Pelvic Floor Rehabilitation in the Treatment of Fecal Incontinence

Kelly M. Scott, MD[1]

[1] Department of Physical Medicine and Rehabilitation, University of Texas Southwestern Medical Center, Dallas, Texas

Clin Colon Rectal Surg 2014;27:99–105.

Address for correspondence Kelly M. Scott, MD, Department of Physical Medicine and Rehabilitation, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, TX 75390-9055 (e-mail: kelly.scott@utsouthwestern.edu).

Abstract

Fecal incontinence (FI) is a prevalent problem that can drastically affect quality of life. Pelvic floor rehabilitation is an important first-line treatment for patients with FI, and many published case reports and a small number of randomized controlled trials (RCTs) provide limited evidence for its efficacy. Pelvic floor rehabilitation approaches to the treatment of FI include pelvic floor muscle training, biofeedback, and volumetric training with rectal balloon catheters. Various forms of external electrical stimulation have also been described and may be of added benefit. Behavioral bowel retraining is an important part of a good rehabilitative approach as well. Pelvic floor rehabilitation treatment for FI is thought to be effective and safe, with reported success rates in a majority of studies at 50 to 80%. Many more high-quality RCTs are needed to define optimal treatment protocols.

Keywords
- fecal incontinence
- pelvic floor muscle training
- biofeedback

CME Objectives: On completion of this article, the reader should be familiar with pelvic floor rehabilitation for fecal incontinence.

Fecal incontinence (FI) is defined as the involuntary loss of liquid or solid stool that is a social or hygienic problem.[1] Prevalence has been reported at 2 to 24% of the adult population,[1] with 1 to 2% experiencing significant impact on daily activities.[2] Treatments include conservative measures such as dietary modifications, medications, and pelvic floor rehabilitation, as well as more invasive approaches such as the use of perianal injectable bulking agents, sacral nerve stimulation, or surgery.[3] Many patients prefer to avoid the risk of interventions, and a stepwise approach to treatment has been advocated to minimize injury to patients.[4]

Pelvic floor rehabilitation has been used successfully in the treatment of FI, and can produce significant functional and quality of life benefits for patients.[6] Most of the reported literature in this area have been in the form of case reports and nonrandomized prospective trials. In fact, more than 70 such uncontrolled studies have been published, with a great range of treatment protocols. Almost all these studies show a significant benefit to the use of a rehabilitative approach—the majority reports a response range of 50 to 80%.[5] There has only been one published nonrandomized study which reported no benefit to treatment.[6] The patients in that study uniformly had FI due to a neurogenic etiology, which might contribute to the lack of demonstrated benefit from pelvic rehabilitation.

Understandably, there can be a publication bias toward studies with positive results when no randomization has occurred, and it is important to therefore expand research into the area of randomized controlled trials (RCTs) to demonstrate true efficacy. There have been a small number of RCTs on pelvic floor rehabilitation for FI, less than 30 in total of high quality, according to two recently published Cochrane reviews on the topic.[7,8] These RCTs vary widely in terms of treatment protocols and typically had small sample sizes, but for the most part also showed clear benefit for rehabilitative treatments.[9] There have been no significant risks reported to the patient beyond that of time investiture and financial expense. The goal of this review is to summarize the current research and describe the different options available for rehabilitative treatment of the pelvic floor in the management of FI.

Issue Theme Fecal Incontinence; Guest Editor, J. Marcus Downs, MD

Copyright © 2014 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.

DOI http://dx.doi.org/10.1055/s-0034-1384662.
ISSN 1531-0043.

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

Pelvic Floor Rehabilitation

Pelvic floor rehabilitation is a term which comprises many different therapeutic approaches, including but not limited to electromyographic (EMG) biofeedback-guided pelvic floor muscle training (PFMT), which is currently the most widely used rehabilitative treatment modality. Pelvic floor rehabilitation is typically performed under the guidance of a pelvic floor physical therapist, although nurses, physicians, and other staff can receive training to perform many of these interventions. The different rehabilitative techniques can be used independently, but more frequently are used in conjunction with one another in a multimodal approach to produce the maximum benefit for the patient.[9] The primary goal of all forms of pelvic floor rehabilitation is to improve pelvic floor and anal sphincter muscle strength, tone, endurance, and coordination to effect a positive change in function with a decrease in symptoms. Additional goals include increasing the patient's awareness of their own muscles, improving rectal sensitivity, and reducing scar burden to allow for improved muscle function.

