Introduction

Endoscopic ultrasonography (EUS) currently plays an important role in the field of gastroenterology, particularly in the diagnosis and treatment of upper gastrointestinal (GI) and pancreatobiliary diseases. However, it remains underused in the lower GI diseases field, probably because of the lack of knowledge and experience of endosonographers ***(Kim, 2015a).***

Endoscopy alone cannot accurately distinguish between intramural and extramural lesions. By contrast, endoscopic ultrasonography has provided a major breakthrough for characterizing such masses by identifying the layer of origin and enabling guided-tissue acquisition for studies that include cytohistology, immunohistochemical, and flow cytometry. The pathology combined with lesion size, location, and sonographic morphology can help distinguish between benign (the majority of subepithelial lesions) and malignant or premalignant lesions ***(Hwang et al., 2005).***

The normal wall of the large intestine is visualized by EUS as a 5-layer structure. The hyperechoic first layer from the luminal side corresponds to the boundary echo and the mucosa; and the hypoechoic second layer corresponds to the muscularis mucosa layer, the hyperechoic third layer corresponds to the submucosa (submucosal layer), the hypoechoic fourth layer correspomds to the muscularis propria, and the hyperechoic fifth layer to the serosa or adventitia ***(Kobayashi et al., 2015).***

The diagnostic value of EUS is demonstrated in the local staging of rectal cancer, and it also shows benefits in the differential diagnosis of submucosal tumors of the lower GI tract; assessment of IBD with or without perirectal fistula; evaluation of perianal and perirectal inflammatory conditions; and evaluation of anal sphincters ***(Kim, 2015a).***

Prognosis of rectal cancer depends on its local, nodal, and distant tumor status. Rectal cancer is staged using the Tumor-Node-Metastasis (TNM) staging system, which is similar to colon cancer. Rectal cancer has the appearance of a hypoechoic lesion which disrupts the normal five-layer structure of the rectal wall. Utilization of EUS for assessment and determination of tumor penetration into the bowel wall for rectal cancer allows for identification of patients indicated for preoperative neoadjuvant therapy ***(Siddiqui et al., 2006).***

SMT (submucosal tumor) is observed in a wide range of gastrointestinal (GI) diseases and conditions, including compression by extra-GI organs and lesions, congenital tumors, inflammation, and benign as well as malignant neoplastic lesions. In the diagnosis of these diseases and decision-making for therapy, endoscopic ultrasonography (EUS) (by defining the echogenicity of the lesion and the layer of origin), and endoscopic ultrasound-guided fine-needle aspiration (EUS-(FNA) may play a key role ***(Nishida et al., 2013).***

Aim of the Work

The aim of the study is to:

Evaluate the role and the accuracy of EUS and elastography in diagnosis and staging of different ano-rectal lesions as polyps, submucosal Tumors and malignant tumors.

ANORECTAL EUS

Endoscopic ultrasound (EUS) represents a valuable addition to imaging modalities in digestive diseases, fostering a wide range of diagnostic and therapeutic applications for gastrointestinal (GI) and pancreaticobiliary diseases. Provided with superior resolution compared to other cross-sectional imaging techniques and the added possibility to perform fine-needle aspiration for pathological confirmation, EUS may trigger changes to both patients' diagnosis and management, displaying a considerable impact upon clinical decision ***(Chong et al., 2005).***

Several additional techniques have been developed in recent years for enhanced imaging with EUS, including contrast enhancement, elastography, and three-dimensional reconstructions. Such techniques can provide a better characterisation of lesions and improve diagnostic accuracy while possibly diminishing the operator dependency of EUS ***(Fusaroli et al., 2011).***

Under the circumstance, a series of therapeutic applications have emerged for EUS, some already established, such as drainage of a variety of extraluminal fluid collections, celiac plexus neurolysis, and other rather experimental indications ***(Kim and Telford, 2009).***

Hence, EUS is improving steadily as a result of both technical developments and the ever growing interest on behalf of GI endoscopists, who are continuously searching for novel applications ***(Cârțână et al., 2016).***

In the early 1980s, Endorectal ultrasound (ERUS) was initially introduced to clinical practice to evaluate the prostate ***(Rifkin et al., 1983).***

