



# A Practical Guide to Biofeedback Therapy for Pelvic Floor Disorders

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## Abstract

**Purpose of Review** Biofeedback therapy (BFT) is effective for managing pelvic floor disorders (i.e., defecatory disorders and fecal incontinence). However, even in controlled clinical trials, only approximately 60% of patients with defecatory disorders experienced long-term improvement. The review serves to update practitioners on recent advances and to identify practical obstacles to providing biofeedback therapy.

**Recent Findings** The efficacy and safety of biofeedback therapy have been evaluated in defecatory disorders, fecal incontinence, and levator ani syndrome. Recent studies looked at outcomes in specific patient sub-populations and predictors of a response to biofeedback therapy.

**Summary** Biofeedback therapy is effective for managing defecatory disorders, fecal incontinence, and levator ani syndrome. Patients who have a lower bowel satisfaction score and use digital maneuvers fare better. Biofeedback therapy is recommended for patients with fecal incontinence who do not respond to conservative management. A subset of patients with levator ani syndrome who have dyssynergic defecation are more likely to respond to biofeedback therapy.

**Keywords** Biofeedback therapy · Defecation disorder · Fecal incontinence · Levator ani syndrome · Pelvic floor dysfunction

## Introduction

The most recent version (i.e., Rome IV) of the Rome criteria for functional gastrointestinal disorders specifies three main anorectal disorders (i.e., defecation disorders (DD), fecal incontinence (FI), and anorectal pain disorders [1]. DD result from a lack of coordination between abdominal and pelvic floor muscles during defecation, resulting in chronic constipation [2]. Biofeedback therapy (BFT) is the mainstay of managing DD; dietary modifications, laxatives, and drugs that relax the internal anal sphincter are of limited benefit [3, 4]. FI refers to the involuntary passage of liquid or solid feces, which generally results from bowel disturbances and/or anorectal sensorimotor dysfunctions [1, 5]. Education, dietary modifications, medications to regulate coexistent bowel disturbances, pelvic floor biofeedback therapy, and if necessary,

surgical or minimally invasive therapies are used to manage FI [6, 7]. For the anorectal pain syndromes (i.e., proctalgia fugax, levator ani syndrome, and unspecified anorectal pain), biofeedback therapy is useful for patients with levator ani syndrome who also have rectoanal dyssynergia [3, 8••]. The levator ani syndrome manifests as chronic or recurrent episodes of anorectal pain, each episode lasting at least 30 min. This review will update practicing gastroenterologists on the indications, techniques, strengths, and limitations of BFT in pelvic floor disorders.

## Techniques

Biofeedback is a behavioral learning process that relies on operant conditioning; visual, auditory, or verbal feedback from instruments that measure anorectal activity is used to rehabilitate anorectal functions [9••, 10••]. The commonly used techniques include solid-state manometry systems, surface EMG probes, simulated defecation training using rectal balloons, sensory training, and home training devices (Table 1).

Prior to BFT, patients should be educated in the normal physiology of defecation, importance of appropriate posture, and breathing techniques. BFT seeks to modulate anal

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**Table 1** Description of individual biofeedback techniques

	Anorectal manometry guided BFT	Surface EMG guided BFT	Simulated defecation training	Sensory training
Device description	Catheter with anal and rectal sensors + display monitor	Intraanal sEMG probe ± a second probe over rectus abdominis, connected to a display monitor	Catheter with a balloon and perfusion port	Catheter with a balloon and perfusion port
Purpose	Patients receive visual feedback of anal and rectal pressures	Measures electrical activity of anal striated muscles and abdominal muscles—visual and auditory feedback	Patients try to expel a rectal balloon (50 mL) while gentle downward traction is applied on the balloon	Rectal balloon is intermittently inflated with progressively lower rectal volumes in patients with reduced rectal sensation and with progressively higher volumes in patients with increased perception.

*BFT* biofeedback therapy, *sEMG* surface electromyography

sphincter tone at rest, improve voluntary contraction of the anal sphincter and puborectalis muscle, improve abdominopelvic coordination during defecation, and modulate rectal sensation. These techniques are tailored to the presenting symptoms and the type of rectoanal sensorimotor dysfunctions. For example, among patients with FI, while the focus is on improving contraction of the anal sphincter and puborectalis, it should be supplemented, when necessary, with therapy to modulate rectal sensation. Because BFT requires active engagement of patients, preserved cognition and sufficient motivation are necessary [10••].

