**ENDOSONOGRAPHY OF THE ANAL CANAL**

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Although the initial application of endoluminal ultrasonography was for the evaluation and staging of rectal cancer, it soon became apparent to clinicians that this modality had tremendous potential in the evaluation of benign disease of the anal canal and pelvic floor.1,2 This article will discuss the current role of endosonography of the anal canal, with emphasis on anatomical considerations as well as the diagnosis of anal pathology.

**INDICATIONS**

Endosonography of the anal canal is indicated for the evaluation of anal sphincter anatomy, as well as the investigation of benign and malignant disease of the anus. Indications are listed in Table 1. The most important uses of this modality is in evaluating the integrity of the anal sphincter mechanism in patients with anal incontinence, in evaluating complex and/or recurrent fistulae in ano, and for the staging and follow-up of anal canal tumors.

**TECHNIQUE**

A digital examination is essential, and complements the endoanal ultrasound examination. The probe is lubricated with a water-soluble jelly, and gently inserted into the anus. Three levels of the anal canal are imaged, and each has specific landmarks that are seen endosonographically. These three levels are: the upper anal canal, the mid-anal canal, and the distal anal canal. The transducer is advanced to the upper anal canal, which is recognized by the U-shaped puborectalis. This structure is the landmark for the upper anal canal, and it is invariably reached without full insertion of the transducer beyond the shoulders of the probe. By avoiding insertion beyond the shoulders of the probe, patient comfort is enhanced on withdrawal. Once the upper anal canal is identified and visualized, the probe is slowly withdrawn until the mid-anal canal is visualized. The mid-anal canal is distinguished by the concentric appearance of the internal and the external anal sphincters. The level at which the circular hypoechoic internal sphincter is most distinct marks the mid-anal canal. The distal anal canal is the last segment of the anal canal to be visualized. This is identified by gradually withdrawing the probe until the internal anal sphincter is no longer evident, and the fibers of the superficial external sphincter are identified. Measurements of the muscle thickness, and any defects, can be determined and recorded. The perineal body thickness in female patients can be measured by placing the examiner’s index finger into the vagina while scanning the sphincter at the mid-anal canal level. The phalanx of the finger will show up as a semi-circular hyperechoic shadow, and the distance from the luminal aspect of the internal sphincter to the ring should be most prominent. If a sphincter defect from an anterior rectal wall retraction of the divided end and bunching of the muscle opposite the disruption. A defect in the external anal sphincter results in a hypoechoic defect, although some defects may be hyperechoic or of mixed echogenicity. When a sphincter disruption is present, the ends of both muscles are widely separated, bridged by scar tissue. In the mid-anal canal, the thickness of the anterior sphincter complex can be measured in female patients by having the ultrasonographer insert an index finger into the vagina and measuring the distance between the plastic cap and the reflection of the phalanx of the examining finger. The width of the anterior sphincter can then be measured, and this is often very helpful in determining if a significant defect is present. Generally, the mid-anal canal anterior muscle thickness measures 10-15 mm, with a lower limit of around 6 mm. In some instances a complete sphincter disruption is not present, but the ultrasound image identifies a significant attenuation.

**POST-OBSTETRIC INJURY DEFECTS**

Endoanal ultrasound is the simplest and best modality for demonstrating the morphology of the anal sphincter, and can recognize defects that are responsible for unexplained incontinence. In a study by Burnett et al using anal endosonography to evaluate 62 patients suffering from incontinence, in which the only predisposing factor was obstetric trauma, it was demonstrated that 90% had defects of the external anal sphincter, 65% had defects of the internal anal sphincter, and 60% had lesions of both sphincters. Sultan et al demonstrated an occult sphincter injury rate of 30% with vaginal delivery in a study that evaluated primiparous females with ante-partum and post-partum endoanal ultrasound examination.13 Zetterstrom et al in a similar study reported a 20% frequency of occult anal sphincter injury after vaginal delivery.14 Obstetric sphincter injuries do not involve the sphincter at the level of the puborectalis, and therefore the appearance of the upper anal canal is usually normal. The ultrasonographer must be cognizant of the level of the anal canal that is being examined, because the normal appearance of the upper anal canal may be misinterpreted as a gap in the external sphincter. It is very important that the exam be interpreted at real-time endoanal ultrasound examination. Obstetric injuries to the anal canal are recognized in the mid-anal canal, where the internal anal sphincter ring should be most prominent. If a sphincter defect from an obstetric injury is present, then the internal sphincter at the mid-anal canal level will usually be discontinuous, with a gap ranging from 2-2.5 cm in width. The disrupted internal sphincter is usually bunchu up contrateral, as the fibers retract opposite to the defect. The corresponding disruption of the external sphincter appears as a discontinuous ring, which is usually hypoechoic, although it can be hyperechoic or of mixed thickness.
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TECHNIQUE

