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REVIEW ARTICLE

Pelvic floor rehabilitation for defecation disorders

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Abstract
Pelvic floor rehabilitation is frequently recommended for defecation disorders, in both constipation and fecal incontinence. However, the lack of patient selection, together with the variety of rehabilitation methods and protocols, often jeopardize the results of this approach, causing difficulty in evaluating outcomes and addressing proper management, and above all, in obtaining scientific evidence for the efficacy of these methods for specific indications. The authors represent different gastroenterological and surgical scientific societies in Italy, and their aim was to identify the indications and agree on treatment protocols for pelvic floor rehabilitation of patients with defecation disorders. This was achieved by means of a modified Delphi method, utilizing a working team (10 members) which developed the statements and a consensus group (15 members, different from the previous ones) which voted twice also suggesting modifications of the statements.

Keywords Defecation disorders · Biofeedback · Guidelines

Introduction

Defecation disorders are found in up to 25% of the adult population [1, 2]. Treatment with pelvic floor rehabilitation (PFR) is often recommended. The variety of methods and of protocols, together with the lack of clear indications (often because of mistaken indications and protocols), causes difficulty especially in evaluating the outcomes of this therapy [3]. The Italian Society of Hospital Gastroenterologists and Endoscopists (AIGO), the Italian Society of Colorectal Surgery (SICCR), the Italian Society of Gastroenterology (SIGE) and the Italian Society of Neurogastroenterology and Motility (SINGEM) convened a working group to identify clear indications, clinical and manometric criteria and protocols for correctly executed PFR.

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Materials and methods

Using a modified Delphi method [4], the working group developed statements on selected topics (indications, manometric criteria, PFR protocols) on the basis of personal experience and literature reviews. The statements developed were then voted on anonymously by a Consensus group of experts (different from the first group). Members of the Consensus group were selected by means of different criteria (gastroenterologists and surgeons with demonstrated experience in gastrointestinal physiopathology—particularly in the field of constipation/incontinence, anorectal manometry and pelvic floor rehabilitation). They worked in different areas of the country; thus representing different socioeconomic and cultural backgrounds. The process lasted approximately 2 years. The Consensus group (which did not develop the statements) voted twice. Between the two votes and after the second vote (for the final version) statements were revised, taking into account the Consensus members' remarks. For the first vote a simple agree/disagree scale was adopted and the Consensus members were also asked to briefly motivate their possible disagreement. For the second vote, a three point scale was used: fully agree, partially agree, disagree

(also requiring members to briefly motivate partial agreement or disagreement). Agreement on a statement by two-thirds (≥ 67%) of the group was defined as consensus.

Indications and clinical criteria

1. The aims of pelvic floor rehabilitation (PFR) are to restore abdominopelvic coordination, sphincter motor function and, if needed, rectal sensitivity in defecation disorders characterized by alteration of these functions.

PFR is reserved for selected patients, in whom there is a specific indication, and when conventional medical treatment (drugs, enemas, diet prescriptions) has failed.

full agreement 93.75
disagreement 6.25

2. PFR success depends on careful diagnosis and accurate patient selection [5]. When extraintestinal pathologies are present, a multidisciplinary approach is mandatory, involving various specialists (gastroenterologist, surgeon, proctologist, gynecologist, urologist, neurologist, physiatrist and physiotherapist).

3. A complete patient history (physiological, pathological and pharmacological) is mandatory, to identify limiting/confusing factors which can invalidate PFR results and make it difficult PFR to be carried out correctly (cognitive or motor limitations, psychiatric illnesses, previous surgery, systemic serious pathologies, limiting medical therapies, conscious or involuntary patient refusal to perform rehabilitation). In patients with eating disorders, this therapy by the inability to perform dietary interventions. It is important to examine concomitant pathologies (for instance, a multidisciplinary approach—gastroenterologist, surgeon and urogynecologist—is needed in many female patients because of simultaneous abnormalities in the vaginal posterior, middle and anterior compartments) [6].

full agreement 93.75
disagreement 6.25

4. A careful cognitive and psychological evaluation of the patient (with the possible involvement of a psychologist and/or psychiatrist) is particularly relevant.

The presence of psychiatric disorders such as anxiety and depression must be carefully evaluated. In many patients PFR is unsuccessful because it breaks the obsessive rituals the patient has developed to manage defecation, and this actually hides underlying psychiatric disorders. In such cases, before PFR psychological or psychiatric treatment is suggested.

full agreement 93.75
disagreement 6.25

5. Motivation, cooperation ability and patient willingness to undergo a demanding, prolonged therapy, must be also evaluated.

The evaluation can be pursued by means of an interview before starting PFR at the purpose of this is to:

- Inform the patient about correct bowel habits (for instance daily evacuation is not essential; if possible, evacuation must not be postponed; prolonged straining must be avoided).
- Clarify reeducation targets and the actual amount of improvement you can obtain with PFR, to avoid unrealistic expectations. This target is obtained by means of simple and short explanations of anatomy and defecation physiology.
- Enable patients to understand their key role in reaching the target and the need for regular daily (not obsessive) exercise (Exercise must be gradually introduced into daily life).