Anorectal manometry and surface EMG are used to improve sphincter endurance and abdominopelvic coordination. Rectal balloons are also used to improve abdominopelvic coordination. In patients with reduced rectal sensation, BFT patients gradually learn to perceive progressively lower balloon volumes.

BFT sessions are approximately 1 h long. While the number and schedule for sessions is variable, a typical course of BFT comprises 5–10 sessions. Over time, patients are gradually encouraged to practice these techniques without feedback. After office-based training, some patients may need to continue practicing these techniques at home with hand-held EMG probes or inflatable balloons, perhaps for 2–3 months [10••].

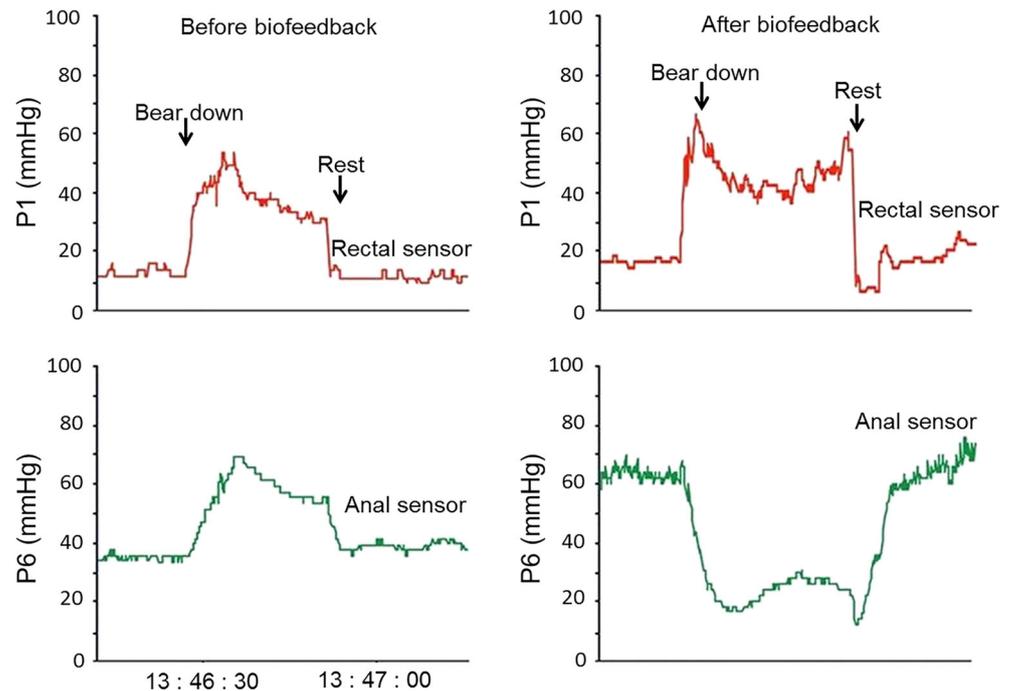
## BFT in Defecation Disorders

Aided by manometry or surface EMG sensors, the therapy is initially designed to improve the abdominal push effort without excessive straining and to coordinate outward motion of the abdominal wall with relaxation of the anal sphincter and puborectalis muscle. Thereafter, patients practice simulated defecation with a 50-mL water or air-filled rectal balloon and/or sensory retraining [10••]. The individual steps are described in Fig. 1. While several uncontrolled and controlled studies suggest that BFT is effective for DD, it is difficult to compare and pool these trials because the study design, BFT protocols, the control arm, and outcome parameters were heterogeneous. The 2015 ANMS-ESNM consensus recommended BFT as the mainstay of management in DD (Level 1, Grade A evidence) [10••].

## Evidence for BFT

In the late twentieth century, several small and non-randomized trials observed that BFT improved symptoms and rectoanal coordination in patients with chronic constipation [11, 12]. Subsequently, a landmark study observed that BFT was effective in constipated patients with but not without DD [13]. There are three major randomized-controlled trials of BFT for DD. The first report, from 2006, comprised 109

