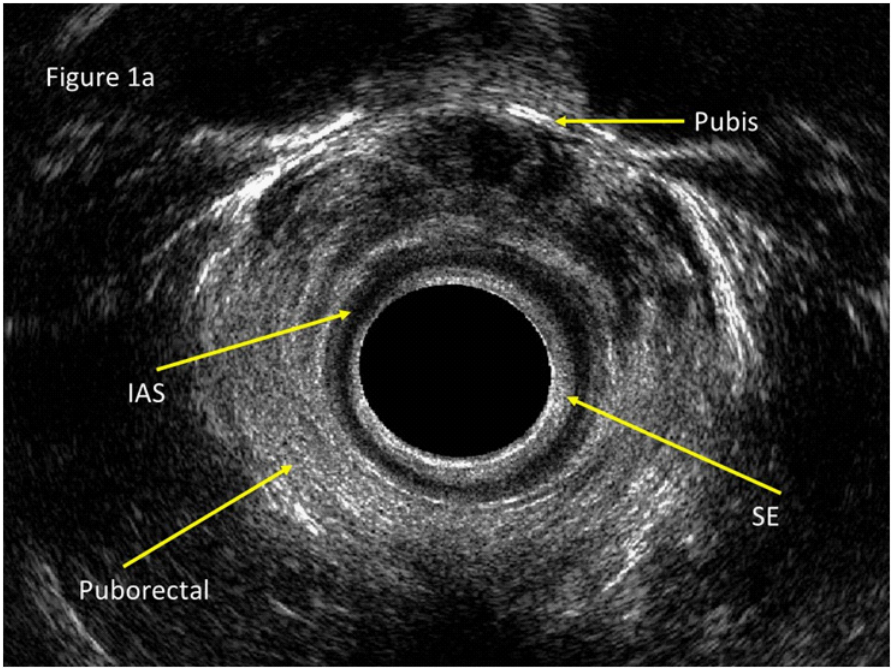
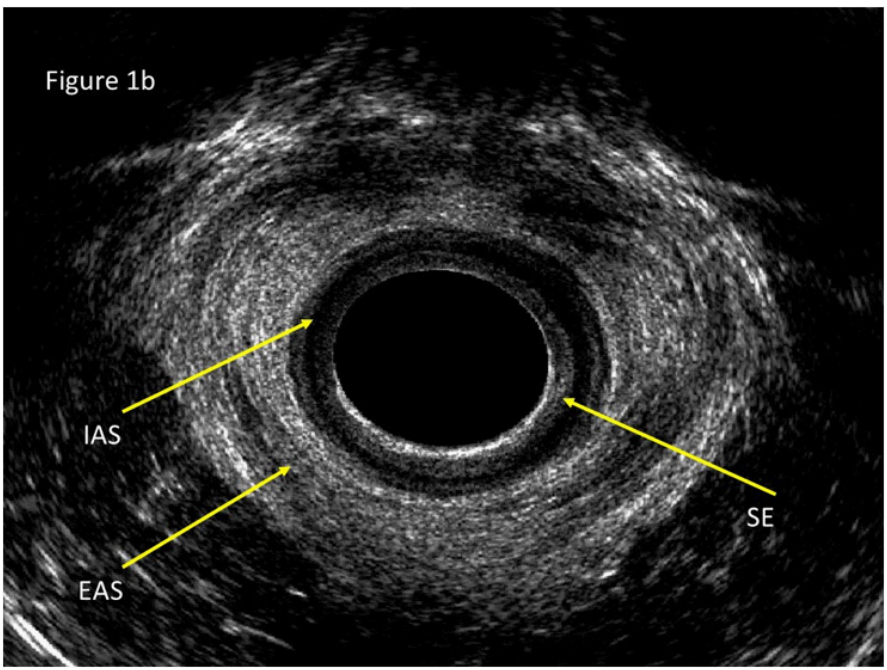
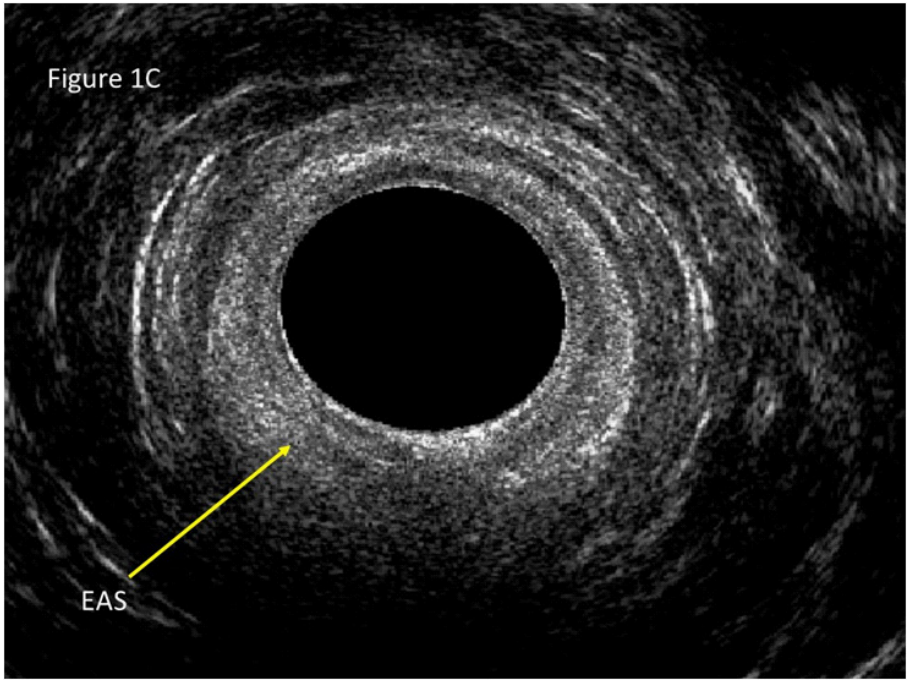


Figure 1: Normal anatomy. **a)** High level of the anal canal. The puborectalis muscles branches and internal anal sphincter **(IAS)** are the structures evaluated.



b) Mid level of the anal canal. The IAS and the external anal sphincter **(EAS)** are the structures evaluated.

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c) Low level of the anal canal. The EAS is only sphincter structure seen at this segment.

As for obtaining endorectal images, the transducer is placed with a coverage that allows for the filling of fluid to connect with the rectal (or tumor) walls, avoiding air inside the coverage that would make it impossible to obtain satisfactory images [18]. To carry out the endorectal study, it is necessary to introduce the transducer with a rigid rectosigmoidoscope, which is specific for each transducer. It is worth mentioning that the latter attachment has a diameter larger than commercial available (e.g. Karl Storz) [19]. The transducer cannot pass through all commercial rectosigmoidoscopes. Once the tumor has been successfully cleared, it must be introduced a couple of centimeters above its upper edge, with the intention to locate nodes in the mesorectum for a proper staging [20].

It is not actually necessary to introduce the rectosigmoidoscope beyond 10 cm from the anal margin. The importance of the endorectal ultrasound focus in the extraperitoneal rectum for assessing the penetration of the tumor and the presence of nodes at the level of the middle and lower rectum and determining the need for neoadjuvant therapy.

For the assessment of pelvic floor pathology, a combination of endorectal, endoanal, endovaginal and transperineal ultrasound is usually performed [20]. In order to perform these studies the patient is required to clean the rectum with commercial or saline enemas. Regadas and cols described a standardized technique to perform the pelvic floor ultrasound using the endoanal and endovaginal probe [21,22].