Pelvic floor rehabilitation techniques include bowel management education and retraining, PFMT, biofeedback therapy (BFT), the use of electrical stimulation, and manual myofascial release and connective tissue mobilization techniques.

Bowel Management Education and Retraining

The incorporation of lifestyle education into the therapeutic treatment program is of vital importance for patients with FI. Such training can certainly be done apart from or instead of the other pelvic floor rehabilitation approaches described below, but it is thought that the best results occur when both are undertaken simultaneously. The patients in many of the published studies on FI and rehabilitation are typically, therefore, instructed in basic behavioral and bowel retraining principles alongside undergoing pelvic rehabilitation methods.[7]

Bowel education and retraining can include many different aspects. A focus on lifestyle modifications including instruction as to optimal fluid intake and dietary adjustments can be important in certain patient populations.[10] Patients with irritable bowel syndrome and FI, for example, often find that regulating dairy, gluten, and fiber can be an important component of controlling their stool leakage.[11] It is generally recommended that all patients with FI increase their fiber intake, as Bliss et al were able to demonstrate that fiber supplementation significantly reduced the rate of FI.[12] Behavior modification can also be explored with patients, including training on the establishment of a predictable pattern of bowel evacuation, timing of defecation relative to activities to limit incontinent episodes, techniques to reduce straining, proper defecation posture when sitting on the toilet, and fecal urge suppression techniques.[6,10,13] Weight reduction is typically encouraged, as obesity is a well-documented risk factor for the development of FI.[14]

Pelvic Floor Muscle Training

PFMT describes any number of different approaches for increasing strength, endurance, and coordination of the pelvic floor and anal sphincters. Thoracoabdominopelvic muscle training has also been advocated, as it has been theorized that training all core muscles to work in tandem would be more effective than a narrow focus on the pelvic floor muscles alone.[15] Particular attention is often paid to the transversus abdominus in such expanded approaches. PFMT typically consists of verbally guided instruction in pelvic floor and sphincter contractions (Kegel contractions).[16] Patients can be taught to contract in a variety of ways—some examples include maximal voluntary sustained sphincter contractions, submaximal sustained contractions, and fast-twitch or "quick-flick" contractions.[15,17] A commonly reported PFMT technique is to compare the pelvic floor to an elevator, able to stop at different floors as it ascends and descends.[16] Other reported methods include working on coordination of anal sphincter activity and working to isolate a contraction of the anal sphincter.[17] Some practitioners use their hand placed externally, or a digit placed vaginally or rectally to help instruct the patient in the correct exercise techniques, but most would argue that this constitutes a form of low-tech biofeedback training.

Only one clinical trial, by Norton et al in 2003, compared pelvic rehabilitation to a bowel education and retraining program.[17] This study demonstrated comparable benefit in all treatment groups, and the authors concluded that no added benefit was seen with pelvic rehabilitation compared with education alone. However, the education treatment group received instruction in a "bowel urge resistance program" which included training to hold stool in the rectal vault while sitting on the toilet for increasing amounts of time. It is not clear whether such urge suppression techniques are substantially different from pelvic floor muscle strength training with sustained submaximal contractions, and therefore this study's reported conclusions of no benefit from PFMT apart from educational instruction may not be valid.

PFMT without the concurrent use of biofeedback has been well established for use in patients with urinary incontinence.[16] However, there have not been many trials that have looked at PFMT apart from biofeedback training in the treatment of FI. Three studies have shown digitally taught PFMT to be equivalent to PMFT combined with biofeedback.[17–19]

Only one RCT has been done to evaluate the difference between varied types of pelvic floor exercises.[19] Bartlett et al in 2011[15] found no difference in outcomes between two separate PFMT techniques, both trained with biofeedback guidance (sustained submaximal anal and pelvic floor exercises vs. rapid squeeze plus sustained submaximal exercises). Both groups had significant improvement in FI.

