Anal Endosonography: Relationship with Anal Manometry and Neurophysiologic Tests

R. J. F. Felt-Bersma, M.D., Ph.D.,*† M. A. Cuesta, M.D., Ph.D.,*
M. Koorevaar, B.S.,† R. L. M. Strijers, M.D.,‡
S. G. M. Meuwissen, M.D., Ph.D.,† E. J. Dercksen, M.D.,*
R. I. C. Wesdorp, M.D., Ph.D.*

*From the Departments of *Surgery, †Gastroenterology, and ‡Neurophysiology, Free University Hospital, Amsterdam, The Netherlands*

Thirty-seven patients were referred for evaluation of anal function; their clinical diagnoses were traumatic fecal incontinence (13), idiopathic (pudendal neuropathy) fecal incontinence (7), fecal soiling (9), and other (8). In all patients, anal endosonography (sphincter defects and internal sphincter thickness [IST]) and anal manometry (maximal basal pressure [MBP] and maximal squeeze pressure [MSP]) were performed. In 18 patients, neurophysiologic tests (EMG-maximal contraction pattern [MCP], single-fiber EMG [fiber density; FD], and pudendal nerve terminal motor latency [PNTML]) were also performed. Endosonography demonstrated in seven patients both an internal and external sphincter defect (Group 1), in seven patients an internal sphincter defect and in one patient an external sphincter defect (Group 2), and in 22 patients no sphincter defect (Group 3). There was a significant difference among these three groups for MBP and MCP, the lowest being in Group 1. Between the patients with traumatic fecal incontinence and idiopathic fecal incontinence, no differences in IST, MBP, MSP, MCP, FD, and PNTML were found. In two patients with a suspected obstetric trauma, there was an unexpected additional severe pudendal neuropathy. In one patient with a suspected obstetric trauma, no damage of the anal sphincters could be demonstrated. In one patient with suspected idiopathic fecal incontinence, there was an additional, unsuspected defect of the internal sphincter. There was concordance between endosonography and EMG in the mapping of the external sphincter. Clinical diagnoses can be misleading in differentiating between traumatic and idiopathic fecal incontinence; anal endosonography provides unsuspected and additional information about the sphincters; PNTML can reveal unsuspected neuropathy in traumatic fecal incontinence. Therefore, the combination of endosonography and PNTML is promising in selecting patients for surgery. [Key words: Anal sphincters; Anal endosonography; Anal manometry; Anal electromyography]

Felt-Bersma RJF, Cuesta MA, Koorevaar M, Strijers RLM, Meuwissen SGM, Dercksen EJ, Wesdorp RIC. Anal endosonography: relationship with anal manometry and neurophysiologic tests. Dis Colon Rectum 1992;35: 944–949.

Address reprint requests to Dr. Felt-Bersma: Free University Hospital, Department of Gastroenterology, P.O. Box 7057, 1007 MB Amsterdam, The Netherlands.

Anal endosonography is the latest technique added to the arsenal of anorectal function investigations. It can provide clear images of the internal and external anal sphincters and the adjacent structures.[1-10] Thickness of the internal anal sphincter can be measured,[1,7] and nonsuspected defects of the sphincters can be seen in both incontinent patients[9,10] and continent controls.[9] Fistulas can sometimes be visualized,[2,4,6] and confirmation of endosonographic detection of external anal sphincter defects by electromyographic mapping is reported.[3,5]

To assess the value of endosonography in anorectal function investigations, the relationship among anal endosonography, anal manometry, and neurophysiologic tests was investigated.

PATIENTS AND METHODS

Thirty-seven patients (9 men and 28 women; mean age, 51 ± 14 years; range, 18–76 years) were referred for anorectal function investigations. Their medical history was taken, inspection of the anus and perineum was performed, and the sphincters and pelvic floor were palpated. In all patients, endosonography and anal manometry were performed. In 18 patients, neurophysiologic tests were also performed.

