Therapeutic Application of Manometry: Biofeedback for Management of Fecal Evacuation Disorders

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Abstract

Anorectal dyssynergia is an important cause of defecation disorder, especially among patients with chronic primary constipation. Patients with this condition have an incoordination of abdominal wall muscles and pelvic floor during bearing down, which results in impaired evacuation. Dietary modification, lifestyle modification, and laxatives—which are the standard treatment of constipation—are not able to correct the pathophysiology of this condition.

Biofeedback has been recommended as the treatment of choice for this condition. It is an instrument-based behavioral learning process and has demonstrated a superior benefit over standard treatment or laxatives in several randomized controlled trials. This treatment improves constipation and overall symptoms, as well as dyssynergic pattern of defecation, and showed a long-term efficacy. To date, the biofeedback treatment protocol has not been standardized and a wide variety of techniques have been reported, with insufficient data to determine the most effective modality. In this review, we focus on a manometry-based biofeedback method which measures the pressure at the rectum that represents the propulsive or pushing force, and anal sphincter pressure that represents the sphincter relaxation or contraction. We thoroughly describe the practical biofeedback technique for dyssynergic constipation patients that has been used in our center. Although only studies of biofeedback therapy from Asian countries have been

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reviewed, the response rate in our center and other centers in Asia was comparable to the western studies.

Keywords
Biofeedback therapy • Constipation • Defecation disorder • Dyssynergic defecation • Evacuation disorder

Introduction

Constipation is a common gastrointestinal symptom worldwide. Population-based studies have reported a wide range of prevalence from 0.7 to 79 % in the general population, depending on how constipation is defined, and the study method [1]. Studies among the patients without organic abnormality, so-called primary chronic constipation, in the referral center where colonic and anorectal physiologic studies were performed revealed that there was no physiologic abnormalities detected in 47–60 % of the patients, and this group of patients commonly had clinical characteristics of irritable bowel syndrome-constipation (IBS-C) [2–4]. Inappropriate contractions of pelvic floor muscles, or dyssynergic defecation which resulted in impaired evacuation, was detected in 27–59 %, followed by a slow colonic transit in 3–47 % of patients. A combination of dyssynergic defecation and slow transit as well as dyssynergic defecation with IBS-C are commonly present [2–4]. Though the symptoms associated with constipation are often intermittent and mild, they may be chronic, debilitating, not respond to simple treatments, and have significant impact on the patient's quality of life [5]. Among the patients with chronic or severe symptoms, investigation to find out the underlying pathophysiology of constipation which leads to specific treatment may not only provide a sustained improvement of symptoms, but also improve quality of life.

Fecal evacuation disorder or defecation disorder in severe chronic constipation is commonly caused by dyssynergic defecation, so called anismus, pelvic floor dysfunction, anorectal dysfunction, pelvic floor dyssynergia, obstructive defecation, paradoxical puborectalis contraction, pelvic outlet obstruction, and spastic pelvic floor syndrome [6]. A careful clinical assessment including digital examination can raise the suspicion of this condition [7]. However, definite diagnosis requires anorectal physiological tests including either anorectal manometry, defecography, or a rectal balloon expulsion test, that reveals an incoordination of abdominal wall muscles and pelvic floor muscles during bearing down, which results in impaired rectal emptying. Dietary modification, lifestyle modification, and laxatives—which are the mainstay of constipation treatment—are not able to correct the pathophysiology of this condition and are commonly associated with treatment failure.

Biofeedback therapy is an instrument-based behavioral learning process that is based on "operant conditioning" techniques. This has been used since 1987 for treatment of spastic pelvic floor syndrome [8]. To date, several randomized controlled trials in chronic constipation patients with dyssynergic defecation demonstrated a superior clinical response over standard treatment including laxatives, and

also showed a long-term efficacy [9–12]. Therefore, biofeedback therapy turns out to be a standard and specific treatment for this condition [13–15]. The principle of biofeedback therapy for dyssynergic defecation is to provide feedback information about how anorectal and pelvic floor muscles are working while the patient is pushing and bearing down. The patient will learn how to relax the anal sphincter muscles and how to push properly to induce adequate rectal propulsive force to overcome anal sphincter pressure. Rectal sensory trainings are also performed in some patients who have impaired rectal sensation (Fig. 6.1). Only a few studies of biofeedback therapy from Asian countries have been published, and the response rate was comparable to the western studies [4, 16, 17]. However, this treatment is readily available only in tertiary care centers.

