ANNALS OF SURGERY
Vol. 218, No. 2, 201–205

Anal Sphincter Defects

Correlation Between Endoanal Ultrasound and Surgery

K. I. Deen, F.R.C.S., D. Kumar, F.R.C.S., Ph.D., J. G. Williams, M.Ch., F.R.C.S., J. Olliff, M.R.C.P., F.R.C.R.,* and M. R. B. Keighley, M.S., F.R.C.S.

From the Departments of Surgery and Radiology, Queen Elizabeth Hospital Edgbaston, Birmingham, United Kingdom*

Objective
This study was performed to (1) correlate anal sphincter defects, identified by endoanal ultrasound with operative findings, and (2) define the appearance of such sphincter defects as seen at operation.

Summary Background Data
Endoanal ultrasonography is a minimally invasive method of imaging the anal sphincter complex and enables identification of anal sphincter defects. Little is known about the accuracy and limitations of endoanal ultrasound in identifying such defects. Furthermore, there are no data about the appearances of these endosonic sphincter defects as seen at operation.

Methods
Forty-four patients (40 women; age range, 26 to 80 years; mean age, 56 years) with fecal incontinence, undergoing pelvic floor repair, were investigated by endoanal ultrasound before operation. Endosonic findings were correlated with the appearances of external anal sphincter, internal anal sphincter, and intersphincteric space, at operation. Diagnosis of the site and type of defect was made by macroscopic appearances. Uncertainty about the type of sphincter defect was resolved by obtaining muscle biopsies for histology.

Results
All external sphincter defects seen by endoanal ultrasound (n = 23) were confirmed at operation. Twenty-one of 22 internal sphincter defects identified by endosonography also were confirmed at operation. In ten patients with a neuropathic anal sphincter complex, the morphology was normal on endosonography, and this was confirmed at operation. (Sensitivity and specificity of 100% for external anal sphincter; 100% and 95.5%, respectively, for internal anal sphincter)

Conclusions
These data show that endoanal ultrasound is an accurate method of identifying anal sphincter defects.

Conventional assessment of the anorectal sphincter complex has been by electromyography and manometry.[1,2] Although these techniques provide an estimate of sphincter weakness and neuromyopathy, very little information on sphincter morphology is obtained. Furthermore, accurate localization of weak areas of the

Table 1. SITE OF SPHINCTER DEFECTS

	Anterior	Posterior	Lateral
External sphincter	18	4	1
Internal sphincter	15	7	—

sphincter complex is difficult even with electromyographic sphincter mapping. Electromyography is invasive, painful, and time consuming, and is a potential source of subcutaneous infection.

More recently, endoanal ultrasound (EAU) has proven to be of value in identifying such defects of the external anal sphincters, comparing well with electromyography.[3,4]

Little is known about the accuracy of anal ultrasound in identifying internal sphincter defects. Also, there is a lack of knowledge on the macroscopic appearances of external and internal anal sphincter defects identified by EAU. The aim of this study therefore was to correlate defects of the anorectal sphincter complex identified by endosonography with operative findings and to define the nature of such injuries.

PATIENTS AND METHODS

Forty-four patients (40 women and 4 men) whose ages ranged from 26 to 80 years (median age, 56 years) were studied by EAU as a part of routine preoperative anorectal assessment. Indications for surgery were postobstetric fecal incontinence (n = 35) and rectal prolapse in association with fecal incontinence (n = 5). Iatrogenic injury to the sphincters was responsible for fecal incontinence in three patients, whereas the cause of sphincter damage in one patient was unclear. Anal manometry using a closed water-filled balloon showed a median resting pressure of 75 cm H_2O (range, 20 to 160 cm H_2O) and a median squeeze pressure of 120.5 cm H_2O (range, 30 to 280 cm H_2O).

All patients underwent surgical exploration of the anorectal sphincters before sphincter/pelvic floor reconstruction.

Supported by the Medical Research Council (K.I.D.).

Address reprint requests to D. Kumar, F.R.C.S., Ph.D., Consultant Senior Lecturer, Department of Surgery, Queen Elizabeth Hospital, Edgbaston, Birmingham B15 2TH, United Kingdom.

Accepted for publication November 6, 1992.