Anal Endosonography

Anal endosonography was performed using a Brüel & Kjær (Copenhagen, Denmark) ultrasound scanner Type 1846 with a rectal endoprobe Type 1850 and 7 MHz transducer. The probe was covered by a sonolucent plastic cone of 1.7 cm external diameter, filled with degassed water. The patient was examined in the dorsal position. The probe was inserted and slowly withdrawn. Serial radial images of 1 cm throughout the anus were obtained. The aspect of the internal and external sphincters and possible defects as well as the quadrants where they occurred were registered. The internal anal sphincter thickness (IST) was measured directly from the hard copy using a ruler, since the electronic calipers measure only in 1-mm steps. Because of slight irregularity, the thickness of the internal sphincter was measured laterally (at 3 and 9 o'clock, averaged).

Anal Manometry

A water-filled, open-tipped catheter, low-compliance perfusion system with pressure transducers (Beckman Type 4-527-C; Beckman Instruments, Mijdrecht, The Netherlands) connected to a dynograph recorder (Beckman R 611) was used. A three-lumen polyvinyl rectal catheter with an internal diameter of 1.1 mm was used. Three side ports were situated 1 cm apart in a longitudinal axis and 90° apart around the circumference of the probe. The perfusion rate was 0.5 ml per minute. The patients were in the left lateral position. After introduction, the catheter was left to accommodate for several minutes and the rectal pressure was set to zero. The catheter was then withdrawn with steps of 1 cm and remained at least two minutes at each station in the anal canal. The maximal basal pressure (MBP) was noted as the average recording of the three leads.

Then the catheter was introduced and withdrawn again 1 cm at a time while the patient was asked to squeeze, twice at each station to register the maximum increase in pressure as the maximal squeeze pressure (MSP).

Neurophysiologic Investigations

A concentric needle electrode was inserted in the external anal sphincter on the left and right sides, respectively. Registration was performed using a Medelec (Old Woking, United Kingdom) MS 8 in the left lateral position. The motor unit action potentials during squeezing at low effort (sweep speed, 10 msec/division; gain, 200 μV/division) were displayed on an oscilloscope and recorded on photosensitive paper for analysis afterward. During squeezing the maximal (voluntary) contraction pattern (MCP) was analyzed (sweep speed, 200 msec/division; gain, 200 μV/division) and coded as 1 = "no activity;" 2 = "solitary pattern," 3 = "solitary-mixed pattern," and 4 = "mixed-interference pattern" (normal).

Single-fiber electromyography was done with a needle electrode with a recording surface 25 μm in diameter. It was inserted into the left and right external anal sphincter, where serial recordings of 20 different single muscle fiber action potentials were made. Analysis of the tracings allowed the calculation of the mean fiber density for the right (r-FD) and left (l-FD) anal sphincter and both (mean FD) anal sphincters. Potentials were accepted when the amplitude was more than 150 μV with a rise time of less than 300 milliseconds. Filter settings were 500 to 10,000 Hz.

Pudendal nerve terminal motor latency (PNTML) was measured with a specially constructed finger stall with stimulating electrodes mounted at the tip and recording electrodes at the base. The device was placed on the glove of the index finger of the investigator (R.L.M.S.) and thus introduced in the anal canal. The pudendal nerve of each side was stimulated with a supramaximal stimulus duration of 0.05 milliseconds. The deflection of the baseline was called the pudendal terminal latency. The PNTML of the right (r-PNTML) and left (l-PNTML) sides were thus measured, and the mean PNTML between the right and left sides was calculated.

Statistical Analysis

Statistical analysis was performed with the Pearson product-moment correlation coefficient and the Spearman rank correlation coefficient. Results are expressed as age-adjusted and sex-adjusted means. Measurements were compared among Groups 1, 2, and 3 by way of linear regression to adjust for differences in age and sex distributions. The groups' traumatic and idiopathic fecal incontinence were compared using Student's *t*-test.