Anal endosonography is optimized by the use of the sonolucent plastic cap that covers the transducer. A small pinhole at the apex of the plastic cap allows for removal of air bubbles. Once the cap has been filled with water, and all air bubbles removed, it is ready for insertion into the anal canal. The patient is examined in the left lateral position. Prior to the endoanal ultrasound examination, careful inspection of the perianal area followed by a digital examination is essential, and complements the endoanal ultrasound examination. The probe is lubricated with a water-soluble jelly, and gently inserted into the anus. Three levels of the anal canal are imaged, and each has specific landmarks that are seen endosonographically. These three levels are: the upper anal canal, the mid-anal canal, and the distal anal canal. The transducer is advanced to the upper anal canal, which is recognized by the U-shaped puborectalis. This structure is the landmark for the upper anal canal, and it is invariably reached without full insertion of the transducer beyond the shoulders of the end of the probe. By avoiding insertion beyond the shoulders of the probe, patient comfort is enhanced on withdrawal. Once the upper anal canal is identified and visualized, the probe is slowly withdrawn until the mid-anal canal is visualized. The mid-anal canal is distinguished by the concentric appearance of the internal and the external anal sphincters. The level at which the circular hypoechoic internal sphincter is most distinct marks the mid-anal canal. The distal anal canal is the last segment of the anal canal to be visualized. This is identified by gradually withdrawing the probe until the internal anal sphincter is no longer evident, and the fibers of the superficial external sphincter are identified. Measurements of the muscle thickness, and any defects, can be determined and recorded. The perineal body thickness in female patients can be measured by placing the examiner's index finger into the vagina while scanning the sphincter at the mid-anal canal level. The phalanx of the finger will show up as a semi-circular hyperechoic shadow, and the distance from the luminal aspect of the internal sphincter to the digital reflection on the scanner represents the perineal body thickness. This can be measured and recorded.

ULTRASOUND ANATOMY OF THE ANAL CANAL

Endoanal ultrasonography very nicely demonstrates the normal anal canal. The upper anal canal with the puborectalis serves as a reference point for the examination. The puborectalis is a horseshoe-shaped, mixed echogenicity structure. The upper portion of the internal sphincter can usually be seen in the upper anal canal, but can be variable. It is seen as a densely hyperechoic ring inside the puborectalis. At the level of the mid-anal canal, the internal sphincter defines this level, as the internal sphincter is seen as a prominent, circular, hypoechogenic structure. The internal sphincter is black, hypoechogenic, ring, approximately 2-4 mm in thickness. The high water content of the internal sphincter is the reason why it appears hypoechogenic. Between the transducer and the internal sphincter is a hyperechoic ring, which represents the subepithelial tissues, including the submucosa and hemorrhoidal plexus. The external sphincter is a broad, mixed echogenicity, cylindrical band, approximately 5-8 mm in thickness. The striations of the muscle fibers can be seen, particularly with higher frequency transducers. The thickness of the total anal sphincter mechanism anteriorly measures 10-15 mm in females. In some instances the longitudinal muscle can be visualized as a thin, hyperechoic band surrounded by a thin, hypoechogenic band between the internal and the external sphincter. In the distal anal canal the internal sphincter no longer visible as the probe extends distal to the intersphincteric groove. The external sphincter can still be seen as a mixed echogenicity structure, which is elliptical in shape, with the anterior and posterior raphae giving this appearance.

ANAL SPHINCTER MAPPING

Endoanal ultrasonography has replaced concentric needle electromyography as the procedure of choice for sphincter mapping. Reliable mapping with minimal patient discomfort is the major reason for this transition. Identifying a sphincter defect by physical examination is often difficult. Endoanal ultrasonography is emerging as the method of choice for identifying sphincter defects. This modality can define the anatomy of the anal canal, and can delineate and distinguish both the internal and the external anal sphincter. For this reason, anal ultrasonography has emerged as a significant modality for the evaluation of the patient with fecal incontinence. No correlation exists between the internal anal sphincter thickness and gender, body weight or height. However, it has been shown that increased thickness occurs with advancing age. Sphincter defects are recognized by the identification of discontinuity in the ring structure. This is most easily identified when a gap is seen in the internal anal sphincter. This is often associated with thickening of the internal sphincter opposite the defect, from retraction of the divided end and bunching of the muscle opposite the disruption. A defect in the external anal sphincter results in a hypoechogenic defect, although some defects may be hyperechogenic or of mixed echogenicity. When a sphincter disruption is present, the ends of both muscles are widely separated, bridged by scar tissue. In the mid-anal canal, the thickness of the anterior sphincter complex can be measured in female patients by having the ultrasonographer insert an index finger into the vagina and measuring the distance between the plastic cap and the reflection of the phalanx of the examining finger. The width of the anterior sphincter can then be measured, and this is often very helpful in determining if a significant defect is present. Generally, the mid-anal canal anterior muscle thickness measures 10-15 mm, with a lower limit of around 6 mm. In some instances a complete sphincter disruption is not present, but the ultrasound image identifies a significant attenuation.