ENDOANAL ULTRASOUND

Endoanal ultrasound was performed in the left lateral position with a type 1847 Bruel and Kjaer ultrasound scanner (Bruel and Kjaer, Harrow, UK) and 7 MHz rotary probe (type 1850). The transducer was enclosed within a water-filled sonolucent cone, 1.7 cm in diameter, which was in turn covered by an ultrasonic gel-filled condom. This arrangement enabled repeated examinations without the need for probe sterilization except in high-risk situations such as hepatitis B and human immunodeficiency virus. Assessments were performed at upper, mid, and lower anal canal levels as previously described.[4] Endoanal ultrasound was performed within 1 month before surgery in all cases. A defect in the external anal sphincter was identified as a wedge-shaped loss of normal sphincter muscle that was either hypoechogenic or hyperechogenic relative to the rest of the muscle. An internal sphincter defect was identified as a loss of continuity in the hypoechoic ring representing the muscle. The diagnosis of a sphincter defect based on endosonography was made only if the defect was seen at two or more levels of the anal canal.

SURGICAL EXPLORATION

Surgical exploration was performed in the lithotomy or jacknife position under general or spinal anesthesia, with the urinary bladder catheterized and the perineum prepared and draped. A perianal skin incision was made anterior or posterior to the anal margin, depending on the type of procedure.[5,6] The intersphincteric plane between internal and external anal sphincter was routinely identified. Internal anal sphincter muscle was seen as a pale white layer beneath anal canal mucosa within the external anal sphincter. In contrast, external sphincter muscle was identified at operation by its reddish appearance. When macroscopic distinction between the two muscles was not clear, muscle biopsies were obtained for histologic evaluation. The specimens were fixed and

Table 2. CORRELATION BETWEEN SURGERY AND ENDOSONOGRAPHY

	Defects*	Normal	Sensitivity	Specificity
External sphincter	23/23	10/10	100%	100%
Internal sphincter	21/22	10/10	100%	95.5%

* An endosonic defect was seen at two or more levels of anal canal being scanned.

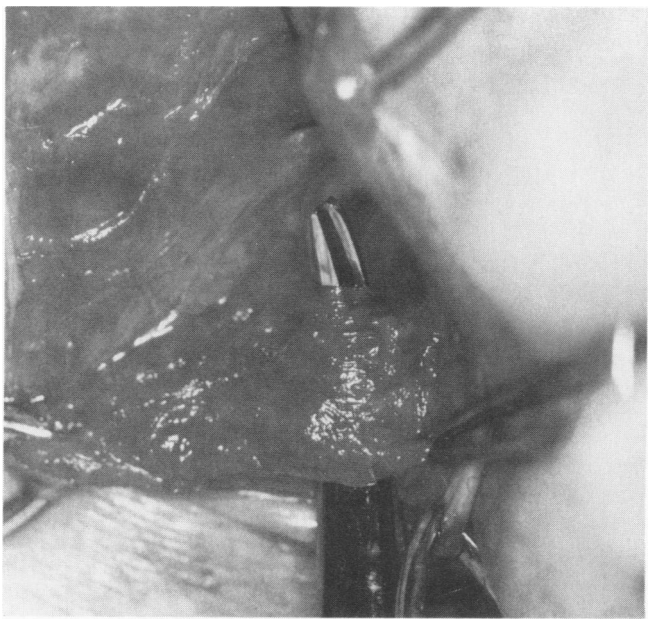

Figure 1. Morphologically normal subcutaneous component of external anal sphincter. The pair of scissors is seen underlying the ring of red muscle.

stained with hematoxylin and eosin before light microscopy.

STATISTICS

The significance of EAU and operative findings was performed on a test of proportions. A test of sensitivity and specificity of the predictive value of EAU also was performed.

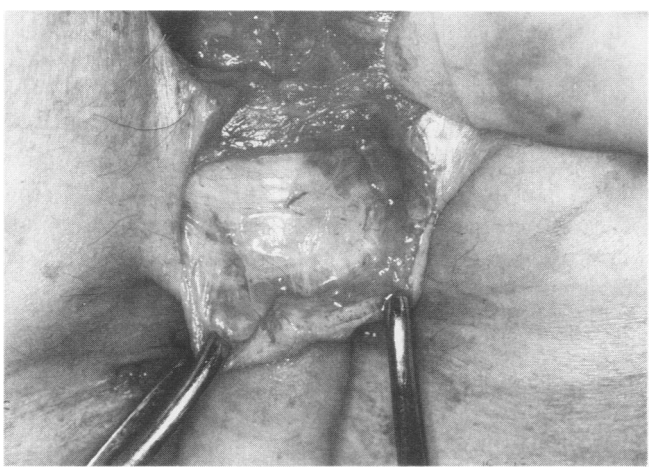

Figure 2. Normal internal anal sphincter muscle. External anal sphincter is seen as a band of red muscle at the upper margin of internal sphincter separated from it by the intersphincteric groove.