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Meanwhile, Dietz and cols basically proposes the transperineal (translabial) procedure for pelvic floor pathology [23,24]. In our experience, the latter technique favors the simultaneous assessment of the three compartments of the pelvic floor in real time, allowing for a better understanding of the diseases in this area [25]. The application of gel for intrarectal ultrasound allows for a better assessment of the anorectal region (anatomical and functional) [26].

ANAL ABSCESS AND FISTULA

The septic processes of the anorectal region are mostly easy to diagnose by a specialist by the clinical symptoms; however, during the acute process the endoanal ultrasound allows for the assessment of the extent of the abscess. Its major usefulness is observed in patients with anal pain, in which there is no clear data of an abscess, allowing to rule out the presence of a septic process in these patients [27]. The intersphincteric abscess is the location most frequently encountered in this clinical setting (Figure 2) [28,29].

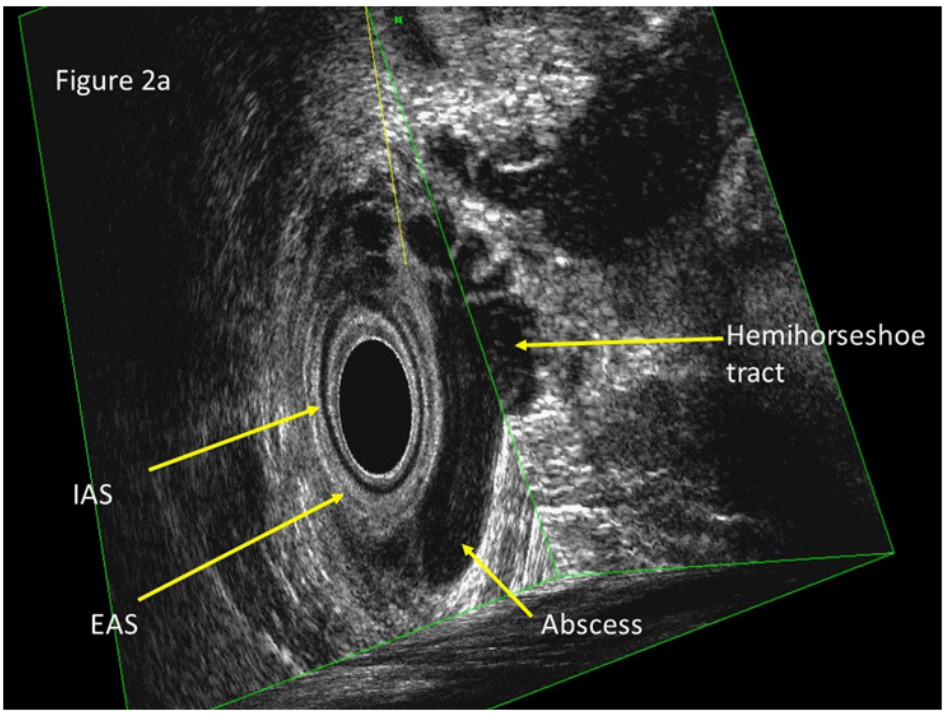
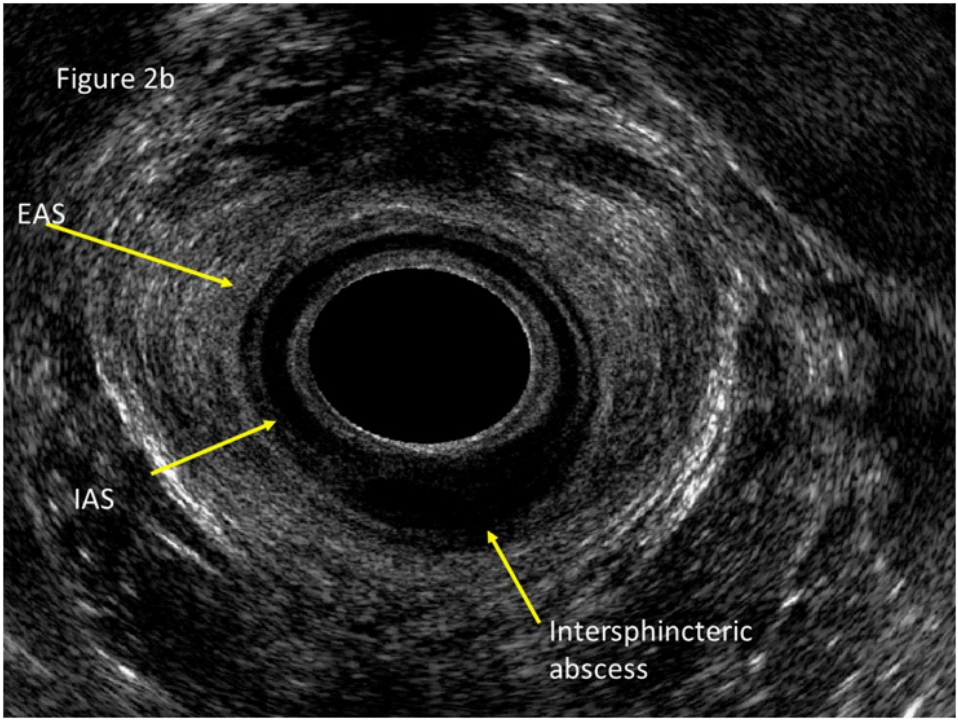


Figure 2: Anal abscess. **a)** Axial-longitudinal image with an hypoechoic area that extends from the anterior region with a left hemihorshoe tract.

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b) Intersphincteric abscess in the posterior midline mid anal level.

Moreover, an anal fistula assessed by ultrasound allows to characterize its main tract, secondary tracts, cavities, and, in most cases, the internal fistulous opening **(IFO)** [30].

When an active external fistulous opening **(EFO)** allows its catheterization, applying diluted hydrogen peroxide through it allows us to see more clearly all the above mentioned elements of the fistula. Hydrogen peroxide is prepared with a 1:3 dilution, and usually less than 2 ml is sufficient [31]. We use a syringe with a trimmed tip venous catheter, and although the possibility of a gas embolism is low, it is necessary to be especially careful not to force the entry of the catheter, due to the risk of penetrating a blood vessel resulting in a complication (Figure 3).