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Associated with a coexisting occult sphincter defect. In patients with satisfactory performed lateral internal sphincterotomy is often reported that troublesome fecal incontinence after ultrasound operative incontinence. The resultant internal sphincter defect results. The endoanal ultrasound exam can help in determining the location of the pull-through in relation to the anal sphincter. The anal sphincter anatomy in these patients is usually markedly abnormal, with congenital absence of any discernible internal sphincter muscle being the most consistent finding.

**CO RELATION OF EN DO ANAL U LTR ASO NOGRAPHY WITH SURGICAL FINDINGS**

The accuracy of endoanal ultrasonography in detecting sphincter defects is evaluated by comparison of ultrason sound findings and the findings of the status of the anal sphincter muscles at the time of surgical dissection. Deen et al correlated the findings at surgery with preoperative endoanal ultrasound examination in 44 incompetent patients, and reported that all sonographically identified external sphincter defects were confirmed at surgery, and that 21 of 22 internal sphincter defects were correctly identified.12 Sultan et al confirmed corresponding defects at the time of surgery with preoperative ultrasound scans in 12 consecutive patients operated on for anorectal incontinence.13

**POST ANORECTAL SURGERY**

Some patients who undergo anorectal surgery experience post-operative anorectal incontinence. In many instances, this will resolve spontaneously, but in some patients a long-term disability results. The endoanal ultrasound exam can help in determining if an anatomic injury is present. For example, in patients undergoing anal dilatation for treatment of anal fissure, the ultrasound image following this treatment often demonstrates a disrupted internal anal sphincter with fragmentation of the hypoechoic ring.11 The extent of an internal sphincterotomy for the treatment of anal fissure may explain some instances of post-operative incontinence. The resultant internal sphincter defect can be evaluated post-operatively, in patients suffering from incontinence, with the use of endoanal ultrasonography to measure the extent of the defect. A study by Tjandra et al using endoanal ultrasound11 reported that troublesome fecal incontinence after a satisfactorily performed lateral internal sphincterotomy is often associated with a coexisting occult sphincter defect. In patients undergoing fistulotomy for anal fistula, the endoanal ultrasound exam can help determine the extent of the muscle defect in patients with post-operative incontinence.

**CONGENITAL ABNORMALITIES**

Patients who have undergone surgery for imperforate anus frequently have residual problems with anal incontinence on a lifetime basis. Endoanal ultrasonography can help determine the location of the pull-through in relation to the anal sphincter. This is particularly true of its role in evaluation of anorectal septic disorders.

**FISTULA IN ANO**

Endoanal ultrasonography for fistula in ano should include examination of the anal canal, as well as scanning of the distal rectum to identify high blind tracts. For rectal imaging, a water-filled balloon covering the transducer is used, while optimal imaging of the anal canal is achieved with the plastic cap covering the transducer, which is filled with water. A careful digital anorectal examination complements the ultrasound exam. The exam is begun with imaging of the rectum and surrounding structures looking specifically for any suprapravelator extensions. Following this the balloon covering the transducer is replaced with the plastic cap and a sequential exam, beginning in the upper anal canal, with gradual withdrawal to include the mid- and distal anal canal.14 is then performed, looking carefully for criteria that identify the internal opening, and for fistula tracts in their relationship to the muscles and surrounding areas. Horseshoe extensions can be appreciated, and the relationship to the levator muscles can be delineated by evaluation of both the rectal imaging and anal imaging.