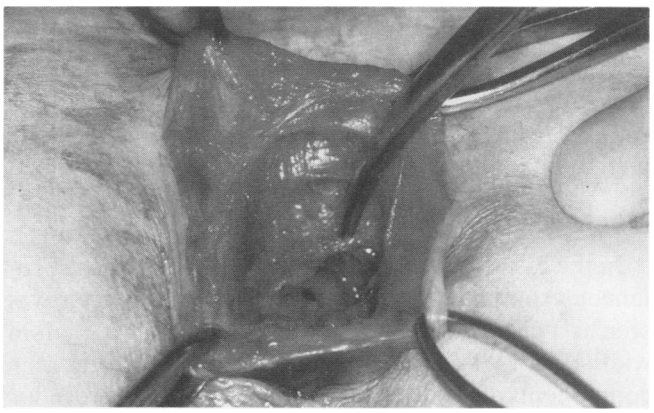

Figure 3. Attenuated external anal sphincter muscle. The tip of the scissors is seen protruding through a thin area of scar tissue.

ETHICAL CONSIDERATIONS

Permission to obtain biopsies of the anal sphincters was granted by the Ethical committee of the South Birmingham Health Authority.

RESULTS

Endosonic Defects

Endoanal ultrasound detected 23 external anal sphincter defects and 21 internal anal sphincter defects. Combined external and internal defects were encountered in 11 cases. The puborectalis was identified as being abnormal by endosonography in two cases. Eighteen external sphincter defects were anterior, four were posterior defects, and one was a left lateral defect. In the case of internal sphincter defects, 15 were anterior and 7 posterior (Table 1). All 23 external anal sphincter defects and 20 internal anal sphincter defects were confirmed at operation ($p < 0.001$) (100% sensitive and specific for EAS and 100% sensitive/95.5% specific for IAS [Table 2]). An endosonic IAS defect was found to be incorrect at the time of surgery. Accurate confirmation of the puborectalis muscle defect as identified on ultrasound was not possible. This was because full mobilization of this muscle was not performed at the time of surgery. In two instances, where an endosonic internal sphincter defect was identified, the presence of scar tissue made distinguishing between external and internal sphincter difficult at operation. Tissue biopsies of the muscle present in this area showed striated muscle, only helping to confirm the endosonic findings.

Normal Endosonography

In the case of 10 patients who underwent pelvic floor repair for neuropathic faecal incontinence without a sphincter defect on endosonography, the sphincters were seen to be intact at operation.

Macroscopic Appearances

In the case of normal sphincter complexes, the subcutaneous component of the external anal sphincter was seen as a distinct ring of red muscle about 1 to 1.5 cm in width (Fig. 1). This lay caudal to the superficial and deep components of external anal sphincter, which were indistinguishable from one another. Anteriorly, contributions of the external anal sphincter toward the perineal body were seen as distinct bands. The internal anal sphincter was seen as a pale layer of muscle separated from the external anal sphincter by the intersphincteric groove (Fig. 2).

A complete disconnection of muscle edges, as suggested by endosonic images, was not seen at operation. Instead, defects in the external sphincter complex were identified as bands of fibrous tissue linking the healthy edges of muscle together. At other times, especially where EAU showed a gap in the external sphincter at rest but appeared to completely encircle the anal canal on squeezing, the sphincter at surgery appeared extremely attenuated (Fig. 3).

Internal anal sphincter defects were seen as areas of scarring or complete absence of sphincter muscle. The latter appearance was so when the defect occupied more than 180 degrees of the circumference.

In the case of combined external and internal sphincter defects (Fig. 4), the intersphincteric plane became obliterated and identification of muscle groups was made possible by dissecting laterally to meet virgin territory where the intersphincteric space was once more recognizable.