Biofeedback Therapy

BFT is a term that can be used to describe many different types of training regimens for the pelvic floor. Biofeedback is

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

defined as the process of gaining greater awareness of many physiological functions, primarily using instruments that provide information on the activity of those same systems, with a goal of being able to manipulate them at will.[20] BFT has been used in medicine for more than 30 years and has been used for the treatment of FI since as early as 1974.[21] For pelvic floor rehabilitation purposes, the most common type of biofeedback is EMG BFT, which was first introduced in 1979.[22] Data are recorded either through surface electrodes or via the use of intravaginal or intrarectal sensors. Other forms of pelvic floor BFT include the use of ultrasound (either intrarectal, intravaginal, or perineal); rectal balloons; digital guidance (the use of an intrarectal/intravaginal finger or hand placed on the perineum); and anorectal manometry.[7,23]

There are three main approaches in how biofeedback is used as a part of pelvic floor rehabilitation for FI.[7] The most common type is for strength and endurance training for the pelvic floor and/or anal sphincter. The biofeedback apparatus gives information about how strongly the muscles are being contracted, and the patient can use that information to learn how to do the pelvic floor exercises more effectively. It is also thought that biofeedback motivates the patient to improve by giving information on performance and progress. The theory behind strength and endurance training is that if the sphincter muscles are stronger, the patient will be able to hold in the stool for a longer period of time and enable them to make it to the restroom with less accident.

The second treatment modality is to use BFT to improve rectal sensitivity or compliance. This type of treatment has also been termed volumetric rehabilitation or discrimination training and is typically done with rectal balloons.[24] The balloon is inflated with air or water to determine the first sensation of rectal filling. It is then gradually inflated with decreasing amounts of air or water to teach the patient to appreciate stool in the rectal vault at progressively lower volumes. The rationale behind sensory retraining is to allow the patient to detect smaller volumes of stool at an earlier time, again making it possible for them to reach the restroom before an accident occurs. It also allows for the patient to have more time to perform a voluntary anal sphincter contraction before the volume of stool in the rectal vault overwhelms the patient's ability to hold it inside. Rectal balloons can also be used on patients with fecal urgency and rectal hypersensitivity—the balloons are in those cases simply inflated to progressively larger volumes, which the patient is then coached in how to tolerate without feeling the need to expel the rectal contents.[7]

The third BFT approach deals with coordination training for the anal sphincter. Multiple balloons are again inserted—a large one in the rectum itself and one or two smaller ones in the anal canals. These are typically connected to a manometric pressure-recording device. When the larger balloon is inflated, the rectal–anal inhibitory reflex is triggered, and the patient is taught to appreciate the momentary internal anal sphincter relaxation that results. The patient can then be taught to do a voluntary external sphincter contraction to counteract the involuntary relaxation of the internal sphincter.[7,25] This type of coordination training does not seem to be as commonly studied in recent decades as it was in the past. More recent studies have referred to "coordination training" instead as a combination between motor skills training and sensory discrimination training.[24,26]

Summary of Selected Biofeedback Trials

Ilnyckyj et al in 2005 looked at anal sphincter exercises plus biofeedback plus education versus exercises and education alone in a group of 18 women.[18] Exercises were taught with verbal and written instructions in the education group. The biofeedback group was instructed in how to do the exercises with visual manometric, physical (hand), and verbal cueing. No differences were found between the groups, and overall 61% of participants demonstrated a complete response.

Norton et al in 2003 demonstrated no difference between three groups who were all taught the same pelvic floor exercises.[17] One group was taught exercises only, one group was taught exercises with the use of a hospital-based, computer-assisted sphincter pressure biofeedback device, and one group was instructed in hospital biofeedback-guided exercises along with the use of a home EMG biofeedback device. All groups demonstrated improvement in around 50% of participants.

Solomon et al in 2003 randomized 120 patients to one of three groups—manometric biofeedback, ultrasound-guided biofeedback, or pelvic floor exercises taught via digital examination with verbal guidance alone.[19] They also did not find a statistically significant difference between their groups, and approximately two-thirds of patients in all groups had a clinical benefit.

Heymen et al in 2009 looked at whether the addition of manometric biofeedback-guided rectal balloon sensitivity, strength, and coordination training to a standard PFMT program would improve continence.[26] Biofeedback training resulted in greater reduction in FI severity and days with FI. At the 3-month follow-up, 76% of patients treated with BFT versus 41% of patients treated with pelvic floor exercises reported adequate relief. Benefit to the biofeedback group carried over into the 12-month follow-up as well.

Miner et al in 1990 conducted a study of 25 patients in which they compared rectal balloon training with sensory biofeedback to a "sham retraining" group which performed the same balloon maneuvers without any feedback or instruction from the therapist.[27] They found that the biofeedback group had reduced frequency of incontinence compared with the sham group, as well as reduced sensory thresholds compared with the sham group (although both groups had improved thresholds). Miner et al subjected both groups to subsequent strength and coordination training, and they did not find that this extra training significantly improved continence. At the end of their study, 50% of patients had no incontinence episodes at all and 76% of patients had reduced the frequency of incontinence episodes by more than 75%. They showed that the improvements seen were associated with the improvements in rectal sensation in both groups, and were not associated with any change in sphincter pressures or in the continence to rectally infused saline. They

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

were able to demonstrate sustained improvement over 2 years in 16 of the 22 patients who presented for follow-up.