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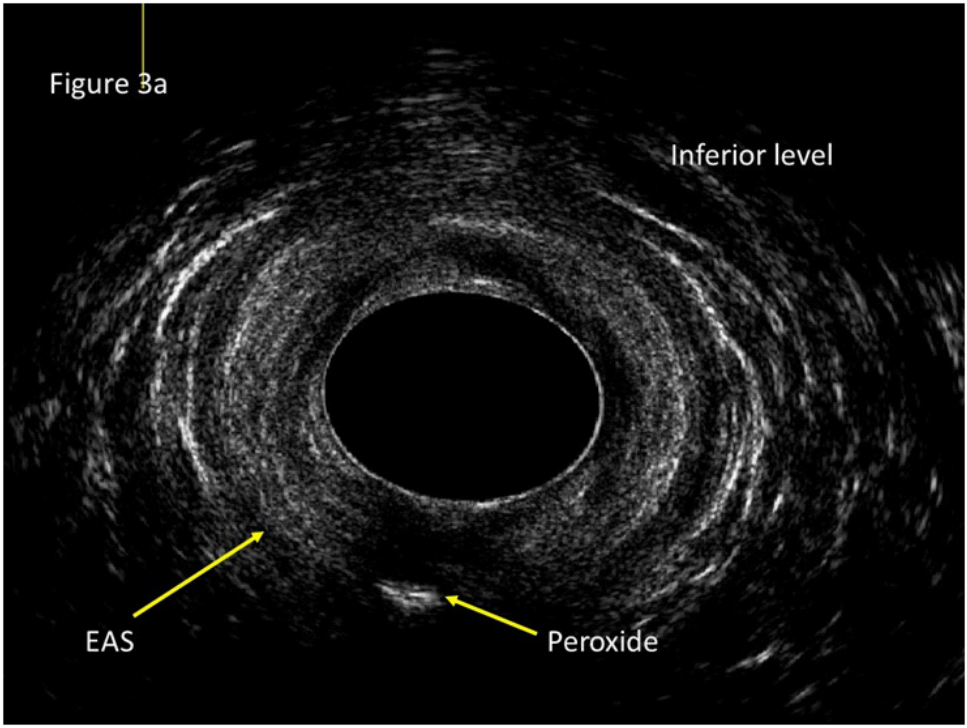
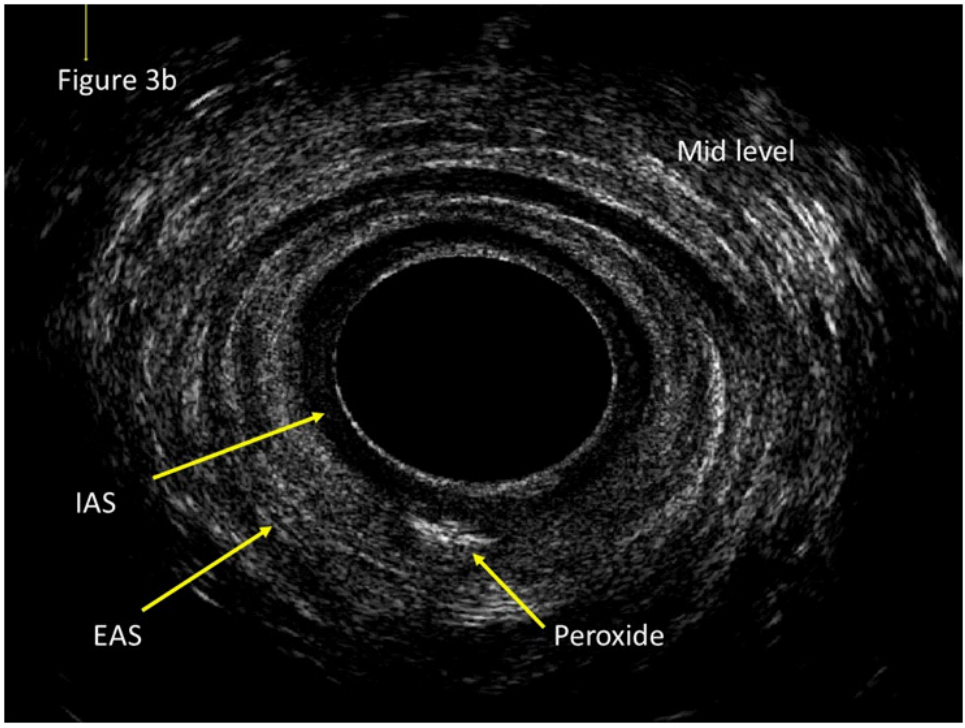
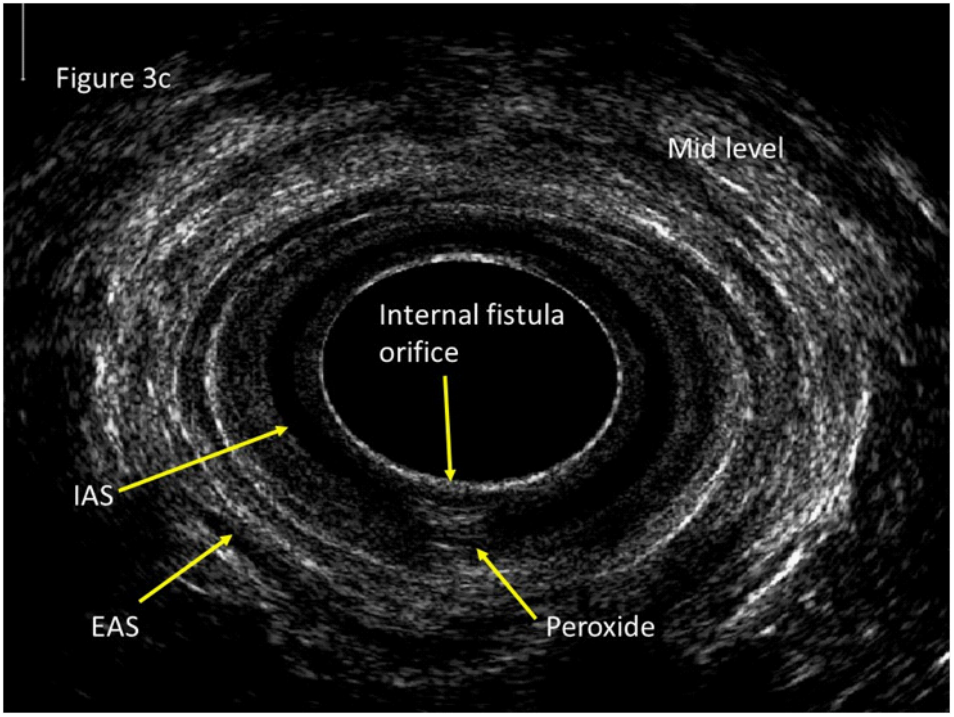


Figure 3: Anal fistula. **a)** Intersphincteric fistula with hydrogen peroxide.

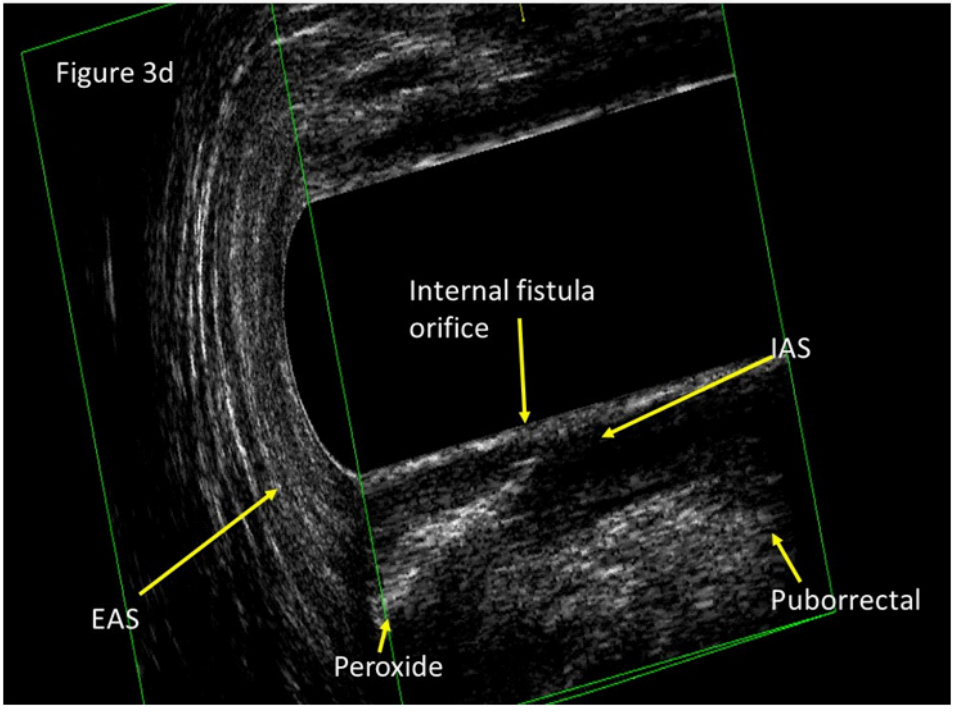


b) Intersphincteric fistula with hydrogen peroxide.