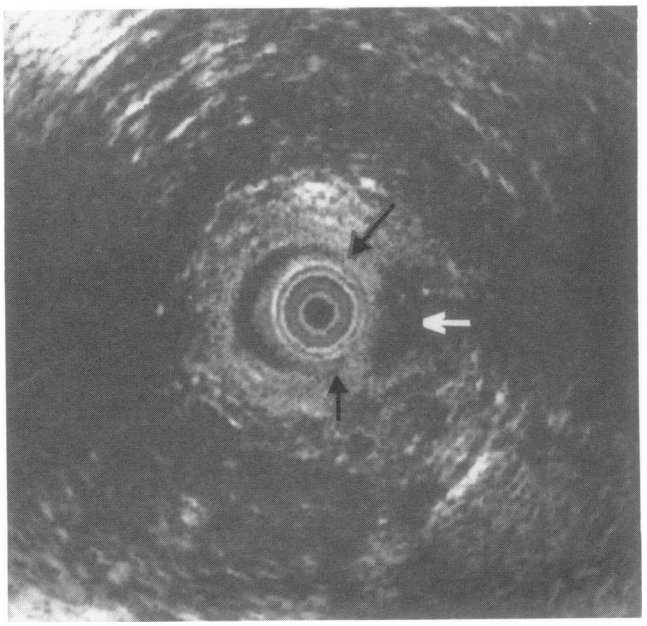

Figure 4. Combined anterior external (white arrow) and internal (black arrows) sphincter defects seen at endosonography. The orientation of the image is as seen when scanning in the left lateral position.

DISCUSSION

Endoanal ultrasound has been established as being accurate in locating defects of the external sphincter complex by correlating well with electromyographic mapping.[2] No literature describes its accuracy in detecting internal anal sphincter defects as well as macroscopic appearances of damaged sphincters seen on endosonography, however. This study confirms the accuracy of EAU in detecting both external as well as internal sphincter defects.

The appearances we have described were in patients who had sustained sphincter injury many months before assessment by anal ultrasound and surgical treatment. We should therefore expect to find areas of fibrosis in tissue that has undergone the process of repair. We have experience neither with endosonic nor with operative findings of more recent sphincter injuries. One would believe that operative findings would match EAU findings more closely if sphincter repair was performed shortly after sphincter damage.

Digital assessment of anal sphincter defects could only locate obvious gaps in the external anal sphincter. The accuracy of such an assessment is highly dependent on the experience of the clinician. Furthermore, accurate localization of deep external sphincter defects, areas of sphincter weakness, and internal anal sphincter defects are out of the reach of a digital examination.

In view of the high sensitivity and specificity of EAU in diagnosing sphincter defects, it would now appear that electromyographic mapping would take second place to EAU in identifying such abnormalities. However, electromyography is useful in supplementing EAU in situations in which a degree of uncertainty exists, such as in posterior external anal sphincter injury where an echopoor area could also represent reflections from the anococcygeal raphe. Yet another situation in which EMG would be complementary is during the learning phase of EAU. The learning curve associated with EAU is relatively short, and misdiagnoses most likely will be made during this period, as we found out during the early part of the study. Ideal methods of learning EAU would be to study patients with known sphincteric defects, such as those after internal sphincterotomy. In our experience, an accurate diagnosis of sphincter defects can be made only if the defect is seen at two or more levels of the anal

canal during endosonography. This is because the external anal sphincter is often seen as an incomplete ring anteriorly in the upper anal canal, and in the lower anal canal the internal anal sphincter often has variable caudal extensions, giving the impression of a defect in this muscle.

This study has shown conclusively that features of EAU correlate well with operative findings of external and internal anal sphincter defects. Endoanal ultrasonography, in being quick and well tolerated by the patient, is thus the investigation of choice in mapping defects of the anorectal sphincter complex.

Acknowledgments

The authors thank Mrs. C. Hail for her photographic assistance and Miss C. Billingham for statistical advice.

References

1. Swash M, Snooks SJ. Electromyography in pelvic floor disorders. *In* Henry MM, Swash M, eds. Coloproctology and the Pelvic Floor. London: Butterworths, 1985, pp 88–104.
2. Law PJ, Kamm MA, Bartram CI. A comparison between electromyography and anal endosonography in mapping external anal sphincter defects. Dis Colon Rectum 1990; 33:370–373.
3. Burnett SJD, Speakman CTM, Kamm MA, Bartram CI. Confirmation of endosonographic detection of external anal sphincter defects by simultaneous electromyographic mapping. Br J Surg 1991; 78:448–450.
4. Law PJ, Bartram CI. Anal endosonography: technique and normal anatomy. Gastrointest Radiol 1989; 14:349–353.
5. Keighley MRB, Fielding JWL. Management of faecal incontinence and results of surgical treatment. Br J Surg 1983; 70:463–468.
6. Miller R, Orrom WJ, Cornes H, et al. Anterior sphincter plication and levatorplasty in the treatment of faecal incontinence. Br J Surg 1989; 76:1058–1060.