Although the biofeedback technique has been reported for the treatment of dyssynergic defecation for many years, the technique has not been standardized, and rarely described in practical details. Rao et al. described three phases of the biofeedback therapy for constipation which consisted of (1) patient evaluation/enrollment; (2) active phase of therapy; and (3) reinforcement [18].

In this chapter we describe a practical biofeedback protocol which has been used effectively in our center for several years.

Fig. 6.1 During biofeedback training, the therapist provides feedback information about how anal sphincter and pelvic floor muscles are working, so the patient will learn how to relax anal sphincter muscles and how to push properly by visual and verbal feedback mechanisms

Biofeedback Therapy Devices and Techniques

To date, many varieties of biofeedback training techniques have been reported, with insufficient data to determine the most effective modality, and no uniform treatment protocol established [19–22]. In most centers, a specialized nurse or physical therapist performs this training at an outpatient clinic, however home-based training can also be performed [23, 24]. In the outpatient setting, this therapy generally required four to six sessions every 1–2 weeks, with duration of 30–90 min for each session [4, 9, 12]. Two types of devices have been used, including electromyography (EMG) and manometry, to represent how abdominal muscles, pelvic floor muscles, and the anal sphincter are working.

For manometry-based device, four sensors in a solid-state manometry catheter with a 1 cm interval at the anal sphincter zone and latex balloon at the catheter tip, has been used with software for displaying the manometric data (Fig. 6.2) [4, 25]. The most upper tracing displays the rectal pressure and the other lower tracings display pelvic floor muscles and anal sphincter pressure. The latex balloon, which is placed at the rectum, is used for rectal sensory training. While training with the solid-state catheter, the patient is seated upright in the commode, which is the physiological position for defecation. Use of a water-perfused polyvinyl catheter with a compliant balloon at the tip has also been reported [26, 27]. However, when training is performed in the upright position, this perfusion system may not correctly represent the rectal and anal sphincter pressure while the pelvic floor is descending. Therefore, the training with a water-perfused system is usually performed in the lateral position, which is not a physiologic position, and water dripping out may disturb the patient if training time is prolonged.

For EMG-based device, an anal plug containing longitudinally oriented metal plate electrodes is used. EMG activity is amplified, filtered to eliminate low-frequency EMG signal from the smooth muscle and high-frequency activity representing ambient electric noise, and then averaged and displayed. This recording reflects both the external anal sphincter and puborectalis muscles. A second channel of EMG is recorded from electrodes applied to the skin overlying the rectus abdominis muscles. For this channel, the two active electrodes are positioned in a vertical line with the first situated 2 cm below the umbilicus and the second placed 5 cm below the first one. A reference electrode is placed midway between these two active electrodes. The patient watches a computer monitor displaying the rectus abdominis EMG on

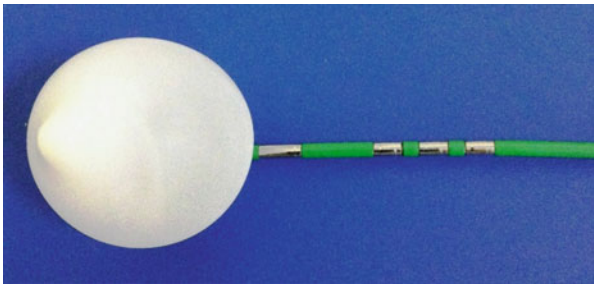

Fig. 6.2 A solid-state manometry catheter (for biofeedback training, a latex balloon is attached at the catheter tip). While training with this catheter, the patient can sit on the commode and training can be performed

the top and the pelvic floor electromyography immediately below it [11]. Commercial software is used to record and display these signals. The rectal balloon cannot be coordinated in the EMG-based system, so rectal sensory training cannot be done. Although there were randomized control studies comparing treatment outcome between different devices, the heterogeneity of these treatment protocols and small sample size make it difficult to detect the difference of outcome [19–22]. In our center, we use solid-state manometry-based devices for training because of the accuracy of pressure measurement and patient preference, as described above, and we always perform rectal sensory training in patients with rectal hyposensitivity.