A study by Bols et al conducted in 2011 looked at rectal balloon sensitivity training in addition to PFMT versus PFMT alone.[28] They randomized 80 patients. The PFMT in this study did not have any EMG biofeedback guidance and consisted of voluntary contractions and relaxations of the pelvic floor and anal sphincter in different starting positions. The PFMT was meant to improve strength, duration, timing, and coordination of contractions. Both groups showed equal improvement in continence, and approximately 50% of all patients had clinically important change in their Vaizey continence score. They found that there was no benefit to adding the rectal balloon sensitivity training in terms of modifying the continence score; however, adding sensory retraining did lead to improvements in quality of life, external anal sphincter fatigue, and maximal tolerable rectal volume.

A systematic review of 46 previously published nonrandomized trials on BFT and PFMT was conducted by Norton and Kamm in 2001.[29] A total of 1,364 patients were included in the review. A total of 49% were said to be cured of symptoms of FI following BFT and 72% were reported to be cured or improved. However, only 8 out of the 46 studies employed a control group. A large retrospective review of 513 consecutive patients treated with biofeedback for FI was published by Byrne et al in 2007.[30] They demonstrated more than 70% of patients with improved short-term outcomes, including decrease in incontinence scores by 32% and quality of life improved by 89%.

Electrical Stimulation

Electrical stimulation is another modality that has been proposed for the rehabilitative treatment of FI. The goal of electrical stimulation is to enhance the strength and/or endurance of striated muscle contraction—the target is typically the external anal sphincter in the case of patients with FI. Another goal can be to allow patients with decreased kinesthetic awareness to become more cognizant of where their pelvic floor muscles are in space and what it feels like when the muscles and sphincter are contracting. Electrical stimulation has been shown to transform fast-twitch muscle fibers to slow-twitch muscle fibers, which is thought to help with improving endurance.[31] It also increases capillary density, allowing more blood flow to the oxidative slow-twitch fibers.[32] Electrical stimulation can be delivered to the pelvic floor and anal sphincter in many different forms, including via surface electrodes or intrarectal probes and with many different stimulation parameters and treatment protocols. Low-frequency stimulation (LFS) has typically been the norm, although a new form of amplitude-modulated medium-frequency (AM-MF) stimulation has recently been proposed.[33] All forms of electrical stimulation are often used in conjunction with PFMT or biofeedback training, although stimulation can be used without any other concurrent rehabilitative treatment. Electrical stimulation can also be used to augment a volitional contraction once the contraction threshold reaches a predefined level, and such a strategy has also been employed in trials.

Summary of Selected Trials Involving Both Biofeedback and Concurrent Electrical Stimulation

Fynes et al in 1999 studied 40 women with FI after obstetric injury.[34] Patients were randomized to two groups with quite different treatment protocols. One group received vaginal pelvic floor manometric pressure biofeedback and home exercises taught by a nurse. The other group received anal EMG biofeedback and home exercises in combination with anal electrical stimulation by a physical therapist. The group receiving anal EMG biofeedback and electrical stimulation showed improved incontinence and improved proportion of patients who became asymptomatic compared with the other group. It is hard to determine what effect, if any, the actual electrical stimulation had in this case, as the two groups had such different treatment protocols.

Mahony et al in 2004 compared intra-anal EMG biofeedback alone versus intra-anal biofeedback that was augmented with electrical stimulation of the anal sphincter in postpartum women with FI.[35] Sixty women were randomized, and of those, 52 had external anal sphincter defects. Both groups demonstrated significant improvements in continence scores, anal squeeze pressures, and quality of life, and there was no statistically significant difference between the groups.