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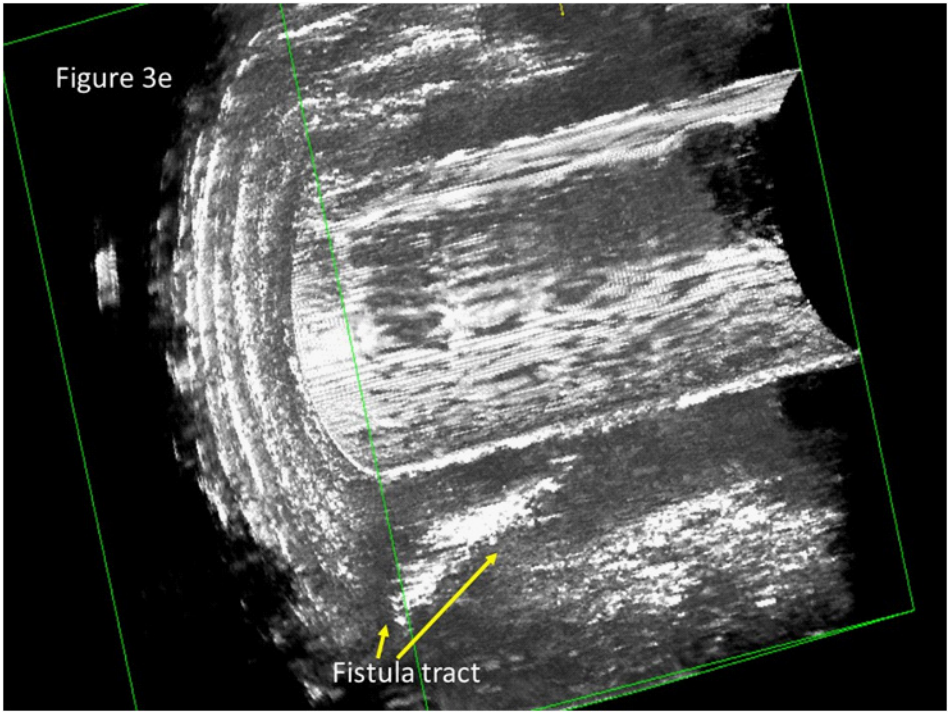


c) Intersphincteric fistula with hydrogen peroxide.



d) Intersphincteric fistula with hydrogen peroxide.

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e) Intersphincteric fistula with hydrogen peroxoide and volume render mode.

Sometimes when the patient has significant outflow of purulent material through the external fistulous opening, we use a gentle touch with the intention to not drain the pus from it, and that this purulent secretion, which usually produce hyperechogenic images (air inside the tract), allows us to observe its location. Moreover, the application of hydrogen peroxide is not indicated in an abscessed fistulous tract (a high volume of purulent material), the peroxide triggers a thermal reaction that is painful for the patient.

During the assessment of anal pain or in the alleged clinical diagnosis of an anal cavity without open external fistulous opening, application of intra-anal hydrogen peroxide is suggested. This technique, which has been developed in our clinic, consists of introducing the untrimmed intravenous catheter (only the plastic part) within the anal canal, pressing its opening with the index finger on the area of fibrosis that may correspond to the internal fistulous opening **(IFO)**. Do not try to cannulate the IFO, as it is a maneuver technically unsuccessful to perform, just keep the finger pressure on the fibrous region with the catheter tip in this place and pass through the hydrogen peroxide. In 50% of cases, this allows us to observe its passage towards the anal cavity (sinus) [32,33].

In a recent meta-analysis comparing endoanal ultrasound and nuclear magnetic resonance **(MRI)** for the diagnosis and characterization of anal fistula there were no significant differences. The biggest advantage of endoanal ultrasound is the ease of performing it in the doctor's office

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and its lower cost in comparison to the MRI. However, the advantage of MRI lies in significantly distinguishing whether it is an "active" fistula or just fibrosis, along with a more complete assessment of the lower pelvic and abdominal structures [34-36].

FECAL INCONTINENCE

The assessment of patients with fecal incontinence includes performing endoanal ultrasound, anorectal manometry and pudendal nerves assessment [37]. However, the endoanal ultrasound is the most important study of all, because it allows us to observe injuries in the sphincter complex and determine if the patient is a candidate for a surgical procedure. Usually, IAS injuries show hyperechoic characteristics, while EAS injuries show variable echogenicity with a tendency to hypoechogenicity (Figure 4) [8].