RESULTS

The clinical diagnoses are shown in Table 1. There were 13 patients with suspected traumatic fecal incontinence, 7 patients with suspected idiopathic (neurogenic-pudendal neuropathy) fecal incontinence, and 9 patients with soiling. The test results of these three groups are shown in Table 2.

Age affected only MBP (regression coefficient, −0.7; $P < 0.01$). Between the patients with traumatic fecal incontinence and idiopathic fecal incontinence, no significant differences in IST, MBP, MSP, EMG (MCP), mean FD, or mean PNTML were found. The patients with soiling had higher MBP ($P < 0.01$) and MSP ($P < 0.01$) than both patient groups with fecal incontinence; no significant differences in IST, EMG (MCP), mean FD, or mean PNTML were found.

Endosonography demonstrated in seven patients both an internal and external sphincter defect (Group 1), in seven patients an internal sphincter defect and in one patient an external sphincter defect (Group 2), and in 22 patients no sphincter defect (Group 3) (see Figs. 1–4). The test results of these three groups are shown in Table 3.

Table 1.
Symptoms and Clinical Diagnoses of the Patients at Presentation

Fecal incontinence	
Trauma	
Surgical	4
Obstetric	9
Idiopathic (neurogenic)	7
Cerebrovascular disease	1
Crohn's disease	1
Soiling	
Fissure/fistula	5
Hemorrhoids/musosal prolapse	2
Rectal prolapse	1
Transsexual vaginal surgery	1
Constipation	2
Others	
Evaluation of patients with a temporary stoma	3
Descending pelvic floor, dullness	1
Total	37

There was only a significant difference among these three groups for MBP ($P = 0.08$; regression $P = 0.03$) and for MCP ($P = 0.05$; regression $P = 0.009$).

In two patients with suspected obstetric trauma, there was unexpected additional severe pudendal neuropathy. In one patient with suspected obstetric trauma, no damage of the anal sphincters could be demonstrated. In one patient with suspected idiopathic (pudendal) incontinence, there was an additional, unsuspected defect of both sphincters.

The correlation coefficient between MBP and MSP was 0.45 ($P = 0.01$); the correlation coefficient between MBP and IST was 0.45 ($P = 0.007$), the correlation coefficient between IST and mean PNTML was 0.58 ($P = 0.012$), and the correlation coefficient between left and right PNTML was 0.62 ($P = 0.006$). The other test results did not correlate significantly. In three patients with both an external and internal sphincter defect where both endosonography and EMG (MCP) were performed, there was concordance in the mapping of the defect in the external sphincter.

DISCUSSION

Fecal incontinence depends on the integrity of the anal sphincters and the pelvic floor, the rectal

Table 2.
Results of Endosonography, Anal Manometry, and Neurophysiologic Tests in Patients with Traumatic Incontinence (TI), Neurogenic (Idiopathic) Incontinence (NI), and Soiling (S)

	TI	(13)	NI	(7)	S	(9)
Endosonography						
Sphincter defect (n)						
Interior/exterior	6	(13)	—	(7)	1	(9)
Interior	4	(13)	1	(7)	3	(9)
None	2	(13)	6	(7)	5	(9)
IST (mm)	2.0	(20)	2.2	(8)	2.8	(6)
Anal manometry						
MBP (mm Hg)	28*	(22)	44	(8)	61*	(7)
MSP (mm Hg)	40†	(22)	35‡	(8)	161†‡	(7)
Neurophysiology						
MCP (codes 1–4)	2.61	(12)	3.18	(5)	3.99	(2)
Mean FD (n)	2.20	(10)	2.72	(5)	1.94	(2)
Mean PNTML (msec)	2.3	(11)	2.05	(5)	2.25	(2)

Results are expressed as adjusted means.
*, †, ‡ $P < 0.01$.