In 1985, Hildebrant and Feifel firstly introduced ERUS as a method to stage rectal carcinoma. Since then, it has been used in the diagnosis of various anorectal diseases and disorders. By utilizing 3-dimensional (3D) ERUS, high spatial resolution mechanically rotating endoprobe and other new techniques, it is possible to diagnose the anorectal diseases in multilane and significantly improved the imaging of anorectal diseases. Over the past three decades, ERUS has been progressively used and now considered to be an integral part of the investigation of various anorectal diseases ***(Saranovic et al., 2007).***

Technique:

Endoanal ultrasound (EAUS) of the anal sphincters is achieved by the simple expedient of replacing the balloon system used for rectal scanning with hard cone ***(Law and Bartram, 1989).*** The cylindric nature of the anal canal favors the 360◦ axial view at right angles to the lumen obtained with mechanically rotated endoprobe. The cone is filled with degassed water for acoustic coupling. Endoanal probes require the use of a latex condom that serves as a water bath in the evaluation of the anal canal and sphincter complex. Sedation is not required before the procedure. There is no need for bowel preparation before the procedure. Sometimes, when we are searching for anal fistulas a limited rectal cleaning can be performed. Probe is introduced into the rectum, aligned in standard orientation (with anterior end uppermost or 12 O'clock, 3 O'clock represent the patient's left side, 6 O'clock represents patient's posterior side and 9 O'clock represents patient's right side), and then slowly withdrawn down the anal canal until the hyperechoic puborectal muscle, used as a landmark, is seen. Images are obtained at proximal, middle and distal levels. EAUS of the anal canal can be performed with the patient in either the left lateral decubitus position with their knees bent at 90◦ or supine lithotomy position. Some image asymmetry may be induced if the patient is in a left lateral decubitus, so it is preferable to examine the patient prone ***(Stoker et al., 2001).***

Examination in the prone position is substantially superior to the left lateral position for demonstrating tears related to obstetric trauma ***(Frudinger et al., 1998).***

Endoanal scanning is performed previously with 7 MHz, nowadays with 10MHz endoluminal transducers. The improvement with 10MHz crystal relates as much to near-field focusing as higher frequency. So, the external sphincter may be more easily recognised what may influence the accuracy of EAUS in the depiction of external sphincter defects and improve the reproducibility of the technique ***(Bartram and Halligan, 2000).***

Nowadays, it is available small endoprobe, 7mm in diameter, that allow us to visualize the anatomy of the anal canal with minimal stretching or compression artefacts as compared to conventional probes resulting in better appearance of mucosa and submucosa of the anal canal ***(Saranovic et al., 2007).***

Normal EAUS anatomy of the anal canal and sphincter complex:

The normal anatomy of anal sphincters is comple but has a basic 4-layer pattern with subepithelial tissues (defined as the layer, the external cone surface, and the inner border of the internal anal sphincter [IAS]) of moderate reflectivity, the IAS of low reflectivity, the longitudinal muscle layer and external anal sphincter (EAS) of variable reflectivity ***(Stoker et al., 2002).***

The anal canal is usually divided into 3 different examination levels. The upper anal canal is identified by a hyperechoic horseshoe sling of the puborectalis muscle posteriorly and loss of the EAS in the midline anteriorly. The middle canal level is identified by the completion of the EAS ring anteriorly in combination with the maximum IAS thickness. In the middle canal, the IAS is seen as a hypoechoic ringlike structure. The EAS, which lies immediately outside the

IAS, is echogenic, less well defined, and broader than the IAS. The lower canal level is defined as that immediately caudal to the termination of the IAS and comprises the subcutaneous EAS ***(Hussain, 1998).***

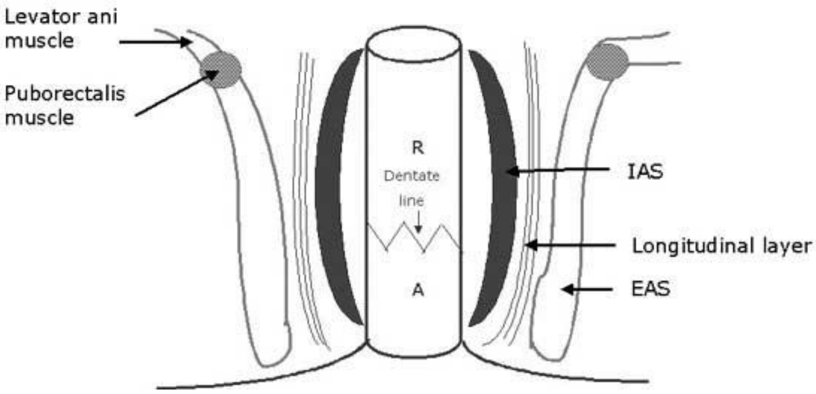
Although the sonographic values are in the same range as that of the literature, there is large difference in the means of EAS thickness between endoanal sonography and MRI, with much thicker EAS and greater variability at endoanal sonography ***(Beets-Tan et al., 2001).*** Moreover, the IAS gets slightly thicker, and the EAS gets thinner with increasing age, at least when measured with endoanal sonography and endoanal MRI. The age-related increase in the IAS size most likely is the result of connective tissue infiltration rather than true hypertrophy ***(Frudinger et al., 2002).***