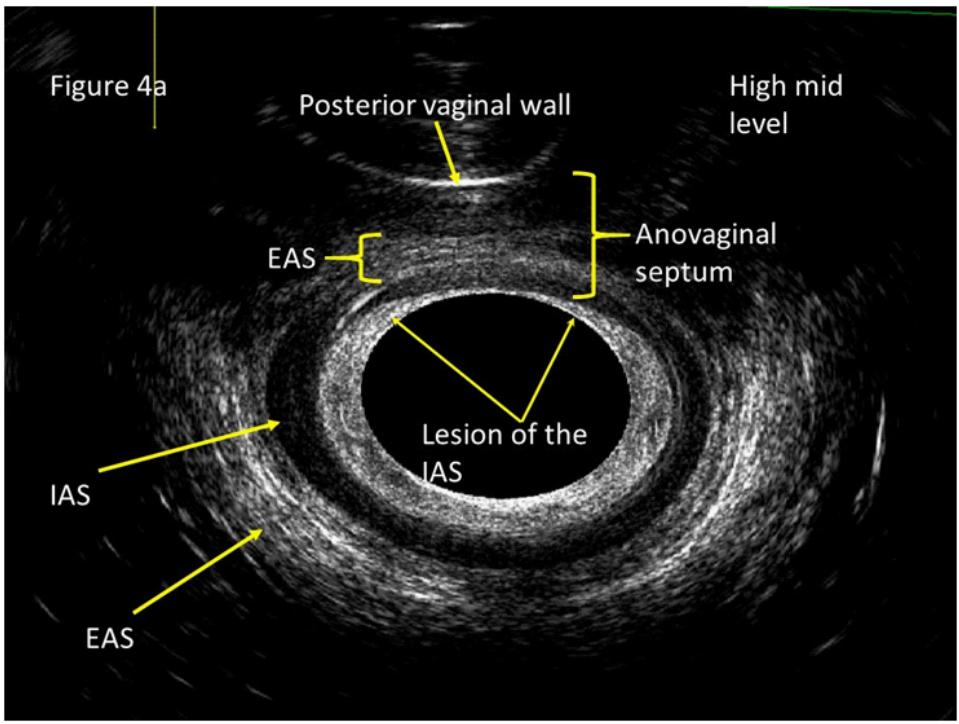
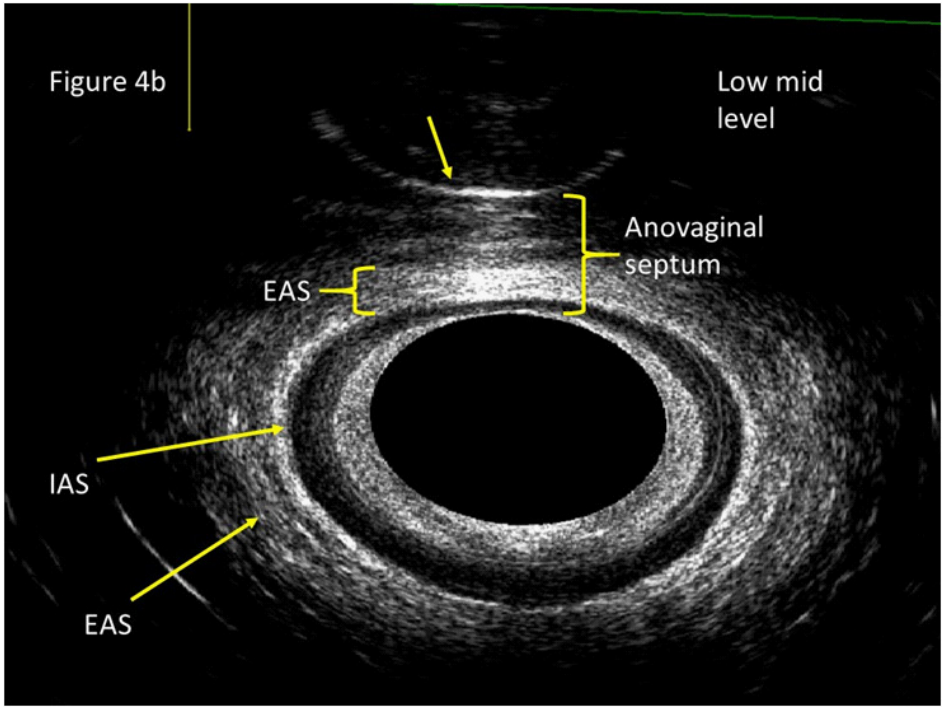
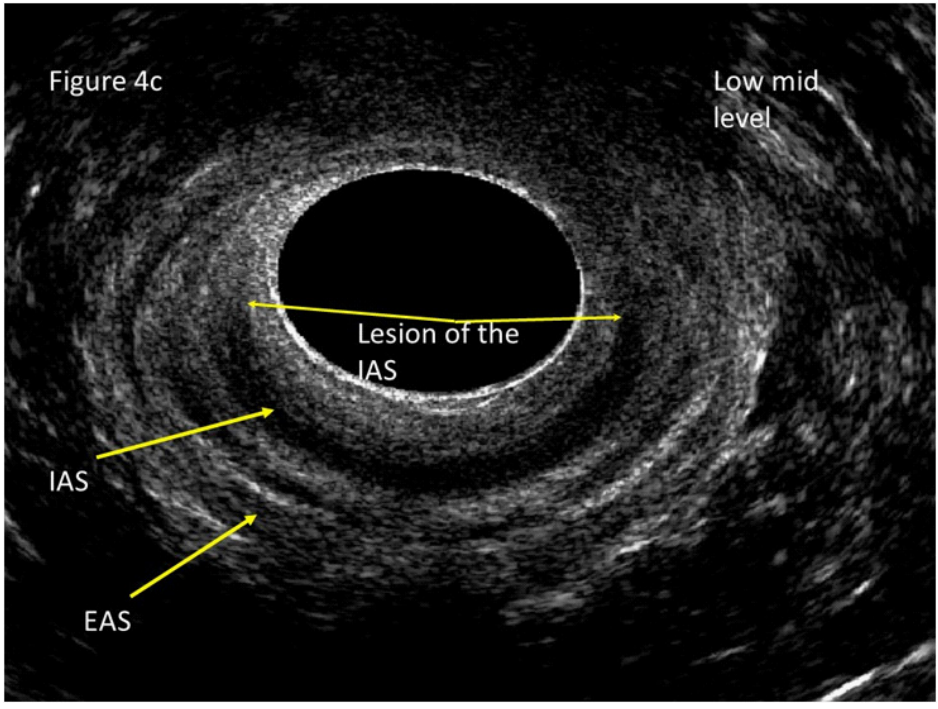


Figure 4: a) Incontinence. Lesions of the anal sphincter.

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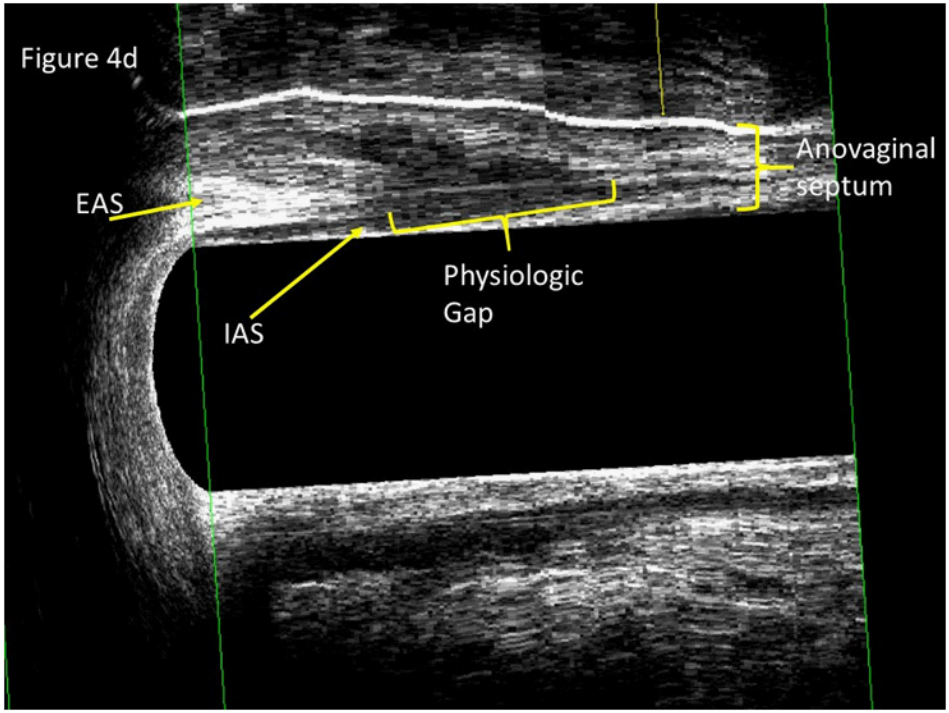


b) Lesions of the anal sphincter.



c) Lesions of the anal sphincter.

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d) Lesions of the anal sphincter.

When conducting the study on women, it is important not to confuse the presence of the "physiological gap" with an anterior middle and upper high sphincter injury. This physiological gap measures 1.25 cm, and corresponds to the anovaginal septum area, where there is no EAS in women. It has been described in men, but only measuring a few millimeters and it is usually barely visible [38]. The report of endoanal ultrasound for fecal incontinence must include the thickness measurement of both sphincters. Regadas and cols describe thickness of the spinchters: male anterior IAS thickness 0.19 cm, female anterior IAS thickness 0.12 cm, male posterior IAS thickness 0.19 cm and female posterior IAS thickness 0.18 cm.

The IAS will be more thickened in elderly patients, and it will be thinner in children; however, thickening is secondary to connective tissue. Both sphincters are usually measured in the right side and left side regions of the low mid-third, corresponding to the site of increased major thickening [1,38-40].

Is necessary to inform the EAS and IAS length in the anterior and posterior region and, in the case of women, the thickness of the anovaginal septum in its 3 segments. Usually the septum is 10 mm thick; a decreased thickness suggest possible sphincter injury [41]. In the authors' clinical practice in Latin American patients, it is difficult to find an anovaginal septum of 10 mm or more. Most of the studies in this regard were conducted in Brazil or in patients of Caucasian descent, concluding that the constitution also translates into the thickness of the septum [38].