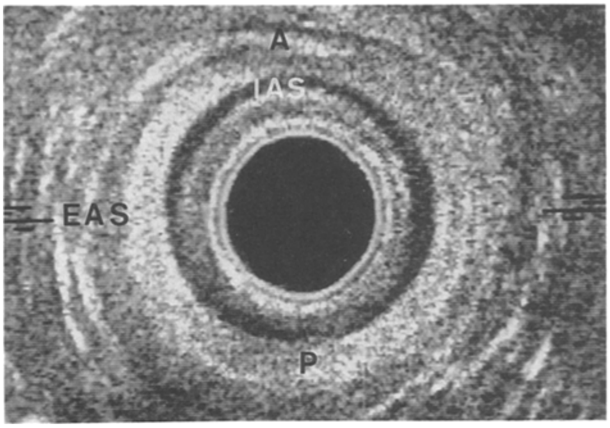

Figure 1. Normal anal canal anatomy at the level of 2 cm. A = anterior; P = posterior. The internal anal sphincter (IAS) is a well-defined hypoechoic inner ring. The external anal sphincter (EAS) is visible as a mixed echoic pattern.

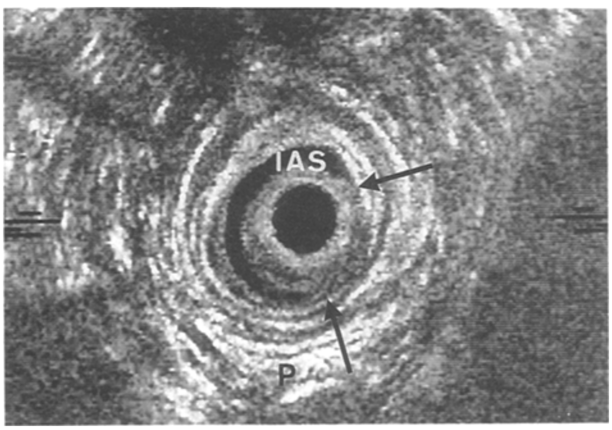

Figure 2. A deformed anus with a left lateral defect in the internal anal sphincter (IAS) in a patient with a previous sphincterotomy. P = posterior.

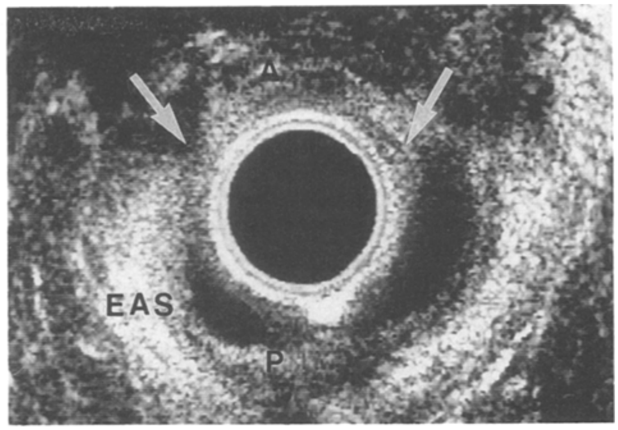

Figure 3. A large anterior defect in both the internal anal sphincter and external anal sphincter (EAS) in a patient with an obstetric trauma. A = anterior; P = posterior.

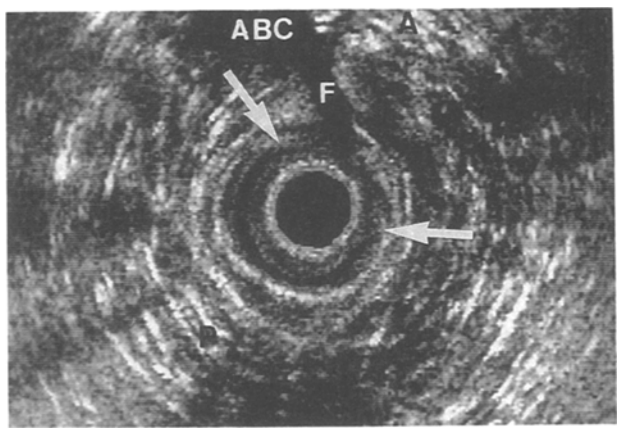

Figure 4. A defect of the internal anal sphincter and a clearly visible fistula (F) through the internal anal sphincter and external anal sphincter leading to a small abscess (ABC) in the external anal sphincter. A = anterior; P = posterior.