**Fig. 1** Anal and rectal pressures in a patient with defecation disorder before and after biofeedback therapy. Paradoxical anal contraction seen at baseline improves and normalizes with five sessions of biofeedback therapy. (Reproduced with permission from Rao SS, Benninga MA, Bharucha AE, Chiarioni G, Di Lorenzo C, Whitehead WE. ANMS-ESNM Position Paper and Consensus Guidelines on Biofeedback Therapy for Anorectal Disorders. *Neurogastroenterology and Motility* 2015;27(5):594–609)



patients with a DD who were unresponsive to conventional treatment and were randomized to EMG-BFT or polyethylene glycol (PEG) [14••]. Symptoms and anorectal physiology improved in 80% of BFT patients vs 22% of PEG-treated patients [14••]. A year later, another controlled trial with 84 patients observed that symptoms improved in 70% of patients treated with six biweekly sessions of BFT versus 30% and 38% in the diazepam and placebo groups respectively [15••]. Rao and colleagues found that symptoms and anorectal parameters (e.g., balloon expulsion time) improved to a greater extent after manometry-guided BFT than after sham feedback and standard treatment. Thereafter, long-term follow up of 26 patients from the original study suggested that benefits of BFT were sustained, while standard therapy was largely ineffective [16].

Biofeedback therapy reduces dyssynergia, dissatisfaction with bowel habits, and laxative use in patients with DD [9••, 14••, 15••]. However, even in controlled clinical trials wherein biofeedback therapy is provided by exceptionally skilled practitioners, the improvement in bowel symptoms was sustained in only 64% of patients [16]. Because patients were permitted to use stool softeners or milk of magnesia, only 2 of 3 pivotal controlled trials of biofeedback therapy recorded complete spontaneous bowel movements (CSBMs), which is the primary endpoint in drug trials for chronic constipation [9••, 15]. Another pivotal trial did not maintain daily bowel diaries during the treatment period [14••]. In the USA, many third party providers do not cover BFT. All these trials of BFT emanated from academic medical centers. However, most practitioners in the community do not have access to BFT for DD. A small

randomized controlled trial observed that 8-session EMG-BFT was superior to 8 sessions of counseling for improving symptoms in 20 community dwelling elderly women. These benefits were sustained upto 3 months post-treatment [17]. Limited evidence suggests that BFT is also effective for DD in patients with inflammatory bowel disease [18].

In contrast to the aforementioned studies, other trials observed equivocal benefits of BFT. For example, EMG BFT was not superior to muscle coordination training for improving symptoms and anorectal physiology [19]. A Cochrane systematic review addressed the utility of BFT for the treatment of DD [20]. This review suggested that several studies were of poor methodological quality and that the evidence is not sufficient to allow a firm conclusion. However, the review included several suboptimal early pilot studies and trials that included patients with constipation due to causes other than defecation disorder (e.g., rectocele, slow transit constipation) that are less likely to respond to BFT [13], thereby probably diluting the benefits of BFT.

### BFT in Pediatric Constipation

Few studies have evaluated the effects of BFT for managing children with DD. Among 129 constipated children, stool frequency, soiling episodes, and laxative use were not significantly different between conventional treatment (dietary modification, education, laxatives and enema) and manometry-guided BFT [21••]. Another randomized trial concluded that addition of BFT to conventional treatment (dietary fiber, laxatives, and enema) improved defecation dynamics but not

symptoms in constipated children [22]. Other trials came to similar conclusions [23–25], underscoring the importance of dietary modification, toilet training, and adequate laxative treatment in the management of pediatric constipation. In a recent retrospective report, symptoms improved in 38 of 44 constipated children with pelvic floor dysfunction, who had failed dietary and pharmacological treatment. However, the effects of BFT on rectoanal pressures were not significant [26].

### Factors Affecting Outcomes of BFT

Among constipated patients, BFT benefits patients with pelvic floor dysfunction but not patients with isolated slow colon transit [13]. In a post hoc assessment of two prospective trials that provided office or home BFT to 127 patients with DD, patients who used digital maneuvers to defecate or had low bowel satisfaction at baseline were more likely to respond while baseline demographic features, constipation symptoms, manometric and sensory parameters, and balloon expulsion time did not predict the response to BFT [27]. Whether the specific BFT techniques affect the response to BFT is unclear. Anal manometry and surface EMG techniques were equivalent in one study [28], while both of these techniques were superior to balloon-assisted BFT in other studies [11, 29].

### BFT in Fecal Incontinence

The objectives, which are tailored to the underlying deficit(s), are to isolate and strengthen pelvic floor muscles, modulate rectal sensation, and if necessary, improve abdominopelvic coordination [30, 31]. Aided by observation of the visual color-coded display of anal canal and rectal pressure on the screen, patients are trained to squeeze the external anal sphincter muscles without co-contracting the brace muscles and while continuing chest breathing. The squeeze should commence slowly and be sustained for at least 10 s. With rectal balloon distention, patients with increased rectal sensation can be trained to tolerate larger rectal volumes, i.e., to reduce the perception of uncontrollable urgency. Conversely, patients with hyposensation can learn to recognize lower rectal volumes and contract the pelvic floor muscles in response to rectal distension [30, 32, 33]. Indeed increased rectal sensation explained improved fecal continence in FI [33, 34].