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It is not easy to determine the thickness of the anovaginal septum without any reference that clearly delimits the posterior wall of the vagina. It is suggested to introduce the index finger opposite to the dominant hand (with which the ultrasound is performed), maintaining a gentle pressure with the finger perfectly well extended on the posterior wall of the vagina. It is difficult to define how much pressure is maintained on the wall, as it is possible to deform and decrease the thickness of the septum; for this reason, we sometimes use a cotton tampon (menstrual protectors), however, more studies are needed to validate this technique [8,42].

RECTAL CANCER

Neoadjuvant therapy (preoperative chemotherapy and radiotherapy) is the gold standard for the management of locally advanced rectal cancer [43]. Middle and lower rectal tumors are susceptible for endorectal ultrasound, keep in mind that upper rectal tumors are handle as colon tumor without indication for this study [19]. Penetration of the tumor into the different layers of the rectum are assessed using the staging proposed by Hildebrandt and Feifel and posterior modifications (Table 2) [44]. Mesorectal nodes are reported as present (positive) or absent (negative), without taking into account the number of them. The characteristics required to define a positive node are: echogenicity similar to that of the tumor and a size of 1cm or more [45,46].

Table 2: Rectal cancer staging by Hildebrand and Feifel.

Classification	Characteristics
uT1	Tumor confined to submucosa
uT2	Tumor extend into and/or thicken the muscularispropria
uT3	Tumor reach the peri-rectal fat
uT4	Tumor infiltrate adjacent organs (prostate or vagina) or pelvic side wall.
N -	Normal perirectal nodes
N +	Perirectal nodes with malignant involvement

The 3D ultrasound technology allows to follow the image of a probable positive node along its length, and it can determine whether it is a blood vessel or is a neoplastic node. For 2D images, sometimes more training is required to define and perform several scans to reach a conclusion. MRI becomes complementary to the endorectal ultrasound to determine the presence of malignant nodes. (Figure 5) [47,48].

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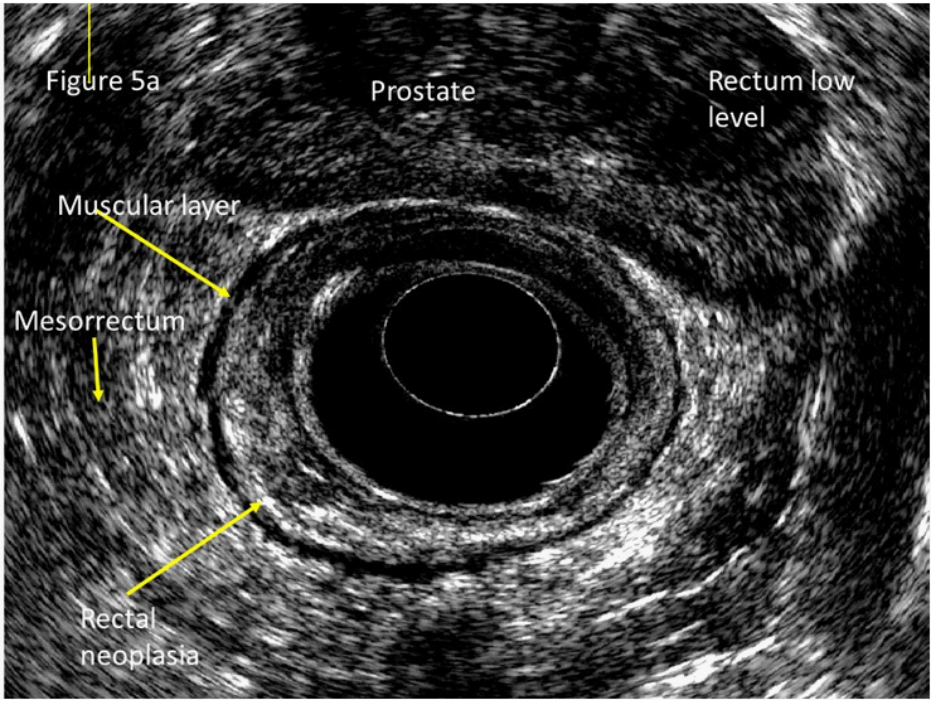
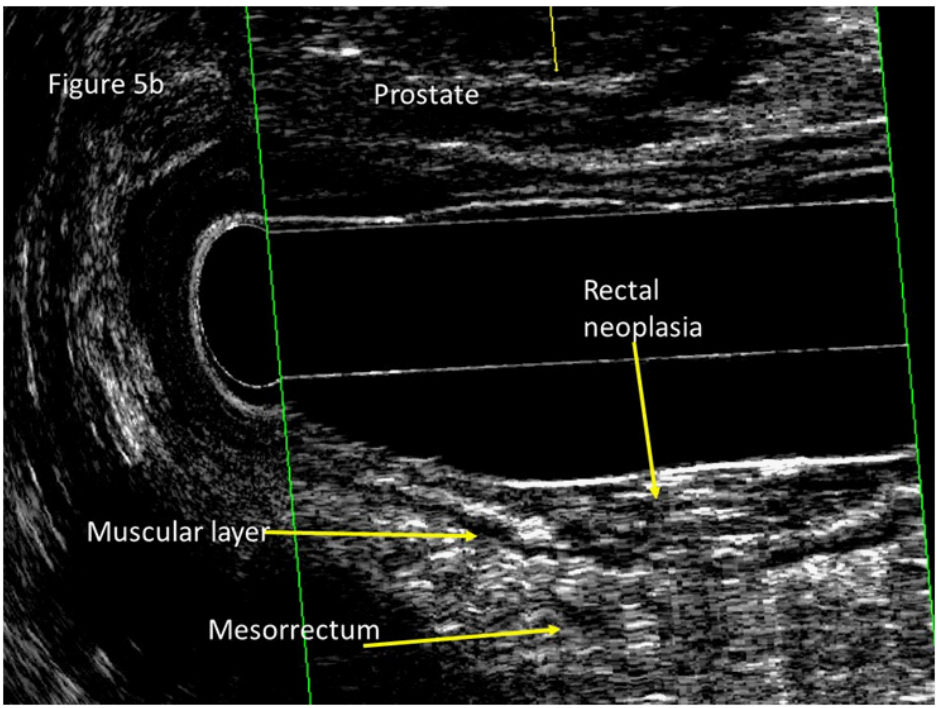
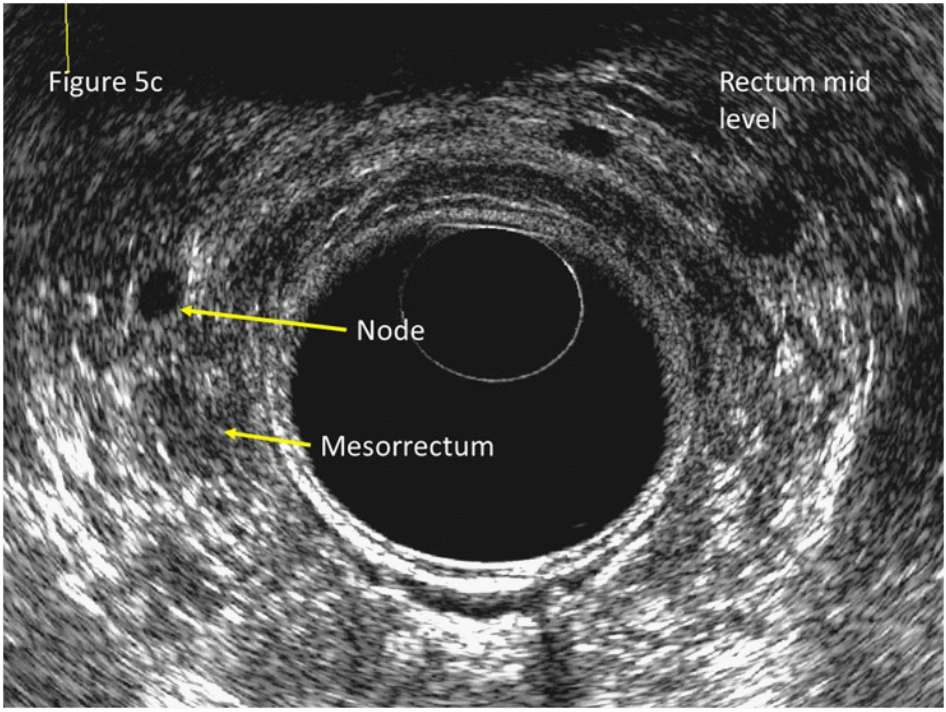


Figure 5: Rectal cancer staging. **a)** Rectal neoplasia with infiltration limited to the submucosa.



b) Axial-longitudinal image with a posterior localization of the neoplasia.