Table 3.
Results of Endosonography, Anal Manometry, and Neurophysiologic Tests in Patients with Both an Internal and External Sphincter Defect (Group 1), an Internal Sphincter Defect (7) or an External Sphincter Defect (1) (Group 2), or no Sphincter Defect (Group 3)

	Group 1	(n = 7)	Group 2	(n = 8)	Group 3	(n = 22)
Endosonography						
IST (mm)	1.8	(6)	2.6	(8)	2.3	(20)
Anal manometry						
MBP (mm Hg)*	27	(7)	35	(8)	49	(22)
MSP (mm Hg)	64	(7)	86	(8)	75	(22)
Neurophysiology						
MCP (codes 1–4)†	2.0	(2)	2.8	(5)	3.4	(12)
Mean FD (n)	2.7	(2)	2.3	(5)	2.2	(10)
Mean PNTML (msec)	2.3	(2)	2.5	(5)	2.3	(11)

Results are expressed as adjusted means.
* Regression $P = 0.03$.
† Regression $P = 0.009$.

compliance, and the anorectal sensitivity.[11] For an adequate evaluation several means of investigations must be applied. In this study, the results of anal endosonography, the latest tool in evaluating anorectal function, are compared with the results of anal manometry and of neurophysiologic tests.

The clinical division between traumatic and idiopathic (neurogenic) fecal incontinence is seriously challenged with anal endosonography. Visualization of the integrity of the sphincters permits selecting adequate therapy. In our series, in one patient suspected on clinical grounds of having idiopathic fecal incontinence, an unsuspected sphincter defect was found; in another patient suspected on clinical grounds of having traumatic fecal incontinence, no abnormalities of the sphincters were found. Also, in the four male patients with fecal incontinence after perineal interventions, a defect in both sphincters was found with anal endosonography and was difficult to assess clinically because of severe scar tissue.

Determination of the mean PNTML also seems important, since two patients with sphincter trauma (confirmed by anal endosonography and surgical exploration) were found to have a very prolonged mean PNTML. It has been shown that both the anal sphincters and the pudendal nerve may be damaged during childbirth.[12,13] These findings may have implication for patient management. Until now, patients with fecal incontinence were on clinical grounds divided into traumatic or idiopathic fecal incontinence, receiving a sphincter repair or a postanal repair. Missed sphincter defects would then wrongly undergo a postanal repair. It is also generally known that poor pudendal nerve function leads to unsuccessful sphincter repair. This may be an argument not to operate at all or to add a postanal repair to the sphincter repair in these patients. Further observations are warranted to support this. In our series, after clinical investigation, selection of therapy until now has been made on the results of anal endosonography; in the future, however, we will include PNTML in our decision.

In patients with fecal soiling, sphincter defects with anal endosonography were demonstrated in four of the nine patients. All of them had been operated upon, three because of fissures and one because of a fistula, and all had had persistent complaints of soiling after surgery. They all had generally normal pressures with anal manometry and normal findings with neurophysiologic tests. It seems, therefore, that anal endosonography has a place in the clinical workup of the patient with soiling and previous surgery to differentiate between a traumatic sphincter defect and persistence of the original disease. Neurophysiologic tests have no place in the clinical workup of patients with fecal soiling. The limited value of anal manometry in patients with soiling was already established.[14]

The MBP is generated for 85 percent by the internal anal sphincter and for 15 percent by the external anal sphincter.[15] More recently, it has been estimated that the MBP is generated for 30 percent by the external anal sphincter, for 55 percent by the internal anal sphincter, and for 15 percent by expansion of hemorrhoidal plexuses.[16] Our study shows in a clinical setting in patients the relationship between the internal and external anal sphincters and the MBP without the use of anesthetics. Both the lower MBP with an internal sphincter defect and the correlation between MBP and the IST underline the importance of the internal anal sphincter in generating MBP. Further lowering of the MBP is seen when there is an additional external sphincter defect. There was tendency of a lower MSP in patients with an external sphincter defect, thus demonstrating the relationship between the external sphincter and the MSP.