### Evidence for BFT

There are two landmark controlled trials of BFT for FI. The first trial randomized to 4 groups (i.e., (1) standard care (advice); (2) advice + instruction on sphincter exercises; (3) hospital-based BFT; and (4) hospital BFT + home EMG-BFT) [35]. Standard care included nine sessions with a specialist

nurse who offered advice on diet, fluids, techniques to improve evacuation, a bowel training program, and dose titration of antidiarrheal medications. BFT was not superior to standard care with advice (53% improved in BFT group versus 54% in standard care + advice) in 171 patients with FI. This suggests that biofeedback therapy does not offer any added benefit over standard care alone. However, this study did not evaluate the efficacy of biofeedback therapy in patients who did not respond to conservative measures. Addressing that limitation, 168 patients with FI underwent a 4-week run-in period; symptoms were adequately relieved in 21% and 14% withdrew from the study [36••]. Thereafter, 108 remaining patients were randomized to 6 biweekly sessions of EMG + biofeedback or Kegel's exercises alone. At 3 months, the improvement (i.e., partial or complete continence) was greater (76% versus 41%) in patients treated with BFT. This improvement was sustained at 12 months [36••]. Based on these findings, the guidelines recommend initial management of FI with conservative measures. Biofeedback therapy is the resolve for patients who do not respond to conservative measures. While home training is often recommended, the only study that formally evaluated this question did not observe any additional benefits of home training over hospital-based BFT alone [35]. The ANMS-ESNM position paper recommended BFT for the short-term and long-term treatment of FI with Level II, Grade B evidence. However, a meta-analysis concluded that due to limited data, it is difficult to assess the role of BFT in FI [37]. There is some evidence that biofeedback and electrical stimulation may be superior to electrical stimulation alone or exercises alone [37] (Table 2).

The CAPABLE trial, which has been published in abstract form only, randomized FI patients into one of four groups: placebo + education ( $n=42$ ), placebo + biofeedback ( $n=84$ ), loperamide + education ( $n=88$ ), and loperamide + biofeedback ( $n=86$ ). At 24 weeks, the change in the severity of FI relative to baseline was not significantly different among these groups versus the placebo + education group [38]. Supporting an earlier study, the improvement was greater for loperamide + education versus biofeedback alone [39]. Another study reassessed outcomes at 7 years after BFT in 61 of 109 initially treated patients. Of those 61 patients, the improvement was sustained in 54% of patients [40]. Patients who do not respond to biofeedback therapy may be candidates for surgery or less invasive options (i.e., sacral nerve stimulation or perianal injection of bulking agents) [6]. In a randomized, controlled, evaluator-blinded trial, 126 adult patients with anal incontinence were randomly assigned to a transanal, submucosal injection of dextranomer in hyaluronic acid or to sphincter training with home BFT; the efficacy of these approaches did not differ [41].

These trials, which were conducted in specialized centers, provided, typically six, biweekly sessions. A report from a secondary care center suggests that a less intense program