The frequency of loss to follow-up is 0–30 %, which is similar between different biofeedback techniques and the control group [9, 11, 12, 19–22, 26]. In this review, we only focus on the manometry-based method, which measures the pressure at the rectum that represents the propulsive or pushing force, and anal sphincter pressure that represents sphincter relaxation or contraction. The practical technique that has been used in our center consists of three steps:

Step 1. Provide Education on Anorectal Anatomy and Defecation Physiology

An understanding of normal defecation physiology, including an occurrence of high-amplitude colonic-propagated contractions after meals and awakening, may help the patient learn the sense of defecation and take advantage of these contractions to promote bowel movement and avoid unnecessary straining. The patient should be advised to respond to the sensation of stool and go to the toilet after awakening. An early morning caloric meal or a wake-up meal is usually recommended for patients in our center to promote the sensation of bowel movement. A previous study in Asia suggested that skipping breakfast was associated with constipation in working women in Japan [28].

At this step, the therapist can also elucidate the correlation between toilet-sitting posture and appropriate anorectal anatomy for stool passage, as well as the correlation between intra-abdominal pressure control by abdominal breathing and the effective pushing force. Patient education about anorectal anatomy and normal physiology of defecation can be done after making the diagnosis of defecation disorder. The appropriate toilet-sitting posture, abdominal breathing exercise, and recognition of normal defecation physiology can be practiced at home prior to scheduling the patient for biofeedback treatment. This process should be repeated again at the first session of biofeedback treatment for understanding tracings on the monitor, which represent coordination of abdominal muscles as well as pelvic floor and anal sphincter.

Step 2. Identify and Target Defecation Problem Individually

Because biofeedback therapy is a labor-intensive treatment, patient training by targeting on a specific problem—and not providing universal training—may shorten

treatment duration and create positive reinforcement. The therapist should evaluate whether the patient has specific problem(s) which can lead to dyssynergic defecation. These problems may be divided into three major groups: (1) ineffective rectal propulsive force; (2) paradoxical contraction or inadequate anal sphincter relaxation; or (3) rectal sensory impairment. Treatment should focus on each problem individually (Table 6.1). Preliminary data from our center revealed that among 33 patients with functional defecation disorders by ROME III criteria prior to the biofeedback treatment, 48 % were unable to performed abdominal breathing exercise or hold their breath while bearing down, 70 % had anal sphincter contraction or inadequate relaxation and 57 % of these patients did not recognize this inappropriate anal sphincter contraction. Thirty-six percent of patients did not have urgency sensation when 50 cc. rectal balloon was inflated and 42 % of patients did not recognize the relaxation of anal sphincter during rectal balloon distension. A pathophysiologic mechanisms of dyssynergic defecation described in Table 6.1 should be identified and informed to the patients. During biofeedback training, patient and the therapist should focus on correcting the problem(s).

Ineffective rectal propulsion The problems that are associated with ineffective rectal propulsion are: (i) inappropriate toilet sitting posture; (ii) breathing or exhalation during pushing; and (iii) inappropriate use of muscles during pushing. These problems can be identified by observing the breathing pattern, abdominal wall muscle usage, sitting position, and manometric tracing profiles while the patient is pushing. When asking the patient to bear down, a patient with ineffective rectal propulsive force may exhale or not hold their breath, or cannot contract their diaphragm and abdominal wall muscles appropriately to increase the intra-abdominal pressure [29], which can be observed in the manometric tracing on the computer screen (Figs. 6.3 and 6.4). Among these patients, therapy should emphasize abdominal breathing exercises to strengthen the diaphragm and abdominal wall muscles. Breath holding while bearing down should also be advised, and patients should be advised to keep practicing at home. Appropriate toilet-sitting posture, which includes slight bending forward and increased hip flexion by lifting both feet, may widen the recto-anal angle and let stool come down easily. Looking at the screen under the therapist's supervision will help the patient understand the importance of breath holding and appropriate sitting posture. However, increased pushing effort should be carefully advised, particularly to the patients with paradoxical anal sphincter contraction, because increased pushing force may also increase anal sphincter pressure. During biofeedback training, the appropriate pushing pressure is the level that just overcomes the anal sphincter pressure while the rectal balloon is inflated. Experiences in our center suggest that slowly and gently increasing pushing force can induce anal sphincter relaxation more easily than rapidly increasing pushing force or excessive straining. Between biofeedback sessions, stool softeners—including osmotic laxatives—may be useful in patients who have hard stool. This will help to avoid excessive straining at home during the biofeedback treatment program.