Electromyography (MCP) correlated with MSP; MCP and endosonography had complete concordance concerning anal sphincter mapping, and the latter was also recently reported.[3,5] It seems, therefore, that electromyography has no place in the workup of the incontinent patient and that the only valuable neurophysiologic test is PNTML measurement.

CONCLUSION

Endosonography is a valuable tool to demonstrate the integrity of the sphincters. Combination with PNTML measurements may be very promising in selecting patients with fecal incontinence and soiling for surgery.

ACKNOWLEDGMENTS

The authors thank J. Nauta of the Department of Theory of Medicine for the statistical analysis and B. U. Ridwan for his assistance in data management.

REFERENCES

1. Law PJ, Bartram CI. Anal endosonography: technique and normal anatomy. Gastrointest Radiol 1989;14: 349–53.

2. Law PJ, Talbot WR, Bartram CI, Northover JM. Anal endosonography in the evaluation of perianal sepsis and fistula in ano. Br J Surg 1989;76:752–5.
3. Law PJ, Kamm MA, Bartram CI. A comparison between electromyography and anal endosonography in mapping external anal sphincter defects. Dis Colon Rectum 1990;33:370–3.
4. Tio TL, Mulder CJ, Wijers OB, Sars PR, Tytgat GN. Endosonography of the peri-anal and peri-colorectal fistula and/or abscess in Crohn's disease. Gastrointest Endosc 1990;36:331–6.
5. Burnett SJ, Speakman CT, Kamm MA, Bartram CI. Confirmation of endosonic detection of external anal sphincter mapping. Br J Surg 1991;78:448–50.
6. Choen S, Burnett S, Bartram CI, Nicholls RJ. Comparison between anal endosonography and digital examination in the evaluation of anal fistulae. Br J Surg 1991;78:445–7.
7. Burnett SJ, Bartram CI. Endosonographic variations in the normal internal anal sphincter. Int J Colorectal Dis 1991;6:2–4.
8. Law PJ, Kamm MA, Bartram CI. Anal endosonography in the investigation of faecal incontinence. Br J Surg 1991;78:312–4.
9. Burnett SJ, Spence-Jones C, Speakman CT, Kamm MA, Hudson CN, Bartram CI. Unsuspected sphincter damage following childbirth revealed by anal endosonography. Br J Radiol 1991;64:225–7.
10. Cuesta MA, Meijer S, Derksen EJ, Boutkan H, Meuwissen SG. Anal sphincter imaging in fecal incontinence using endosonography. Dis Colon Rectum 1992;35:59–63.
11. Felt-Bersma RJ, Klinkenberg-Knol EC, Meuwissen SG. Anorectal function investigations in incontinent and continent patients: differences and discriminatory value. Dis Colon Rectum 1990;33:479–86.
12. Snooks SJ, Swash M, Mathens SE, Henry MM. Effects of vaginal delivery on the pelvic floor: a 5 year follow up. Br J Surg 1990;77:1358–60.
13. Jacobs PP, Scheuer M, Kuipers JH, Vingerhoets MH. Obstetric fecal incontinence: role of pelvic floor denervation and results of delayed sphincter repair. Dis Colon Rectum 1990;33:494–7.
14. Felt-Bersma RJ, Janssen JJ, Klinkenberg-Knol EC, Hoitsma HF, Meuwissen SG. Soiling: anorectal function and results of treatment. Int J Colorectal Dis 1989;4:37–40.
15. Frenckner B, von Euler C. Influence of pudendal block on the function of the anal sphincters. Gut 1975;16:638–44.
16. Lestar B, Penninckx F, Kerremans R. The composition of anal basal pressure. An in vivo and in vitro study in man. Int J Colorectal Dis 1989;4:118–22.