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c) Mid rectal level with positive neoplasic nodes.

Another classification used is the Wong's classification (Table 3), which not only takes into account the penetration but also how much the tumor penetrates the mesorectum. Under this classification, an incipient T3 has a penetration lower than 2mm and it would not be a candidate for neoadjuvant therapy. In this regard, MRI is less effective than the ultrasound for determining the penetration in rectal layers [49-51].

Table 3: Wong´s classification for endorectal ultrasound rectal cancer staging.

Wong's classification.		Description
uTw	uT0/uT1	Amenable to local excision
uTy	uT2/superficial u T3	Recommend radical surgery over local excision. May require neoadjuvant therapy. Pathologic features and nodal status helpful in determining need for neoadjuvant therapy.
uTz	Deep uT3/any uT4	Recommend neoadjuvant therapy
uN1	Probable or definite	Recommend neoadjuvant therapy
uN1	Equivocal	Base treatment on T stage and pathologic features

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The endorectal ultrasound also allows to assess the distance between the levator muscle and the distal edge of the tumor, a fact rarely mentioned but that allows a prognosis prior to the surgery to be performed [52]. Tumor infiltration into the levator muscle is clearly observable with the ultrasound, and in these cases, we will have the necessary documentation of an extra-elevator abdominoperineal resection [49].

Moreover, in the era of the "Watch and Wait" therapy for the treatment of rectal cancer, ultrasound becomes a necessary tool for patient follow-up. Dr. Regadas has proposed a post-neoadjuvant therapy classification, in order to assess the evolution of these patients [53].

Endoanal ultrasound has been used to assess the degree of penetration of malignant anal tumors of epidermoid histology. The Goldman and Giovannini [54] classification is used for staging, however, the NCCN and European guidelines do not mention it as part of the study of these tumors [55].

PELVIC FLOOR ASSESSMENT

Constipation

Constipation secondary to outlet obstruction is usually assessed by X-ray or MRI defecography. Regadas and cols conducted a study in 2008, which validates that the ultrasound defecogram has the same validity as the conventional defecogram with the advantage of not requiring a fluoroscope with high exposure to X-rays [56]. Regadas's technique consists of obtaining 4 cubes, at 16 Mhz, performing pushing and contraction maneuvers [56]. The first cube consists of the assessment of the anorectal region without performing any maneuver; the second requires the patient to push, allowing the transducer to move with the maneuver. This second cube allows us to assess the descent of the perineum. In third cube, the patient is asked to push again, maintaining the transducer fixed. With this third cube, it is possible to observe if the angle of the puborectalis muscle opens or determine a paradoxical contraction [56].

The fourth cube is obtained by introducing ultrasonographic gel into the rectum, approximately 60 to 120ml. The patient is asked to push with the intention to observe the presence of a rectocele and/or an internal prolapsed [56,57].

As specialists, we are aware that the conditions when performing an ultrasound defecography are not the ideal ones for a physiological evacuation: patient in left lateral decubitus and with a transducer in the rectum, for which many patients without clear outlet obstruction symptoms can be overdiagnosed. Endoanal and endovaginal use of the BK 4838 probe complements this exploration (Figure 6) [58].

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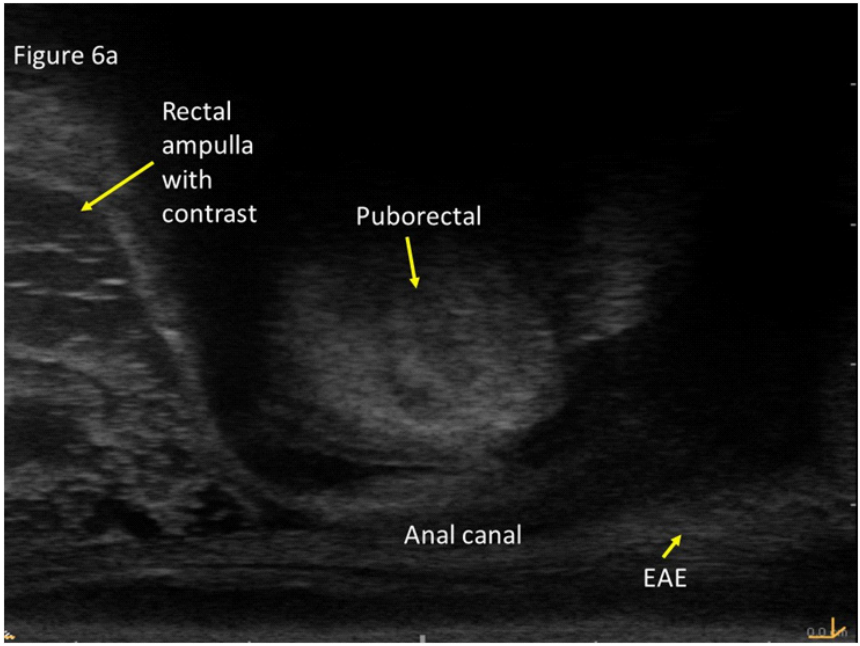
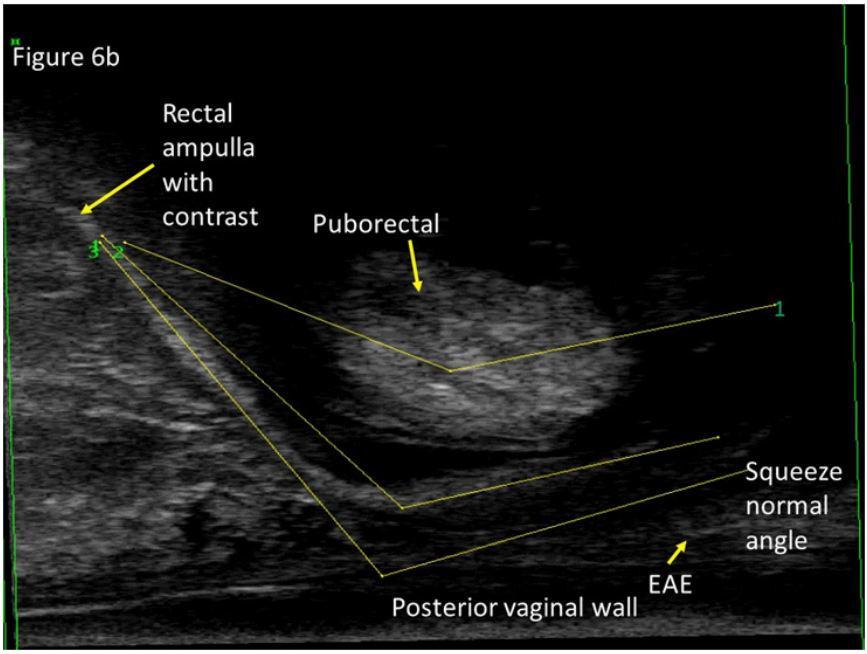


Figure 6: Transvaginal and transrectal ultrasound. **a)** Transvaginal ultrasound. The probe in in contact with the posterior vaginal wall. We can appreciate the contrast media (gel) in the rectal ampulla.



b) Transvaginal ultrasound with evaluation of the puborectalis muscle movement. The angles of movement of the puborectalis muscle is evaluated pushing maneouver, squeeze maneouver and in a relax position.