Table 6.1 How to identify defecation problem(s) in dyssynergic constipation patients, and treatment strategy for each problem

Problem	How to identify the problem	Treatment strategy
Inadequate rectal propulsion		
Inappropriate toilet sitting posture Breathing or exhalation during pushing Inappropriate use of muscles during pushing	Observe the patient position during pushing. Observe the patient respiration during pushing (whether the patient does not hold breath during pushing). Cannot or does not use diaphragm or perform diaphragmatic breathing during pushing (abdominal girth does not increase during inspiration before pushing).	Correct posture (mild bending of the body forward and hip flexion during pushing) Advise about breath holding while bearing down Advise the patient to do a halfway inspiration and hold breath before pushing Abdominal breathing exercise training Carefully advise about increasing pushing effort; it should gradually and gently increased after inspiration by diaphragmatic breathing
Paradoxical contraction or inadequate anal sphincter relaxation		
Does not know where the sphincter muscle is Does not know the sensation of sphincter muscle relaxation or contraction Does not know how to control and relax the anal sphincter muscle	Cannot contract the anal sphincter upon request to do so. Ask whether the patient has sensation of relaxation during anal sphincter relaxation in response to rectal balloon distention. If the patient has paradoxical contraction of the anal sphincter during pushing, ask the patient whether the patient experiences the sensation of sphincter contraction. Observe contraction or relaxation of the anal sphincter after asking the patient to squeeze and push.	Let the patient squeeze and observe the tracing displayed on the computer screen to realize that anal sphincter can be controlled. Help the patient to realize and distinguish anal sphincter-relaxing sensation by passive (rectal balloon distention) and active anal sphincter relaxation (pushing). Visual and verbal feedback to help the patient realize the sensation of anal sphincter relaxation and contraction during pushing. Visual and verbal feedback to relax the anal sphincter while pushing and contracting while squeezing.
Impaired rectal sensation	High rectal sensory threshold for first sensation of stool or urgency. Does not know what the sensation of stool or urgency is.	Use rectal balloon distention at a volume that can generate the first sensation of stool or urgency, and then gradually decrease rectal balloon distension to establish the rectal sensation at an appropriate volume. The patient may not have sensation of stool or urgency, but may have other sensation in response to 60–120 ml rectal balloon distention. The therapist should try to change the patient's concept of the sensation of stool/urgency so that response to that sensation is appropriate.

Paradoxical contraction or inadequate anal sphincter relaxation Some patients with dyssynergic defecation are not only unable to contract or relax the anal sphincter, but also do not know where their anal sphincters are and how they are working while bearing down. These patients may not be able to realize contraction and relaxation of anal sphincter as desired and hence, unable to control it.

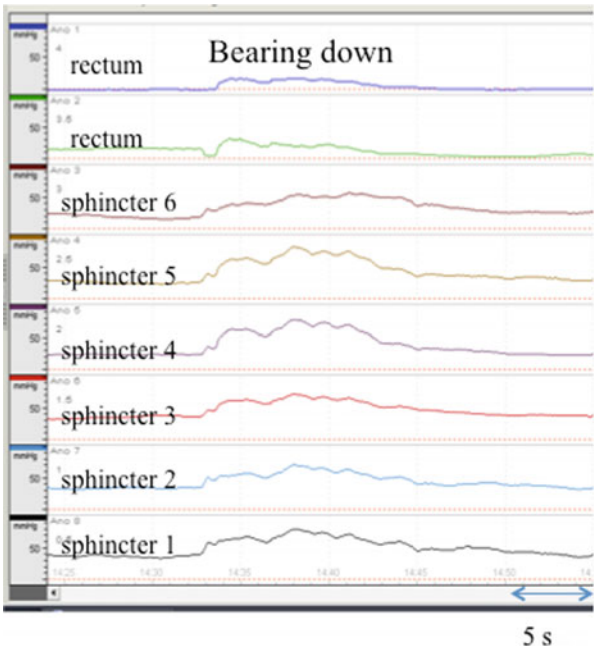

Fig. 6.3 This tracing demonstrates impaired rectal propulsive force from inappropriate use of abdominal muscles without breath-holding. Pushing force is weak but sustained. Paradoxical anal contraction is also shown