A couple of studies by Schwandner et al have looked at a new type of combination treatment they termed triple target treatment or 3T. 3T consists of AM-MF stimulation, EMG-triggered AM-MF stimulation, and EMG biofeedback training. The group has published a RCT comparing 3T to standard EMG biofeedback in 2010 and another in 2011 comparing 3T to the more standardly used LFS.[33,36] The 2010 study was significantly underpowered because less than 40% of their subjects completed the 9-month treatment protocol, but the intention to treat analysis demonstrated improved continence in the 3T group. The 2011 study showed statistically significant improvements in continence in the 3T group compared with standard LFS; however, the LFS group did not have EMG biofeedback and the 3T group did. This 2011 study had more acceptable drop-out rates than the 2010 study, and was conducted for only 6 months instead of 9 months. The Schwandner group has also published further subgroup analysis based on their 2010 study.[37] They reported that patients with sphincter damage and neuropathic anal incontinence responded better to 3T than to EMG biofeedback alone. This is potentially significant because these patient subgroups have traditionally not fared well in pelvic floor rehabilitation studies, but more research is needed as to the effectiveness of 3T training, the optimal length of treatment needed, and whether patients have the ability to be compliant with treatment over long time periods.

Summary of Selected Trials Involving Electrical Stimulation without Concurrent Biofeedback Training

Osterberg et al in 2004 compared electrical stimulation to levatorplasty and found that surgery afforded improved

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

incontinence at 3 months, but not at 12 or 24 months.[38] There was no difference in fecal urgency or use of pads between the groups. Quality of life was greater in the surgical group at all time points.

Naimy et al in 2007 studied 40 women with FI after third- or fourth-degree obstetric tears.[39] The women were randomized to receive either EMG-guided biofeedback muscle training or electrical stimulation delivered via anal probe. Each patient in either group had two sessions of instruction with a physical therapist, but then were left to complete the biofeedback or electrical stimulation for 20 to 30 minutes twice daily on their own at home for 8 weeks. Neither group improved in terms of Wexner incontinence scores nor in terms of FI quality of life scores, and there was no statistical significance between groups. Both treatments resulted in improvement in patients' subjective perception of incontinence control.

Norton et al in 2006 compared daily anal electrical stimulation of two different frequencies—35 versus 1 Hz (which they considered to be a "sham" treatment).[40] Treatments were conducted daily for 8 weeks, and while 90 patients participated in the study, only 70 completed it. On intention to treat analysis, there were no differences between the groups in terms of any outcome measures, and 63% of patients who completed treatment felt that it had improved their symptoms at least somewhat. They speculated that improvements in both groups were possibly related to improved rectal sensation rather than direct muscle strengthening, or alternatively a placebo effect.

A study by Healy et al in 2006 randomized 48 patients to endoanal electrical stimulation with a home unit versus endoanal electrical stimulation plus augmented biofeedback under supervision of a physical therapist.[41] Both groups improved in terms of continence scores, manometric pressure readings posttreatment, and quality of life.

Pelvic Floor Rehabilitation following Surgery

Only one randomized trial has been conducted on the use of pelvic floor rehabilitation following surgery for sphincter repair. Davis et al in 2004 compared anal sphincter repair with or without subsequent biofeedback training which was started 3 months postoperatively.[42] There were 38 total patients randomized in this small study. No difference was found between the groups regarding continence score at 9 months, patient satisfaction, or quality of life measures. In contrast, there have been many nonrandomized trials and retrospective reviews which have reported significant benefit to BFT and pelvic floor rehabilitation after surgery.[43–47] More RCTs in this area are obviously needed.

Pelvic Floor Rehabilitation versus Sacral Nerve Stimulation

There has been one randomized trial comparing sacral nerve stimulation to an "optimal medical management" program that included bulking agents, dietary management of fluid and fiber, and pelvic floor rehabilitation (pelvic floor exercises with biofeedback provided by digital guidance only). Tjandra et al[48] in 2008 found that sacral nerve stimulation significantly improved the number of incontinent episodes per week and incontinent days per week by the 12-month follow-up. Quality of life also improved significantly. This study did not demonstrate any improvement in incontinence or quality of life in the group randomized to optimal medical management, which does not match with the majority of reported RCTs showing a clear benefit for the medical management and rehabilitative approach. Again, more research in this area is needed.