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COMPREHENSIVE ASSESSMENT OF PELVIC FLOOR: RECTOCELE, ENTEROCELE, CULDOCELE, CYSTOCELE, UTERINE PROLAPSE

The transperineal or translabial ultrasound uses a convex linear transducer of 3 to 6 MHz, which is placed in the perineal region with the intention of displaying the anterior, middle and posterior compartment of the pelvic floor [59]. This study has not yet obtained the importance and popularity it deserves, although Dr. Dietz from Australia and Dr. Schobieri from USA have boosted its use through studies and courses for several years. Among the limitations that we believe have affected the take-off of this technique, there is the difficulty in assessing the images and its correct performance [60].

Dr. Schobierei proposes the following items to consider: This study must be performed in any patient who will undergo pelvic floor surgery. Normally, when we conduct the study, in the case of our Coloproctology Service, referring almost exclusively to patients with pathology of the posterior compartment, we find alterations in the middle and anterior compartment in 90% of patients. Once before these findings, with a more complete interrogation and complementary physical examination, we know that these patients will also require a comprehensive treatment of the pelvic floor. Dietz mentioned the other side of the coin in a work from 2014, in which the presence of enteroceles is found in 40% of a group of healthy patients [61].

In the case of recurrent pathology of posterior compartment after surgery, as in rectal prolapse, we recommend performing the transperineal ultrasound. We have observed that in patients with early recurrence (less than 6 months), the source of prolapse was not intussusception, but an enterocele that encouraged prolapsing of a section of the rectal wall. This has leaded us to assume that the rectal prolapse is probably not a single pathology, but a number of different disorders with one result: prolapse. One line of research will be the use of this tool prior to treatment of any rectal prolapse, intending to establish which one is the best technique according to the transperineal ultrasound results [56,59].

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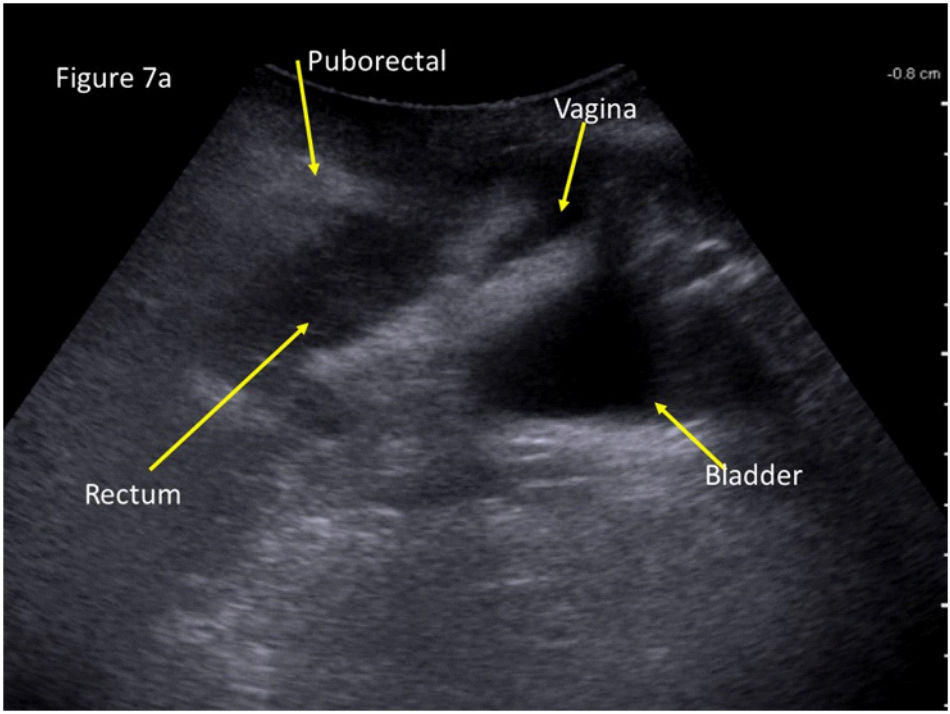
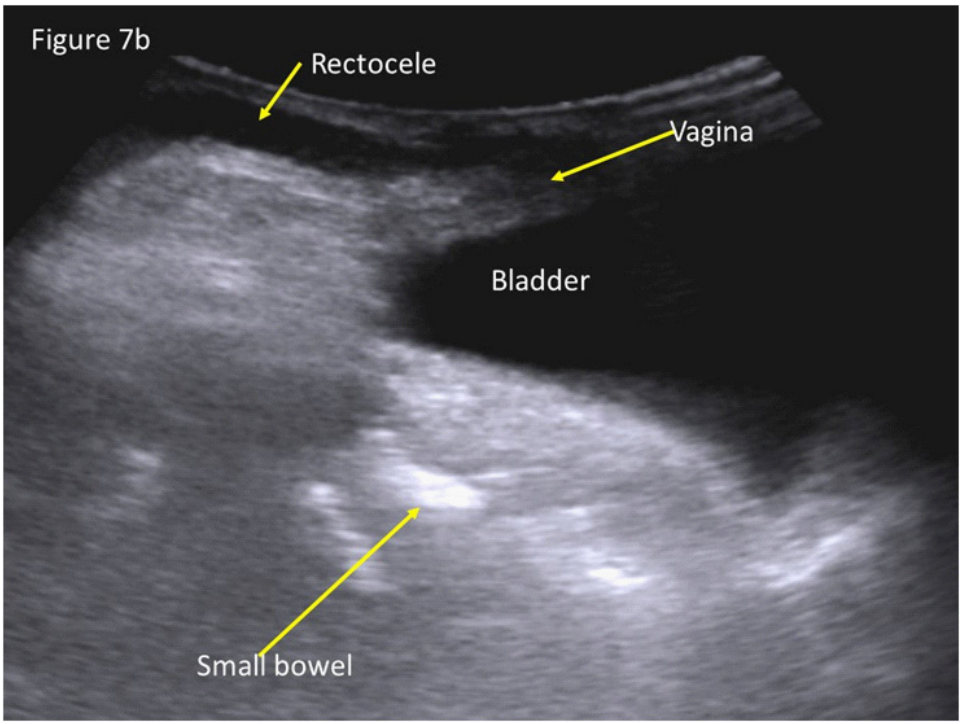


Figure 7: a) Transperienal ultrasound. Patient with hysterectomy.



b) During squeezing maneouver.

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CONCLUSION

Ultrasound in the area of Coloproctology is an essential tool for the correct assessment of the patient in a vast majority of conditions allowing for an individualized treatment. The incorporation of elastography to these transducers appears to be the next step, which will allow us to assess the content of collagen in tissue, allowing to differentiate between inflammatory and scar tissue. Moreover, the endoscopic ultrasound (ultrasound through the colonoscope) does not seem to be a substitute for the 3D technology of the new specific transducers in the region, with a lower image quality. We believe that the transperineal ultrasound will be the tool of the future for the assessment of the pelvic floor.

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