**Table 2** Landmark trials and systematic reviews on the utility of biofeedback for pelvic floor disorders

Author name	Year	Group	Number of patients	Study groups	Outcome parameters	Conclusion
Chiarioni [14••]	2006	DD	109	RCT Group 1—5 weekly EMG-BFT sessions Group 2—PEG laxative (14.6–29.2 g/day) plus 5 weekly counseling sessions	Symptoms and anorectal manometry assessed at 6, 12 and 24 months	BFT is more effective than PEG
Rao [9]	2007	DD	77	RCT Group 1—manometry guided BFT Group 2—sham BFT (manometry probe placed in the rectum + relaxation audiotape) Group 3—standard therapy (advice, diet, exercise, laxatives)	Defecation index, BET, CSBMS, colon transit, global bowel satisfaction	BFT was superior than the other groups for all parameters
Heymen [15••]	2007	DD	84	RCT (following 4-week run in with education and medical management) Group 1—BFT Group 2—diazepam Group 3—placebo	Patient reported adequate relief, number of unassisted bowel movements, pelvic floor EMG	BFT is superior to diazepam and placebo in the management of pelvic floor dyssynergia
Woodward [20]	2014	DD	17 studies (n = 931)	Systematic review—role of BFT in chronic constipation (included causes other than DD)		Insufficient evidence to allow firm conclusions regarding efficacy and safety of BFT in chronic constipation
Norton [35]	2003	FI	171	RCT Group 1—standard care (bowel training program and dose titration of antidiarrheals) + advice (on diet, fluids, techniques to improve evacuation) Group 2—advice + sphincter exercises Group 3—hospital-based pressure BFT Group 4—hospital pressure BFT + home EMG-BFT	Episodes of incontinence, continence score, QOL, SF-36, and HAD scale	BFT is not superior to standard care + advice in improving QOL and symptoms of FI
Heymen [36••]	2009	FI	108	RCT in patients who failed medication, education and behavioral changes: Group 1—pelvic floor exercise Group 2—BFT + pelvic floor exercise	FI severity index, days with FI, ARM, patient reported adequate relief	BFT was more effective than pelvic floor exercises in FI patients who did not respond to conservative management
Norton [37]	2012	FI	21 studies (n = 1525)	Systematic review—effects of BFT and/or pelvic floor muscle training in FI		Limited number and methodological weaknesses of trials makes it difficult to assess the role of BFT in FI
Chiarioni [8••]	2010	LAS	157	RCT Group 1—EMG-BFT Group 2—EGS (anal) Group 3—pelvic floor massage	Patient reported adequate relief, pain days per month, pain intensity	BFT is superior to EGS and massage in LAS associated with tenderness on levator traction

BFT biofeedback therapy, DD defecation disorder, FI fecal incontinence, LAS levator ani syndrome, PFD pelvic floor dysfunction, BET balloon expulsion time, CSBMS complete spontaneous bowel movement score, VAS visual analog scale, SF-36 short form-36, HAD hospital anxiety and depression scale, QOL quality of life, ARM anorectal manometry, EGS electrogalvanic stimulation

(i.e., median (inter quartile range) of 3 (2) outpatient sessions) followed by practice at home also improves fecal continence [31]. In that study, the frequency of FI declined by  $\geq 50\%$  in 71% of 205 patients and 47% were continent.

### BFT in Specific Groups

Among women with obstetric sphincter injury, the benefits of BFT and anal sphincter electrostimulation were not significantly different [42]. BFT improved the severity of symptoms and quality of life in patients with scleroderma and FI; this improvement was comparable to that after BFT in patients with functional FI [43]. Involuntary fecal leakage is a component of anterior resection syndrome, a complication that occurs after sphincter saving surgery for rectal cancer. BFT significantly reduced daily stool frequency and improved QOL scores in these patients [44]. Another study used electrical stimulation and biofeedback (ES + BF) therapy for pelvic rehabilitation after intersphincteric resection [45]. Mean stool frequency reduced from 18.8 per 24 h before ES + BF training to 7.8 per 24 h after training. There was significant improvement in the Wexner score as well (17.74 versus 12.93). BFT during the temporary stoma period had no significant effect on anorectal dysfunction after sphincter saving surgery as discussed in the recently published interim report of a randomized trial [46].

### Factors Affecting Outcomes of BFT

Patient factors and methodological variables predict the response to BFT. Short-term treatment success was associated with female sex, older age, and more severe incontinence at baseline [47]. By contrast, baseline severity did not predict a better response in another retrospective study [48]. Among a cohort of 205 patients at a secondary referral center of whom 115 completed biofeedback therapy, women, patients who completed therapy, had good exercise techniques, and received more sessions of therapy, and practiced more at home, were more likely to respond [31].

### BFT for Levator Ani Syndrome

A landmark trial compared the efficacy of BFT, electrogalvanic stimulation, and digital massage in 157 patients with LAS. Patients were divided into two groups; those with LAS “highly likely” and LAS “possible” respectively had and did not have tenderness with traction of the levator ani. Among patients with highly likely LAS, adequate relief of symptoms was reported in 87% participants who received BFT. The response rate was lower for other treatment groups. The number of pain days per month declined from 14.7 at baseline to 3.3 after BFT, 8.9 after electrogalvanic stimulation, and 13.3 after

massage. Clinical improvement was sustained at 12 months. Patients with a “possible” diagnosis of LAS had negligible improvement with any treatment [8••].

### Conclusions

Several controlled trials demonstrate that BFT is effective for managing symptoms in patients with DD. However, BFT for DD is not widely available and most studies were conducted in tertiary centers. Further studies that evaluate the efficacy of BFT in community patients with DD are necessary. In patients with FI, BFT is recommended for patients who do not respond to conservative therapy. BFT is also beneficial for a subset of patients with LAS>.