Predictors of Success with Pelvic Floor Rehabilitation

There have only been a few studies which have looked at which types of patients will most likely benefit from a rehabilitative approach to treatment for FI. Good sphincter function and mild to moderate symptomatology are considered as more favorable prognostic factors.[49] Disruption of the anal sphincter, spinal cord transection or other neurogenic disorders, severe impairment of rectal sensory function, cognitive impairments, severe depression or other mental illness, and age younger than 6 years are all thought to be predictors of poor response to biofeedback and other rehabilitative treatments.[24]

Discussion

It is evident that more RCTs need to be conducted, but these early preliminary results seem to suggest that there is a definite role for pelvic floor rehabilitation in the treatment of FI. Biofeedback pelvic floor training seems to be effective in a majority of patients in most studies, although there is some question as to whether the results are due to improved strength and endurance of the anal sphincter and pelvic floor muscles, or whether the improvement can be attributed to improved rectal sensitivity. Electrical stimulation is also an area where more research is needed; however, there is a possibility that it can produce an added benefit when added to biofeedback training alone. Trials conducted to date have used widely divergent treatment protocols and therefore we do not have good evidence to suggest one type of rehabilitative technique or training regimen as being superior at this time.

It is important, as well, to consider the patient as an individual and to understand that the causes of FI are varied, even within the umbrella of pelvic floor dysfunction itself. Whitehead et al in 1985 demonstrated that 5 out of 18 of their patients with FI had resolution of symptoms once their underlying constipation was improved, and therefore it is important to rule out and treat constipation in any patient with FI.[50] There is good empiric evidence that BFT and other rehabilitative treatments can be very effective for constipation caused by outlet dysfunction, such as in those patients with nonrelaxing puborectalis syndrome.[23,24] Such rehabilitative approaches to constipation and overactive pelvic floor

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

muscles might include rectal balloon training for dyssynergia or EMG biofeedback-guided relaxation training of overactive pelvic floor muscles.[7,24] Terra et al in 2008 demonstrated that one positive predictor of successful outcomes with pelvic floor rehabilitation for the treatment of FI is the presence of perineal and/or perianal scar tissue on physical examination.[51] Many pelvic floor therapists are skilled at manual techniques for myofascial release and connective tissue mobilization. Moreover, the addition of these techniques to the standard treatments described earlier could provide even more benefit for select patients who suffer from FI and have significant scarring of their pelvic floor muscles or sphincters. More research into these areas is also needed.

Conclusion

Pelvic rehabilitation approaches including PFMT, biofeedback-guided strength and endurance training, biofeedback-guided rectal sensitivity and coordination training, and electrical stimulation can be effective tools in the management of FI. More research is needed to further define the role of rehabilitation, predictors of good outcomes, and the most efficacious treatment protocols.