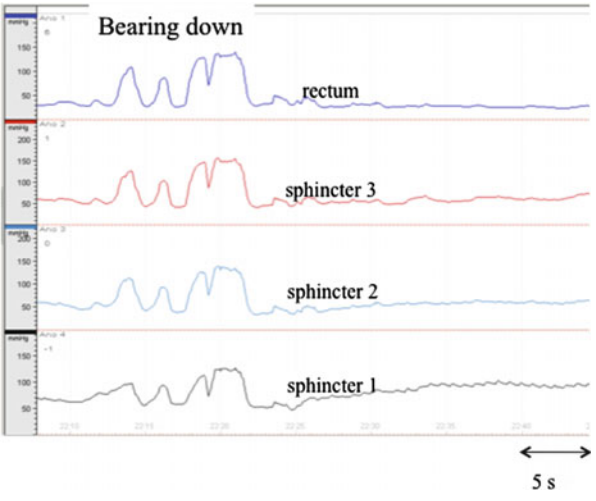

Fig. 6.4 This tracing demonstrates non-sustained rectal propulsive force due to a breath-holding problem

Experiences in our center suggest that patients who cannot realize whether the sphincter contracts or relaxes during pushing will not respond well to the biofeedback therapy, since they cannot maintain appropriate pushing technique learned during the training. Therefore, an initial step for the patients who have paradoxical anal sphincter contraction or inadequate relaxation is to let them realize that anal sphincter can be controlled, and recognize how their anal sphincter is working. During this step in our center, therapists ask patients to squeeze and then quickly relax the anal sphincter without bearing down. The patients will learn how to control the anal sphincter and relationship between and the tracing on the monitor (Fig. 6.5). Then, rectal balloon inflation should be performed to induce more anal sphincter relaxation by activating the recto-anal inhibitory reflex and let patients distinguish difference between the anal sphincter squeezing and relaxing sensations (Fig. 6.6). After the patient knows how to control the anal sphincter and recognize the difference between squeezing and relaxing sensations, the therapist can then ask the patient to push (bearing down) and also watch the tracings in the monitor. If the anal sphincter contracts while the patient is bearing down, the patient should recognize and stop pushing. Each step should be repeated until the patient appreciates each step before performing the next step. The therapist's role is not only to supervise, but also reassure the patient during practicing. Finally, the patient will learn how to relax the anal sphincter while pushing and realize the sensation of the sphincter relaxation by visual and verbal feedback mechanisms. Patients who can relax the anal sphincter and realize whether it relaxes or contracts during pushing usually have a good long-term response to biofeedback therapy.

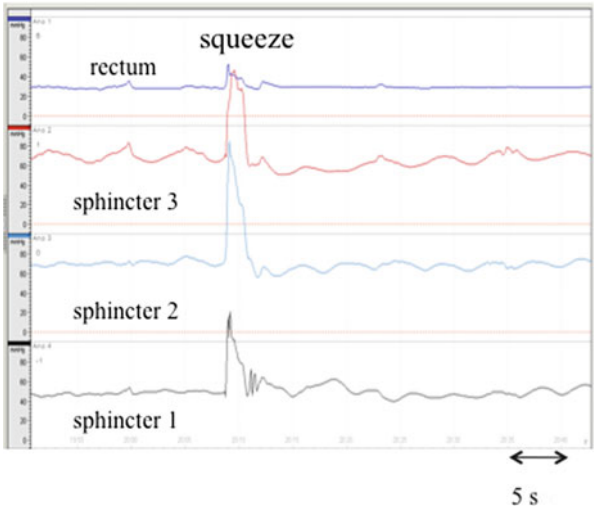

Fig. 6.5 When asking the patient to squeeze and then quickly relax their anal sphincter without bearing down, the patient will learn how to control the anal sphincter and also learn the relationship between patient actions and the tracing on the monitor

Impaired rectal sensation The other important step for the dyssynergic defecation patients—who have high rectal sensory threshold for the first sensation of stool, or for urgency of stool, or even do not know what these sensations are—is sensory training. Previous studies reported that 40 % of patients with dyssynergic defecation also had impaired rectal sensation [30] and this have been reported to be associated with poor biofeedback outcome [4]. This could be explained by either impaired rectal perception for stool urgency that lead to decreased rectal contractility, less sensation of bowel movement or urge to go to the toilet, and as a consequence, result in harder stool and even fecal impaction. This condition may be associated with more severe constipation or megarectum [31, 32]. Although it is unclear whether impaired rectal sensation is the cause or the outcome of severe constipation, there were studies that demonstrated an improvement of rectal perception after biofeedback therapy in patients with constipation [9, 33].