### Compliance with Ethical Standards

**Conflict of Interest** Adil Bharucha reports personal fees from Allergan, outside the submitted work. In addition, Dr. Bharucha has a patent (Portable anorectal manometry device) with royalties paid to Medspira, a patent (Anorectal manometry probe fixation device) licensed to Medtronic, and a patent (Anal plug) licensed to Minnesota Medical Technologies.

Susrutha Puthanmadhom Narayanan declares no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

### References

Papers of particular interest, published recently, have been highlighted as:

•• Of major importance

1. Rao SS, Bharucha AE, Chiarioni G, Felt-Bersma R, Knowles C, Malcolm A, et al. Functional anorectal disorders. *Gastroenterology*. 2016;150:1430–1442.e4.
2. Bharucha AE, Wald A. Chronic constipation. *Mayo Clin Proc*. 2019; In press.
3. Wald A, Bharucha AE, Cosman BC, Whitehead WE. ACG clinical guideline: management of benign anorectal disorders. *Am J Gastroenterol*. 2014;109(8):1141–57 (Quiz) 058.
4. Chakraborty S, Feuerhak K, Muthyala A, Harmsen WS, Bailey KR, Bharucha AE. Effects of alfuzosin, an alpha-1 adrenergic antagonist on anal pressures and bowel habits, in women with and without defecatory disorders. *Clin Gastroenterol Hepatol*. 2018. <https://doi.org/10.1016/j.cgh.2018.08.036>.
5. Bharucha AE, Dunivan G, Goode PS, Lukacz ES, Markland AD, Matthews CA, et al. Epidemiology, pathophysiology, and classification of fecal incontinence: state of the science summary for the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) workshop. *Am J Gastroenterol*. 2015;110(1):127–36.
6. Bharucha AE, Rao SSC, Shin AS. Surgical interventions and the use of device-aided therapy for the treatment of fecal incontinence and defecatory disorders. *Clin Gastroenterol Hepatol*. 2017;15(12):1844–54.