Several studies have reported the experience with endoanal ultrasonography in the evaluation of fistula in ano and perianal sepsis.15,20,21,22 Deen et al reported on 21 consecutive patients with complex fistulae in ano, who underwent anal endosonography.11 In all patients, all fistula tracts and fluid collections were correctly identified when compared to findings at surgery. They used the criteria of a break in the hypoechoic muscularis, a lone criteria for localizing the internal opening, and found that this could be accomplished using this criteria in only 10% of the patients. The St. Marks Group reported a 66% success rate in identification of the internal opening, using criteria described by Choen et al that included a hypoechoic gap in the subepithelial area, a defect in the internal anal sphincter, and a hypoechoic area in the intersphincteric space.13 Williams reported that the accuracy of identifying the internal opening was 80% using these criteria.23 Cho et al further defined the criteria for identifying the internal opening with endoanal ultrasonography, and reported a sensitivity of 94%, specificity of 87% and positive predictive value of 81% using a combination of three criteria. The use of hydrogen peroxide for delineating fistula tracts was described by Cheong and Nogueiras et al.1 A dilute solution of hydrogen peroxide is very gently injected into the external opening by means of a small plastic intravenous cannula. This gas-releasing fluid shows as a brightly hypoechoic image on the sonogram. Ratto et al reported that hydrogen peroxide enhanced endoanal ultrasound yielded higher accuracy than clinical exam or standard anal ultrasonography for transsphincteric tracts, intersphincteric tracts and horseshoe extensions.

Endoanal ultrasonography is proving to be a very useful modality for a wide range of benign disorders in colorectal surgery. This is particularly true of its role in evaluation of anorectal septic disorders. EVALUATION OF ANAL NEOPLASMS

The ability of endoanal ultrasonography to accurately define the anal sphincter anatomy makes its use for assessment of anal neoplasms very reliable. Benign neoplasms such as lipomas and leiomyomas can be demonstrated, along with their relationship to structures of the anal canal.

Malignant lesions of the anal canal can be staged with endoanal ultrasonography prior to treatment, and very useful prognostic information can be gained. This is particularly true of staging and follow-up of squamous cell carcinoma of the anal canal.24,20,30,31 The TNM (UICC) staging system for anal squamous cell carcinoma is partly based on tumor size. Use of endoanal ultrasonography and the ability to accurately measure the diameter of the tumor lends itself well to accurate staging of anal canal neoplasms. In addition, the extent to which these tumors invade the anal sphincter muscles can be determined. The anal canal is examined with the plastic cap over the transducer to evaluate the primary lesion, and the mid- and distal rectum is evaluated using the water-filled balloon covering the transducer to scan the perirectal tissues for metastatic lymph nodes. Most squamous cell carcinomas of the anal canal are treated with chemoradiation as primary therapy, with surgical resection reserved for chemoradiation failures. Endorectal ultrasonography is very advantageous for the follow-up of anal canal cancer following chemoradiation therapy, as it can identify or exclude persistent or recurrent disease.

Needle core biopsies under ultrasound guidance can be obtained if persistent masses or abnormalities are identified following treatment. CONCLUSION

Endoanal ultrasonography has been demonstrated to provide significant advantages in the evaluation of anatomic and pathologic conditions of the anal canal. Expertise in the use of endoanal ultrasonography can be achieved by surgeons who are interested in the diagnosis and management of anal disease, and who are willing to devote a modest investment of time to ascending the learning curve.

**FIGURE 1.** Indications for Endoanal Ultrasoundography

1. Delineation of anal sphincter anatomy
2. Evaluation of anal incontinence
3. Evaluation of complex >r recurrent anal fistula
4. Evaluation of occult perianal sepsis


**Major Perianal Trauma**

Major trauma to the perineum may result in significant injury to the anal sphincter mechanism. Complex injuries often necessitate fecal diversion, as well as sphincter debridement and repair. Once the perineum is healed, the patient can be evaluated for anal sphincter integrity with the use of endoanal ultrasound, and other physiologic modalities such as manometry and EMG pudendal nerve latencies. The endoanal ultrasound is the most useful tool in visualizing the remaining anatomy, and can help make a determination as to whether stoma closure is appropriate, if the patient is diverted.

**Post and Rectal Surgery**

Some patients who undergo anorectal surgery experience postoperative anal incontinence. In many instances, this will resolve spontaneously, but in a small percentage of patients a long-term disability results. The endoanal ultrasound can help in determining if an anatomic injury is present. For example, in patients undergoing anal dilatation for treatment of anal fissure, the ultrasound image following this treatment often demonstrates a hypoechoic ring. In patients who have undergone surgery for imperforate anus undergoing fistulotomy for anal fistula, the endoanal ultrasound can be used to confirm or exclude a coexisting occult sphincter defect. In patients undergoing anal dilatation for treatment of anorectal sepsis/fistula, the endoanal ultrasound can help in determining if an anatomic injury is present. For example, in patients undergoing anal dilatation for treatment of anal fissure, the ultrasound image following this treatment often demonstrates a hypoechoic ring. In patients who have undergone surgery for imperforate anus undergoing fistulotomy for anal fistula, the endoanal ultrasound can be used to confirm or exclude a coexisting occult sphincter defect. In patients undergoing anal dilatation for treatment of anorectal sepsis/fistula, the endoanal ultrasound can help in determining if an anatomic injury is present. For example, in patients undergoing anal dilatation for treatment of anal fissure, the ultrasound image following this treatment often demonstrates a hypoechoic ring. In patients who have undergone surgery for imperforate anus undergoing fistulotomy for anal fistula, the endoanal ultrasound can be used to confirm or exclude a coexisting occult sphincter defect.