Rectal sensory training aims to promote a better awareness of stool, the volume of which is less than that previously perceived by rectal balloon distension. In this training step, the rectal balloon is gradually inflated until the patient perceives the urge for defecation. After that, the balloon is repeatedly inflated with gradually decreasing volume. By asking the patient to observe the change of tracings which represent the rectal pressure, together with paying attention to the sensation in their rectum, the smaller and appropriate volume of stool can be perceived.

Some patients may not have real sensation of stool or urgency, but have other sensation in response to 60–120 ml rectal balloon distention. In this case, the therapist should try to change the patient concept of the sensation of stool/urgency and teach the patient to respond to that sensation appropriately.

On the other hand, rectal hypersensitivity may also be found in patients with defecation disorders [34]. This condition has been demonstrated to be associated

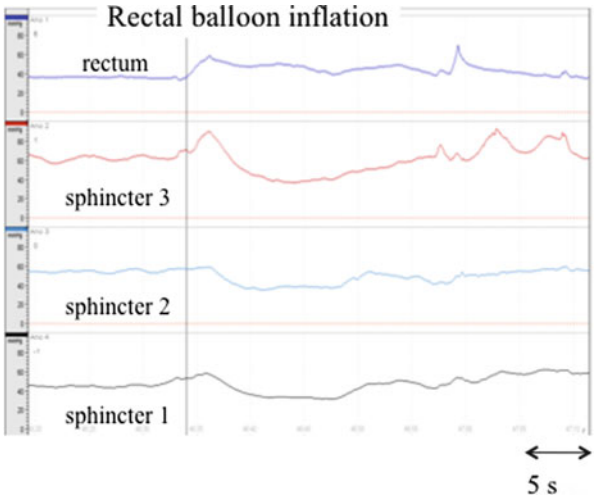

Fig. 6.6 Rectal balloon inflation is performed to induce more anal sphincter relaxation by activating the recto-anal inhibitory reflex, to let patients distinguish the difference between the anal sphincter squeezing and relaxing sensations

with IBS [35, 36]. Our previous study revealed that 58 % of dyssynergic defecation also had clinical features of IBS, and the presence of IBS in dyssynergic constipation patients does not affect the outcome of the biofeedback therapy [4]. However, the effect of rectal hypersensitivity on biofeedback treatment outcome has not been well established, as seen in Table 6.1.

Step 3. Maintenance

Standard treatments of constipation such as adequate fiber intake, exercise, not neglecting stool call, and timed toilet after wake-up or breakfast, should always be advised, and patients should be encouraged to keep practicing at home including abdominal muscle exercise, avoiding excessive straining, and sitting in the correct posture. Dyssynergic constipation patients without delayed colonic transit who can achieve all biofeedback training tasks or overcome all identified physiologic problems usually have a good long-term response without any laxative uses.

However, laxatives can be used when stool is hard, especially in patients with concomitant delayed colonic transit, but enema and maneuver to help defecation should be discarded. Asking the patient to keep a stool diary in which he or she records stool form, defecation time, and laxative or maneuver usage, may help the therapist to evaluate training outcomes more precisely. During each training visit, overall symptoms, as well as specific constipation symptoms during the training interval, should be assessed and therapy should be re-evaluated for each problem discussed above in Step 2 in every session.

Efficacy of Biofeedback Therapy

The efficacy of biofeedback therapy varies between 44 and 100 % [37]. Recent randomized control trials in refractory chronic constipation patients with dyssynergic defecation reported superior benefits over placebo or laxatives with 70–80 % response rate after EMG or manometry-based treatment for four to six sessions [9, 11, 12]. This treatment significantly increased the number of spontaneous bowel movements and improved overall symptoms, constipation symptoms, and dyssynergic pattern of defecation, as well as colonic transit time (Fig. 6.7a, b). Long-term studies also shown these benefits over standard treatment at 1-year follow-up [10, 12]. The protocol in a recent long-term study was six sessions of 1-h manometry-based biofeedback treatment, simulated defecation training, and sensory training. Follow-up schedule was every 3 months, and patients received biofeedback reinforcement at their returning visit [10]. Biofeedback therapy also provides benefits for chronic constipation patients who have combined anorectal dyssynergia and slow transit [3, 4], as well as IBS constipation with evidence of anorectal dyssynergia [4]. One uncontrolled study evaluating biofeedback treatment on isolated slow transit constipation revealed no benefit [38]. Most studies defined treatment failure after four to six sessions, and factors associated with treatment failure included