7. Whitehead WE, Rao SSC, Lowry A, Nagle D, Varma M, Bitar KN, et al. Treatment of fecal incontinence: state of the science summary for the National Institute of Diabetes and Digestive and Kidney Diseases workshop. *Am J Gastroenterol*. 2015;110(1):127–36.
8. Chiarioni G, Nardo A, Vantini I, Romito A, Whitehead WE. Biofeedback is superior to electrogalvanic stimulation and massage for treatment of levator ani syndrome. *Gastroenterology*. 2010;138(4):1321–9. **BFT is superior to electrogalvanic stimulation and pelvic floor massage in LAS associated with tenderness on levator traction. Patients treated with EMG-BFT reported greater symptom improvement i.e., higher rate of patient reported adequate relief, fewer pain days per month, and lower pain intensity.**
9. Rao SS, Seaton K, Miller M, Brown K, Nygaard I, Stumbo P, et al. Randomized controlled trial of biofeedback, sham feedback, and standard therapy for dyssynergic defecation. *Clin Gastroenterol Hepatol*. 2007;5(3):331–8. **BFT is more effective than sham and standard treatment in patients with DD. In this study, patients who were treated with manometry-guided BFT had significant improvement in defecation index, balloon expulsion time, Complete Spontaneous Bowel Movement Score, colon transit, and global bowel satisfaction.**
10. Rao SS, Benninga MA, Bharucha AE, Chiarioni G, Di Lorenzo C, Whitehead WE. ANMS-ESNM position paper and consensus guidelines on biofeedback therapy for anorectal disorders. *Neurogastroenterol Motil*. 2015;27(5):594–609. **BFT recommended for short and long-term treatment of DD (Level I, Grade A), and FI (Level II, Grade B). BFT may be useful for short-term treatment of LAS with DD (Level II, Grade B). It is not recommended for the routine treatment of children with Functional Constipation, with or without overflow FI (Level 1, Grade D).**
11. Bleijenberg G, Kuijpers HC. Biofeedback treatment of constipation: a comparison of two methods. *Am J Gastroenterol*. 1994;89(7):1021–6.
12. Chiotakakou-Faliakou E, Kamm MA, Roy AJ, Storrie JB, Turner IC. Biofeedback provides long-term benefit for patients with intractable, slow and normal transit constipation. *Gut*. 1998;42(4):517–21.
13. Chiarioni G, Salandini L, Whitehead WE. Biofeedback benefits only patients with outlet dysfunction, not patients with isolated slow transit constipation. *Gastroenterology*. 2005;129(1):86–97.
14. Chiarioni G, Whitehead WE, Pezza V, Morelli A, Bassotti G. Biofeedback is superior to laxatives for normal transit constipation due to pelvic floor dyssynergia. *Gastroenterology*. 2006;130(3):657–64. **BFT is more effective than PEG laxative in improving symptoms and anorectal manometry in patients with DD, and the benefits are maintained up to 2 years.**
15. Heymen S, Scarlett Y, Jones K, Ringel Y, Drossman D, Whitehead WE. Randomized, controlled trial shows biofeedback to be superior to alternative treatments for patients with pelvic floor dyssynergia-type constipation. *Dis Colon Rectum*. 2007;50(4):428–41.
16. Rao SS, Valestin J, Brown CK, Zimmerman B, Schulze K. Long-term efficacy of biofeedback therapy for dyssynergic defecation: randomized controlled trial. *Am J Gastroenterol*. 2010;105(4):890–6.
17. Simon MA, Bueno AM. Efficacy of biofeedback therapy in the treatment of dyssynergic defecation in community-dwelling elderly women. *J Clin Gastroenterol*. 2017;51(10):e90–e4.
18. Rezaie A, Gu P, Kaplan GG, Pimentel M, Al-Darmaki AK. Dyssynergic defecation in inflammatory bowel disease: a systematic review and meta-analysis. *Inflamm Bowel Dis*. 2018;24(5):1065–73.
19. Koutsomanis D, Lennard-Jones JE, Roy AJ, Kamm MA. Controlled randomised trial of visual biofeedback versus muscle training without a visual display for intractable constipation. *Gut*. 1995;37(1):95–9.
20. Woodward S, Norton C, Chiarelli P. Biofeedback for treatment of chronic idiopathic constipation in adults. *Cochrane Database Syst Rev*. 2014;(3):Cd008486. <https://doi.org/10.1002/14651858.CD008486.pub2>. **Due to heterogeneity in included studies, no firm conclusion could be drawn regarding the utility of BFT in chronic constipation.**
21. Loening-Baucke V. Biofeedback treatment for chronic constipation and encopresis in childhood: long-term outcome. *Pediatrics*. 1995;96(1 Pt 1):105–10.
22. van der Plas RN, Benninga MA, Buller HA, Bossuyt PM, Akkermans LM, Redekop WK, et al. Biofeedback training in treatment of childhood constipation: a randomised controlled study. *Lancet (London, England)*. 1996;348(9030):776–80.
23. van Ginkel R, Buller HA, Boeckxstaens GE, van Der Plas RN, Taminau JA, Benninga MA. The effect of anorectal manometry on the outcome of treatment in severe childhood constipation: a randomized, controlled trial. *Pediatrics*. 2001;108(1):E9.
24. Borowitz SM, Cox DJ, Sutphen JL, Kovatchev B. Treatment of childhood encopresis: a randomized trial comparing three treatment protocols. *J Pediatr Gastroenterol Nutr*. 2002;34(4):378–84.
25. Sunic-Omejc M, Mihanovic M, Bilic A, Jurcic D, Restek-Petrovic B, Maric N, et al. Efficiency of biofeedback therapy for chronic constipation in children. *Coll Antropolo*. 2002;26(Suppl):93–101.
26. Jarzebicka D, Sieczkowska J, Dadalski M, Kierkus J, Ryzko J, Oracz G. Evaluation of the effectiveness of biofeedback therapy for functional constipation in children. *Turk J Gastroenterol*. 2016;27(5):433–8.
27. Patcharatrakul T, Valestin J, Schmeltz A, Schulze K, Rao SSC. Factors associated with response to biofeedback therapy for dyssynergic defecation. *Clin Gastroenterol Hepatol*. 2018;16(5):715–21.
28. Glia A, Gylin M, Gullberg K, Lindberg G. Biofeedback retraining in patients with functional constipation and paradoxical puborectalis contraction: comparison of anal manometry and sphincter electromyography for feedback. *Dis Colon Rectum*. 1997;40(8):889–95.
29. Pourmomeny AA, Emami MH, Amooshahi M, Adibi P. Comparing the efficacy of biofeedback and balloon-assisted training in the treatment of dyssynergic defecation. *Can J Gastroenterol*. 2011;25(2):89–92.
30. Ozturk R, Niazi S, Stessman M, Rao SS. Long-term outcome and objective changes of anorectal function after biofeedback therapy for faecal incontinence. *Aliment Pharmacol Ther*. 2004;20(6):667–74.
31. Vasant DH, Solanki K, Balakrishnan S, Radhakrishnan NV. Integrated low-intensity biofeedback therapy in fecal incontinence: evidence that “good” in-home anal sphincter exercise practice makes perfect. *Neurogastroenterol Motil*. 2017;29(1). <https://doi.org/10.1111/nmo.1291>.
32. Buser WD, Miner PB Jr. Delayed rectal sensation with fecal incontinence. Successful treatment using anorectal manometry. *Gastroenterology*. 1986;91(5):1186–91.
33. Chiarioni G, Bassotti G, Stanganini S, Vantini I, Whitehead WE. Sensory retraining is key to biofeedback therapy for formed stool fecal incontinence. *Am J Gastroenterol*. 2002;97(1):109–17.
34. Wald A, Tunuguntla AK. Anorectal sensorimotor dysfunction in fecal incontinence and diabetes mellitus. Modification with biofeedback therapy. *N Engl J Med*. 1984;310(20):1282–7.
35. Norton C, Chelvanayagam S, Wilson-Barnett J, Redfern S, Kamm MA. Randomized controlled trial of biofeedback for fecal incontinence. *Gastroenterology*. 2003;125(5):1320–9.
36. 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):1730–7. **BFT added to pelvic floor exercise was**