References

1 Bols EM, Berghmans BC, Hendriks EJ, et al. A randomized physiotherapy trial in patients with fecal incontinence: design of the PhysioFIT-study. BMC Public Health 2007;7:355
2 Perry S, Shaw C, McGrother C, et al; Leicestershire MRC Incontinence Study Team. Prevalence of faecal incontinence in adults aged 40 years or more living in the community. Gut 2002;50(4): 480–484
3 Tan JJ, Chan M, Tjandra JJ. Evolving therapy for fecal incontinence. Dis Colon Rectum 2007;50(11):1950–1967
4 Blussé van Oud-Alblas M, Thomeer BJ, Stam HJ, van Overbeeke AJ, Consten EC. Fecal incontinence: an update on available techniques in diagnosis and treatment. Surg Technol Int 2008; 17:156–164
6 Norton C, Whitehead WE, Bliss DZ, Harari D, Lang J; Conservative Management of Fecal Incontinence in Adults Committee of the International Consultation on Incontinence. Management of fecal incontinence in adults. Neurourol Urodyn 2010;29(1):199–206
5 van Tets WF, Kuijpers JH, Bleijenberg G. Biofeedback treatment is ineffective in neurogenic fecal incontinence. Dis Colon Rectum 1996;39(9):992–994
7 Norton C, Cody JD. Biofeedback and/or sphincter exercises for the treatment of faecal incontinence in adults. Cochrane Database Syst Rev 2012;7:CD002111
8 Hosker G, Norton C, Brazzelli M. Electrical stimulation for faecal incontinence in adults. Cochrane Database Syst Rev 2000;(2): CD001310
9 Santoro GA, Wieczorek AP, Bartram CI. Pelvic Floor Disorders: Imaging and Multidisciplinary Approach to Management. Milan: Springer-Verlag Italia; 2010:317
10 Norton C, Chelvanayagam S. Methodology of biofeedback for adults with fecal incontinence: a program of care. J Wound Ostomy Continence Nurs 2001;28(3):156–168
11 Hansen JL, Bliss DZ, Peden-McAlpine C. Diet strategies used by women to manage fecal incontinence. J Wound Ostomy Continence Nurs 2006;33(1):52–61, discussion 61–62
12 Bliss DZ, Jung HJ, Savik K, et al. Supplementation with dietary fiber improves fecal incontinence. Nurs Res 2001;50(4):203–213
13 Stokes G. Psychological approaches to bowel care in older people with dementia. In: Potter J, Norton C, Cottenden A, eds. Bowel Care in Older People. London: Royal College of Physicians; 2002:97–109
14 Townsend MK, Matthews CA, Whitehead WE, Grodstein F. Risk factors for fecal incontinence in older women. Am J Gastroenterol 2013;108(1):113–119
15 Bartlett L, Sloots K, Nowak M, Ho YH. Biofeedback for fecal incontinence: a randomized study comparing exercise regimens. Dis Colon Rectum 2011;54(7):846–856
16 Bo K, Berghmans B, Morkved S, van Kampen M, eds. Evidence-Based Physical Therapy for the Pelvic Floor: Bridging Science and Clinical Practice. Edinburgh: Elsevier Ltd; 2007:171–178
17 Norton C, Chelvanayagam S, Wilson-Barnett J, Redfern S, Kamm MA. Randomized controlled trial of biofeedback for fecal incontinence. Gastroenterology 2003;125(5):1320–1329
18 Ilnyckyj A, Fachnie E, Tougas G. A randomized-controlled trial comparing an educational intervention alone vs education and biofeedback in the management of faecal incontinence in women. Neurogastroenterol Motil 2005;17(1):58–63
19 Solomon MJ, Pager CK, Rex J, Roberts R, Manning J. Randomized, controlled trial of biofeedback with anal manometry, transanal ultrasound, or pelvic floor retraining with digital guidance alone in the treatment of mild to moderate fecal incontinence. Dis Colon Rectum 2003;46(6):703–710
20 Durand VM, Barlow D. Abnormal Psychology: An Integrative Approach. Belmont, CA: Wadsworth Cengage Learning; 2009:331
21 Engel BT, Nikoomanesh P, Schuster MM. Operant conditioning of rectosphincteric responses in the treatment of fecal incontinence. N Engl J Med 1974;290(12):646–649
22 MacLeod JH. Biofeedback in the management of partial anal incontinence: a preliminary report. Dis Colon Rectum 1979; 22(3):169–171
23 Enck P, Van der Voort IR, Klosterhalfen S. Biofeedback therapy in fecal incontinence and constipation. Neurogastroenterol Motil 2009;21(11):1133–1141
24 Chiarioni G, Whitehead WE. The role of biofeedback in the treatment of gastrointestinal disorders. Nat Clin Pract Gastroenterol Hepatol 2008;5(7):371–382
25 Whitehead WE, Orr WC, Engel BT, Schuster MM. External anal sphincter response to rectal distention: learned response or reflex. Psychophysiology 1982;19(1):57–62
26 Heymen S, Scarlett Y, Jones K, Ringel Y, Drossman D, Whitehead WE. Randomized controlled trial shows biofeedback to be superior to pelvic floor exercises for fecal incontinence. Dis Colon Rectum 2009;52(10):1730–1737
27 Miner PB, Donnelly TC, Read NW. Investigation of mode of action of biofeedback in treatment of fecal incontinence. Dig Dis Sci 1990; 35(10):1291–1298
28 Bols E, Berghmans B, de Bie R, et al. Rectal balloon training as add-on therapy to pelvic floor muscle training in adults with faecal incontinence: a randomized controlled trial. Neurourol Urodyn 2012;31(1):132–138
29 Norton C, Kamm MA. Anal sphincter biofeedback and pelvic floor exercises for faecal incontinence in adults—a systematic review. Aliment Pharmacol Ther 2001;15(8):1147–1154
30 Byrne CM, Solomon MJ, Young JM, Rex J, Merlino CL. Biofeedback for fecal incontinence: short-term outcomes of 513 consecutive patients and predictors of successful treatment. Dis Colon Rectum 2007;50(4):417–427
31 Salmons S, Vrbová G. The influence of activity on some contractile characteristics of mammalian fast and slow muscles. J Physiol 1969;201(3):535–549
32 Hudlická O, Dodd L, Renkin EM, Gray SD. Early changes in fiber profile and capillary density in long-term stimulated muscles. Am J Physiol 1982;243(4):H528–H535
33 Schwandner T, König IR, Heimerl T, et al. Triple target treatment (3T) is more effective than biofeedback alone for anal incontinence: the 3T-AI study. Dis Colon Rectum 2010;53(7):1007–1016