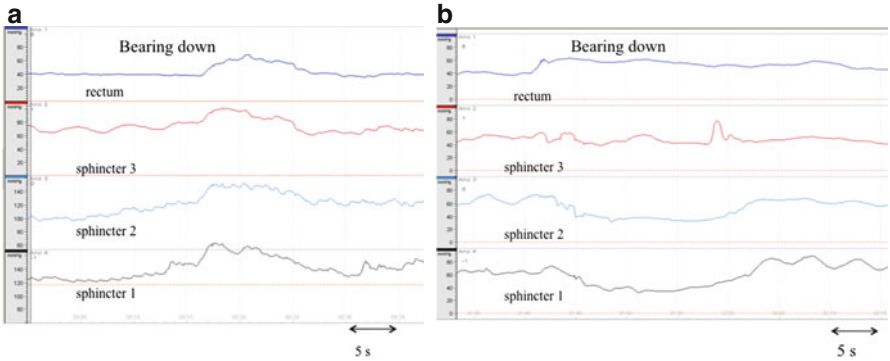

Fig. 6.7 (**a**, **b**) Comparison of anorectal manometry tracing (**a**) before and (**b**) after biofeedback treatment. After treatment, a paradoxical anal sphincter contraction can relax appropriately during bearing down

severe constipation symptom, digital facilitation of defecation, slow transit constipation, impaired rectal sensation, and increased anorectal angle during squeeze [1, 5, 6]. The impact of biofeedback treatment on quality of life or psychological state have not been assessed (Table 6.2).

Conclusion

Chronic constipation patients, especially those who have failed standard therapy, should undergo anorectal function tests to identify the potentially treatable condition of dyssynergic defecation. Biofeedback therapy is the highly effective and preferred treatment. During biofeedback therapy, physiologic problem(s) of defecation should be carefully identified and corrected individually.

Table 6.2 The randomized control studies of biofeedback therapy on dyssynergic defecation

Study	Comparison(n)	Technique	Primary outcome	Loss to follow-up	Follow-up duration	Result
Chiarioni 2006 [12]	Biofeedback (54) *vs.* polyethylene glycol (55) after 30 days run in	EMG, 5 weekly, 30 min/session	Global symptoms improvement	2/54 (3.7 %) *vs.* 4/55 (7.3 %)	24 months	**Favor biofeedback** Major global symptom improvement 80 % *vs.* 22 %, $P<0.01$ More pelvic floor relaxation, improved balloon evacuation and urge threshold; *vs.* polyethylene glycol, $P<0.01$
Heymen 2007 [11]	Biofeedback (30) *vs.* diazepam (30) or placebo pill (24) after 30 days run in	EMG, 6 biweekly, 50 min/session	Adequate relief of constipation	7/30 (23.3 %) 7/30 (23.3 %) 4/24 (16.7 %)	3 months	**Favor biofeedback** Adequate relief of constipation 70% *vs.* 23 % and 38 %, $P<0.01$ More pelvic floor relaxation *vs.* diazepam and placebo, $P=0.001$
Rao 2007 [9]	Biofeedback (28) *vs.* sham feedback (25) or standard treatment (24)	Manometry, 6 biweekly, 1 h/ session	Complete spontaneous bowel movements (CSBMs), global bowel satisfaction	7/28 (25 %) 4/25 (16 %) 1/23 (4.3 %)	3 months	**Favor biofeedback** Global bowel satisfaction 75 % *vs.* 48 % and 63 %, $P<0.01$ Higher CSBMs ($P<0.05$), corrected dyssynergia ($P<0.0001$), improved defecation index ($P<0.0001$), and decreased balloon expulsion time ($P<0.05$) *vs.* sham, standard treatment
Farid 2009 [26]	Biofeedback (24) *vs.* botulinum injection 500 unit (24)	EMG, 8 biweekly, sessions duration not defined	Not clearly defined	3/24 (12.5 %) *vs.* 0 %	1 year	**Similar efficacy** Overall satisfaction 25 % vs. 33 %, $P>0.05$ Both treatments significantly improved dyssynergic pattern and balloon expulsion time, but were not significantly different between groups

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