- more effective than pelvic floor exercises alone in FI patients who did not respond to conservative management.**
37. Norton C, Cody JD. Biofeedback and/or sphincter exercises for the treatment of faecal incontinence in adults. *Cochrane Database Syst Rev.* 2012;(7):Cd002111. <https://doi.org/10.1002/14651858.CD002111.pub3>.
  38. Jelovsek JE, Markland AD, Whitehead WE, Barber MD, Newman DK, Rogers RG, et al. Controlling anal incontinence in women by performing anal exercises with manometric-assisted biofeedback or loperamide: the capable trial. *Female Pelvic Med Reconstr Surg.* 2017;23(5S):S1–S16.
  39. Sjordahl J, Walter SA, Johansson E, Ingemansson A, Ryn AK, Hallbook O. Combination therapy with biofeedback, loperamide, and stool-bulking agents is effective for the treatment of fecal incontinence in women—a randomized controlled trial. *Scand J Gastroenterol.* 2015;50(8):965–74.
  40. Mazor Y, Ejova A, Andrews A, Jones M, Kellow J, Malcolm A. Long-term outcome of anorectal biofeedback for treatment of fecal incontinence. *Neurogastroenterol Motil.* 2018;30:e13389.
  41. Dehli T, Stordahl A, Vatten LJ, Romundstad PR, Mevik K, Sahlin Y, et al. Sphincter training or anal injections of dextranomer for treatment of anal incontinence: a randomized trial. *Scand J Gastroenterol.* 2013;48(3):302–10.
  42. Naimy N, Lindam AT, Bakka A, Faerden AE, Wiik P, Carlsen E, et al. Biofeedback vs. electrostimulation in the treatment of postdelivery anal incontinence: a randomized, clinical trial. *Dis Colon Rectum.* 2007;50(12):2040–6.
  43. Collins J, Mazor Y, Jones M, Kellow J, Malcolm A. Efficacy of anorectal biofeedback in scleroderma patients with fecal incontinence: a case-control study. *Scand J Gastroenterol.* 2016;51(12):1433–8.
  44. 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? *Color Dis.* 2012;14(10):1231–7.
  45. Kuo LJ, Lin YC, Lai CH, Lin YK, Huang YS, Hu CC, et al. Improvement of fecal incontinence and quality of life by electrical stimulation and biofeedback for patients with low rectal cancer after intersphincteric resection. *Arch Phys Med Rehabil.* 2015;96(8):1442–7.
  46. Kye BH, Kim HJ, Kim G, Yoo RN, Cho HM. The effect of biofeedback therapy on anorectal function after the reversal of temporary stoma when administered during the temporary stoma period in rectal cancer patients with sphincter-saving surgery: the interim report of a prospective randomized controlled trial. *Medicine.* 2016;95(18):e3611.
  47. 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):417–27.
  48. Lacima G, Pera M, Gonzalez-Argente X, Torrents A, Valls-Sole J, Espuna-Pons M. Is electromyography a predictive test of patient response to biofeedback in the treatment of fecal incontinence? *NeuroUrol Urodyn.* 2016;35(3):390–4.

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