The anterior morphologic characteristics of the EAS and its relationship with the urogenital diaphragm and the bulbocavernous muscle are different in men and women. In men, the anterior part of the EAS is supported by the bulbocavernous muscle anteriorly. In women, the bulbocavernous muscle is divided by the vagina into 2 halves, and there is no muscular support for the EAS in the anterior midline. Just lateral to the midline on both sides, however, this support is provided by the urogenital diaphragm, which is visible as a shieldlike muscle layer just anterior to the EAS ***(Hussain, 1998).***

The Perianal Anatomic Spaces:

The perianal anatomic spaces are important for the spread of disease in this area. The submucosal (subepithelial) space is defined as the layer between the external cone surface and the inner border of the IAS. The intersphincteric space containing the longitudinal layer, is located between the IAS and EAS. The ischioanal space, which surrounds the anal canal, is pyramid shaped. The space, located superior to the levator ani muscle is named the supralevator space ***(Hussain, 1998).***

A:



B:

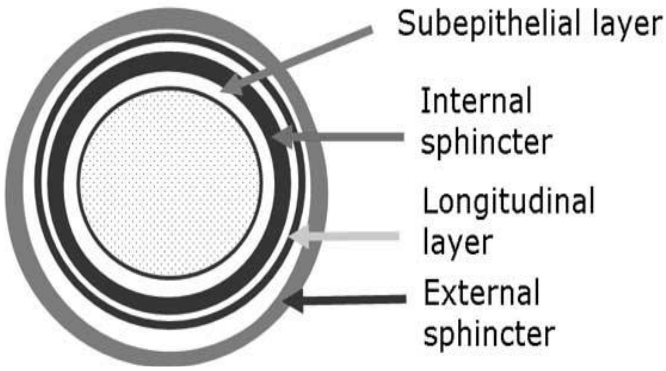
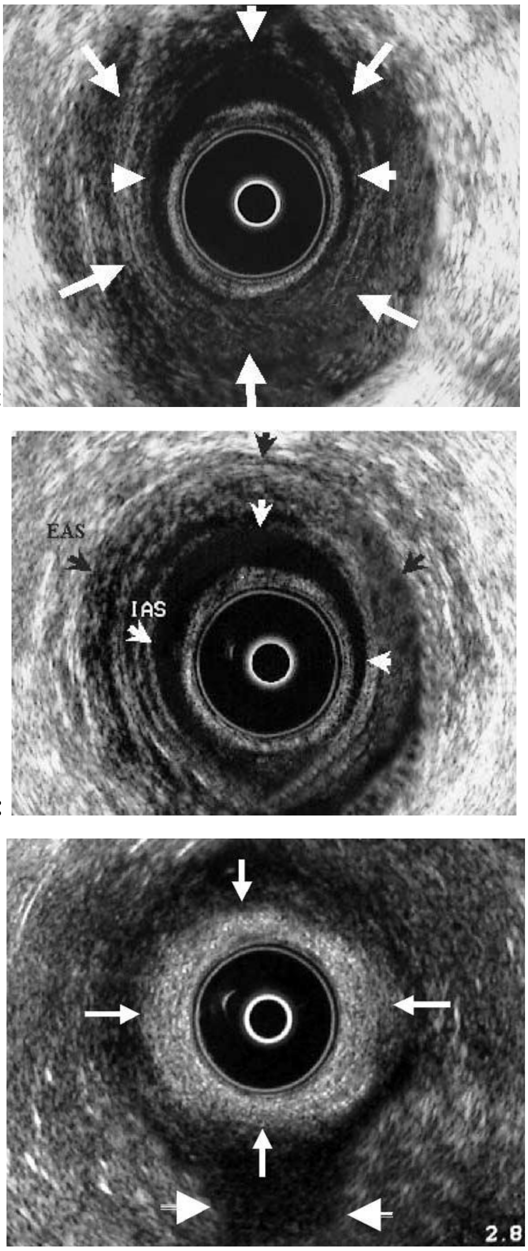


Figure (1): Diagrams of anal sphincters. Coronal (A) and axial (B) views show the IAS and EAS and the other anal canal anatomic structures ***(Engin, 2006).***

A indicates anal canal; and R, rectum.