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

34 Fynes MM, Marshall K, Cassidy M, et al. A prospective, randomized study comparing the effect of augmented biofeedback with sensory biofeedback alone on fecal incontinence after obstetric trauma. Dis Colon Rectum 1999;42(6):753–758, discussion 758–761
35 Mahony RT, Malone PA, Nalty J, Behan M, O'connell PR, O'herlihy C. Randomized clinical trial of intra-anal electromyographic biofeedback physiotherapy with intra-anal electromyographic biofeedback augmented with electrical stimulation of the anal sphincter in the early treatment of postpartum fecal incontinence. Am J Obstet Gynecol 2004;191(3):885–890
36 Schwandner T, Hemmelmann C, Heimerl T, et al. Triple-target treatment versus low-frequency electrostimulation for anal incontinence: a randomized, controlled trial. Dtsch Arztebl Int 2011; 108(39):653–660
37 Schwandner T, Heimerl T, König IR, et al. 3T-AI: a new treatment algorithm for anal incontinence with a higher evidence level [in German]. Zentralbl Chir 2012;137(4):345–351
38 Osterberg A, Edebol Eeg-Olofsson K, Hålldén M, Graf W. Randomized clinical trial comparing conservative and surgical treatment of neurogenic faecal incontinence. Br J Surg 2004;91(9):1131–1137
39 Naimy N, Lindam AT, Bakka A, et al. Biofeedback vs. electrostimulation in the treatment of postdelivery anal incontinence: a randomized, clinical trial. Dis Colon Rectum 2007;50(12): 2040–2046
40 Norton C, Gibbs A, Kamm MA. Randomized, controlled trial of anal electrical stimulation for fecal incontinence. Dis Colon Rectum 2006;49(2):190–196
41 Healy CF, Brannigan AE, Connolly EM, et al. The effects of low-frequency endo-anal electrical stimulation on faecal incontinence: a prospective study. Int J Colorectal Dis 2006;21(8):802–806
42 Davis KJ, Kumar D, Poloniecki J. Adjuvant biofeedback following anal sphincter repair: a randomized study. Aliment Pharmacol Ther 2004;20(5):539–549
43 Arnbjörnsson E, Breland U, Kullendorff CM, Mikaelsson C, Okmian L. Physiotherapy to improve faecal control after Stephens' rectoplasty in high imperforate anus. Z Kinderchir 1986;41(2):101–103
44 Allgayer H, Dietrich CF, Rohde W, Koch GF, Tuschhoff T. Prospective comparison of short- and long-term effects of pelvic floor exercise/biofeedback training in patients with fecal incontinence after surgery plus irradiation versus surgery alone for colorectal cancer: clinical, functional and endoscopic/endosonographic findings. Scand J Gastroenterol 2005;40(10):1168–1175
45 Sun X, Wang R, Zhang L, Li D, Li Y. Efficacy of pelvic floor muscle training for the treatment of fecal incontinence after Soave procedure for Hirschsprung disease. Eur J Pediatr Surg 2012; 22(4):300–304
46 Laforest A, Bretagnol F, Mouazan AS, Maggiori L, Ferron M, Panis Y. Functional disorders after rectal cancer resection: does a rehabilitation programme improve anal continence and quality of life? Colorectal Dis 2012;14(10):1231–1237
47 Leung MW, Wong BP, Leung AK, et al. Electrical stimulation and biofeedback exercise of pelvic floor muscle for children with faecal incontinence after surgery for anorectal malformation. Pediatr Surg Int 2006;22(12):975–978
48 Tjandra JJ, Chan MK, Yeh CHG, Murray-Green C. Sacral nerve stimulation is more effective than optimal medical therapy for severe fecal incontinence: a randomized, controlled study. Dis Colon Rectum 2008;51(5):494–502
49 Boselli AS, Pinna F, Cecchini S, et al. Biofeedback therapy plus anal electrostimulation for fecal incontinence: prognostic factors and effects on anorectal physiology. World J Surg 2010;34(4):815–821
50 Whitehead WE, Burgio KL, Engel BT. Biofeedback treatment of fecal incontinence in geriatric patients. J Am Geriatr Soc 1985; 33(5):320–324
51 Terra MP, Deutekom M, Dobben AC, et al. Can the outcome of pelvic-floor rehabilitation in patients with fecal incontinence be predicted? Int J Colorectal Dis 2008;23(5):503–511

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.