**Evaluation of perianal sepsis/fistula**

Most perianal abscesses are apparent on clinical examination, and require only proper recognition and prompt drainage. Occasionally, however, the presence of an abscess is strongly suspected but not clinically evident on physical examination. Under these circumstances, endosonographic findings correlated with clinical outcome.

**Endoanal ultrasonography**

Endoanal ultrasonography can help determine the location of the pull-through in relation to the anal sphincter. The anal sphincter anatomy in these patients is usually markedly abnormal, with congenital absence of any discernible internal sphincter muscle being the most consistent finding.

**Correlation of endoanal ultrasonography with surgical findings**

The accuracy of endoanal ultrasonography in detecting sphincter defects is evaluated by comparison of ultrasonound findings and the findings of the status of the anal sphincter musculature at the time of surgical dissection. Deen et al correlated the findings at surgery with preoperative endoanal ultrasound examination in 44 incontinent patients, and reported that all sonographically identified external sphincter defects were confirmed at surgery, and that 21 of 22 internal sphincter defects were correctly identified. Sultan et al confirmed corresponding defects at the time of surgery with preoperative ultrasound scans in 12 consecutive patients operated on for anal incontinence. Bachmann Nielsen et al reported on the value of post-operative assessment of sphincter repair by endoanal ultrasonography, and documented persistent defects in four of five patients who experienced postoperative incontinence despite repair. Savoye-Collet et al reported a study using postoperative endoanal ultrasonography of the external anal sphincter in which specific endosonographic findings correlated with clinical outcome.

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Needle core biopsies under ultrasound guidance can be obtained if persistent masses or abnormalities are identified following treatment.

**Conclusion**

Endoanal ultrasonography has been demonstrated to provide significant advantages in the evaluation of anatomic and pathologic conditions of the anal canal. Expertise in the use of endoanal ultrasonography can be achieved by surgeons who are interested in the diagnosis and management of anal disease, and who are willing to devote a modest investment of time to ascend the learning curve.
5. Evaluation of anal pain  
6. Pre treatment staging of anal cancer  
7. Follow up surveillance of anal cancer

REFERENCES


Surgery for Complex Anal Fistulae

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1. Complex anal fistulae can be defined as those with tracks extending above the level of the dentate line (mid-anal canal), multiple tracks, anovaginal fistulae and fistulae associated with Crohn's disease. The Parks Classification relates the type of fistula to the external anal sphincter/puborectalis complex and is divided into Inter-sphincteric, Trans-sphincteric, Supra-sphincteric and Extra-sphincteric. Understanding of the fistula anatomy and anal gland origin theory is critical in the management of complex fistulae. With complex or recurrent anal fistulae, coloscopy is indicated to exclude Inflammatory Bowel Disease. Imaging of the anal canal includes ultrasound, MRI and a fistulogram and examination under anaesthesia is usually required to adequately document the extent of the fistula. Adequate examination will include bidigital palpation and inspection using a suitable retractor, headlight, probe directors and lacrimal probes. Methylene blue and hydrogen peroxide are of limited use.

The Principles in Management include addressing the internal opening and anal gland of origin, preservation of the external anal sphincter and drainage of the external component. The primary track is then treated either by Seton drainage or flap obliteration of the track through the external anal sphincter/puborectalis complex. Sometimes the internal origin is not obvious but in this situation, the fistula is first explored via the ischiorectal fossa as this will create a supra-sphincteric fistula. For Trans-sphincteric Fistulae in the middle or upper aspect of the anal canal, the internal opening and the underlying internal sphincter should first be excised and the track through the EAS curetted. After laying open the external component, the track through the EAS is usually sutured and a rectal or anocutaneous flap advanced to cover the EAS opening on the anal side. Temporary seton drainage of a high cavity may be necessary prior to the definitive procedure.

In the uncommon Supra-sphincteric Fistula, a similar approach is used with the development of a rectal advancement flap. In this situation, it is usually helpful to pass a mushroom catheter via the ischiorectal fossa through the anal canal.