A:

B:

C:

Figure (2): Normal endoanal sonographic appearances of anal sphincters at 3 different levels. A, Upper anal canal level, identified by the horseshoe sling of the puborectalis muscle posteriorly (arrows) and loss of the EAS in the midline anteriorly. The IAS is also shown by arrowheads. B, Middle canal level, identified by the completion of the EAS ring anteriorly (black arrows) and maximum IAS thickness (white arrows). C, Lower canal level, defined as that immediately caudal to the termination of the IAS and comprising the subcutaneous the EAS (arrows). The anococcygeal ligament is also shown posteriorly (arrowheads) ***(Engin, 2006).***

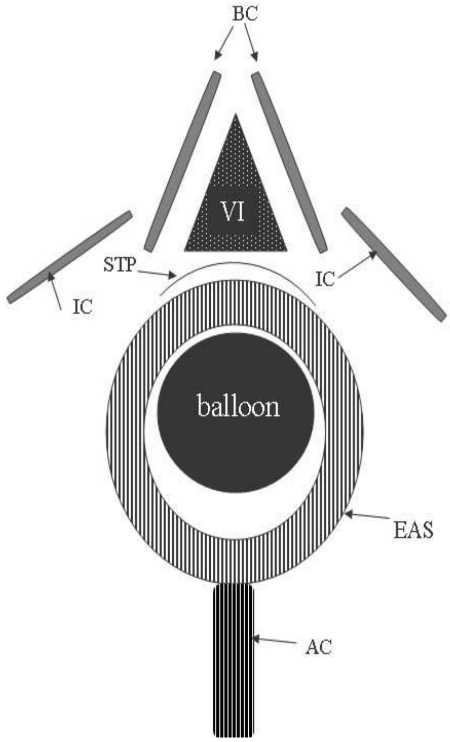


Figure (3): Anterior morphologic characteristics of the EAS and its relationship with the urogenital diaphragm and the bulbocavernous muscle in women. Diagram of the axial view of the lower edge of the anal sphincter shows the EAS, bulbocavernous muscle (BC), ischiocavernous muscle (IC), anococcygeal ligament (AC), superficial transverse perineal muscle (STP), and vaginal introitus (VI) ***(Engin, 2006).***

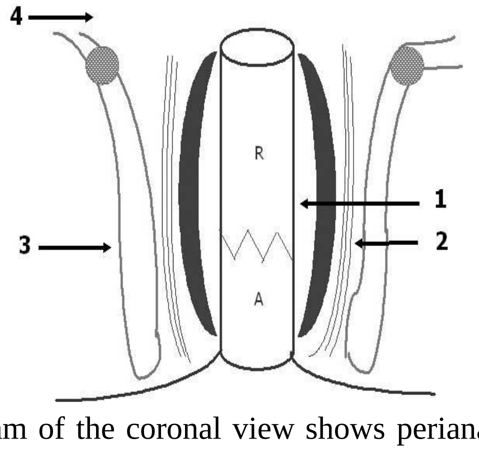


Figure (4): Diagram of the coronal view shows perianal anatomic areas. A indicates anal canal; R, rectum, 1, submucosal space; 2, intersphincteric space; 3, ischioanal space; and 4, supralevator space ***(Engin, 2006).***

Endorectal US technique

In order to improve acoustic coupling between the probe and the rectal wall, the transducer have to be covered with a small finger cot balloon filled with water for imaging of the rectal wall and surrounding structures. For imaging of the anal canal or stenotic lesions it is more convenient to use the rigid plastic cap filled with water because it prevents deformation and motor overload.

The procedure should be carefully explained to the patient together with instructions for mechanical cleansing of rectum. It is very important that the rectum is empty and clear prior to examination because residual stool can deteriorate image quality and impede interpretation. One or two small volume enemas 2 hrs prior to examination are usually effective. The patient is positioned in the left lateral position on the examining table. Digital rectal exam is very useful and should be performed routinely as a first step in ERUS imaging. It provides useful information about anatomy of the anal canal, presence of scars and stenotic lesions that could preclude insertion of the endosonic probe. Thorough digital exam can evaluate the size, location, morphology and fixation of rectal lesion. Moreover, gentle anal dilatation during the exam allows painless insertion of the probe into the rectum. In most cases, anoscopy with large bore proctoscope is performed after digital rectal exam. It allows cleansing of anal canal and rectum and suctioning of any residual stool, but more important, it allows easier passage of the endosonic probe into the rectum. The probe should be placed at least few centimeters above the upper border of the tumor to allow complete imaging of rectal tumor and surrounding tissues because the depth of tumor invasion can differ significantly in proximal and distal parts of the tumor and the lymph nodes in mesorectum are often positioned just above the level of the tumor and can be missed if complete imaging is not performed ***(Saranovic et al., 2007).***

The probe should be prepared before insertion by placing a small finger cot balloon over the transducer head and secured with metal ring. The assistant holds the probe with the balloon in the most dependent position and fills the balloon with 40–50 ml of water with the syringe attached to the spigot at the base of the metal shaft. Entrapped air in the system is then aspirated together with water via the same syringe ***(Saranovic et al., 2007).***

This procedure is repeated as long as the whole system becomes air free. It is very important because even very small residual air bubbles in the balloon can make large artifacts and prevent high-quality imaging. The probe is then lubricated with water-soluble lubricant (ultrasound gel) and inserted into the anal canal. Small lesions in distal rectum and anal canal can be simply imaged with the probe inserted blindly above the lesion, but for imaging of more proximal and bulky lesions the use of proctoscope will facilitate insertion of the probe and ensure that the probe is positioned above the rectal lesion ***(Saranovic et al., 2007).***

The probe is filled with 30–40 ml of water and activated by depressing the button on the proximal end of the probe and the image on display is observed. The volume of water in the balloon should be adjusted according to the rectal diameter ***(Saranovic et al., 2007).***

Fine adjustment of water volume can be performed during scanning until high-quality image is obtained. In most cases 50–60 ml of water in the balloon will be sufficient. The tip of the probe should be sustained all the time in the center of the rectal lumen to gain optimal images of the rectal wall and surrounding structures ***(Saranovic et al., 2007).***

By means of convention, the spigot for introducing water into the balloon should be pointed towards the ceiling while the patient is in the left lateral position. When the probe is in such position, the anterior aspect of the rectum will be presented on top of the display, posterior structures at the bottom, left sided structures are presented on the right side of the display, and right sided structures presented on the left side of the display, as for CT scans ***(Saranovic et al., 2007).***

Ideally, all five layers of the rectum should be clearly visualized circumferentially and once this is achieved the scanning starts. The probe should be slowly withdrawn while carefully observing images in the display. All critical points of the tumor and surrounding tissues together with the distance from the anal verge should be recorded. Several records from top to the bottom of the lesion should be obtained. Frequent adjustments of water volume in the balloon and location of the probe relative to the rectal wall are necessary while the probe is withdrawn in order to get high-quality images. The entire length of rectum few centimeters above and below the tumor is cautiously examined. The whole procedure is then repeated ***(Saranovic et al., 2007).***

Occasionally, more than two passes along the full length of the tumor are required to properly stage a rectal cancer. Technique with water filled balloon over the ultrasonic probe is very useful for imaging rectal cancers and mesorectum but is of limited value in staging cancers of the distal third of the rectum and anal canal. Due to the contraction of perineal muscles and decreased volume of water, troublesome slippage of the probe in and out of the anal canal is frequently encountered and the balloon is frequently distorted leading to motor overload and blockage of the probe. In these circumstances we perform imaging of anal canal with the probe covered with plastic cap filled with water. We found it very useful for imaging stenotic lesions too, because rigid plastic cap facilitates passage of transducer through stenotic lesion and there is no fear of motor overload and blockage of the probe. The main disadvantage of this technique is that images of the rectalwall and especially mesorectum (lymph nodes) are not as clear as when balloon is used because there is no possibility for adjustment of water volume and rectal wall distension. This plastic cap modification is very useful for imaging anal sphincter defects, perianal fistulas and abscesses and other pathology related to the anal canal and pelvic floor muscles ***(Saranovic et al., 2007).***

Normal ultrasound anatomy of the rectal wall and mesorectum:

When the rectal wall is optimally imaged a five-layer structure is identified. Some debate still exists as to what these layers represent anatomically ***(Hildebrandt and Fiefel, 1985)*** proposed the model with three anatomical layers while other