Strict cooperation is needed between the referring physician and the therapist in charge of the patient, as well as between the patient and the therapist.

full agreement 93.75
disagreement 6.25

6. Patients of all ages can undergo PFR, except for young children (pre-school).

The actual cutoff is the presence of organic pathologies and of cognitive and/or motor abnormalities, which can compromise the possibility of actively performing PFR. The patient's effective willingness to follow a demanding and time-consuming treatment is also very important. Younger patients have a better possibility of understanding and performing PFR compared to older ones.

full agreement 81.25
partial agreement 6.25
disagreement 12.50

7. PFR is recommended in the following pathologies [1, 4, 5]: functional defecation disturbances (functional anorectal constipation due to defecation disorder/dyssynergic defecation), mixed constipation (association between anorectal constipation/dyssynergic defecation and primitive slow transit constipation), active fecal incontinence (including incontinence secondary to anterior rectal resection), and chronic anorectal pain.

full agreement 93.75
disagreement 6.25

Constipation

8. In cases of constipation there the main problem, low frequency of evacuations or modified defecation dynamics must be clearly diagnosed. It is also important to know if the patient usually postpones defecation and to know the characteristics of the feces (Bristol stool scale [7]).

full agreement 93.75
disagreement 6.25

9. Defecation scores, questionnaires and diaries [8, 9] allow a better evaluation of defecation in a standardized way, to ensure a more objective assessment of a patient's history before and after PFR. Although the usefulness of scores is universally recognized, these are not always used in clinical practice.

full agreement 93.75
disagreement 6.25

10. Anorectal functional constipation (or abdominopelvic dyssynergia, or functional dyschezia), better defined in the Rome IV [10] criteria as defecation functional disorder, is characterized by poor recruitment and/or poor coordination of the pelvic/abdominal muscles during defecation [11], sometimes due to sphincter hypertonicity and/or to altered (usually decreased) rectal sensitivity.

On the basis of the main symptoms, anorectal constipation is divided by the Rome IV criteria into two subgroups (resulting from insufficient propulsive strength and from a properly defined dyssynergic defecation) [10]. It may or may not be associated with organic abnormalities (such as rectoceles, anal intussusception, perineal descent, enteroceles and sigmoidoceles) which are often the consequences of excessive straining at stool. Even though history and clinical data are often sufficient, the diagnosis must be confirmed by at least two tests (depending on local availability: manometry and balloon expulsion test, or manometry and defecography, pelvic US, etc.). Unfortunately, the literature data do not indicate the exact sequence and the minimum number of tests to be preferred in clinical practice to correctly define the role of anatomic or functional abnormalities underlying defecatory dysfunction.

full agreement 93.75
disagreement 6.25

11. From a pathophysiological point of view, the most suitable therapy for functional defecation abnormalities is PFR [2]; the main aim of PFR is to restore correct abdominopelvic synergy, with adequate coordination and relaxation of the pelvic floor in association with expulsive movements and abdominal wall contraction.

Conventional therapeutic approaches (based on dietary and behavioral modifications, together with different kinds of laxatives, at the maximum tolerated dose, or even in association) must be taken into account before PFR, since the latter is expensive (often not reimbursed by the National Health System), time consuming, unavailable in many places, and when it is available, waiting lists are long. In case of failure of conventional therapies and when the diagnosis of anorectal functional constipation is correct and the coordination disturbance is clear and clinically severe, PFR remains a first-line therapy, associated with dietary and behavioral modifications.

full agreement 81.25
partial agreement 6.25
disagreement 12.50

12. In the presence of mixed constipation (associated anorectal and colonic motor dysfunction), with prominent expulsion deficits, these abnormalities must be verified by diagnostic tests. Colonic abnormalities (megarectum, megacolon) may be identified by radiologic techniques (e.g. barium enema or, preferably, computed tomography (CT) scan of the colon) and intestinal transit time with radiopaque markers, whereas dyssynergia can be identified as detailed in item 9 (see above). It must always be kept in mind that decreased transit time, especially in the left colon/rectosigmoid colon, can be secondary to dyssynergia [12].

full agreement 93.75
disagreement 6.25

Fecal incontinence

13. In fecal incontinence, careful research into etiologic factors (such as post-delivery lesions, adverse effects of surgery or radiotherapy, complications of diabetes mellitus, rectal prolapse, neurologic abnormalities) must precede PFR A patient's obstetric history is always important, and in this instance it is particularly relevant (pregnancy number, abortions, vaginal delivery and cesarean sections, newborn weight, delivery lacerations, episiotomies). Fecal incontinence is often associated with urinary disturbances, which must be looked into. The patient must also be questioned about the type and extent of the problem (gas incontinence, soiling, massive incontinence), and it

must be established whether incontinence is active or passive. Even for incontinence, it may be useful to employ validated scores [13–15].

full agreement 93.75
disagreement 6.25

14. Active incontinence (the discharge of fecal matter in spite of active attempts to retain bowel contents) or urge incontinence [1, 10, 16–18] is frequently multifactorial [3, 10] but mainly due to external anal sphincter (EAS) damage. Often, but not always, sphincter hypotonicity and/or low anal striated muscle recruitment are evident at digital rectal examination. Wide sphincter lesions, spinal cord lesions, dementia, psychosis, and young age (< 8 years), are all contraindications for PFR [1].

Fecal incontinence can be due to peripheral nervous lesions (such as diabetes mellitus, perineal descent, difficult delivery.) or adverse postsurgical effects (hemorrhoids or anal fissure surgery, complications after stapled transanal rectal resection (STARR), anterior rectal resection, total colectomy), reduced rectal compliance, or altered rectal sensitivity (decreased or increased). This multifactorial pathogenesis justifies the combination of techniques involving muscle strengthening and volumetric rehabilitation. Results of PFR in fecal incontinence are much less satisfying than in functional anorectal constipation. Even for fecal incontinence, for a better use of available resources, the patient should have shown resistance to dietary and behavioral instructions [17, 19], and to therapy with thickening drugs, to loperamide and to colestiramin, before PFR is recommended. Moreover, fecal consistency must not be more than 5 according to the Bristol scale. The diagnosis must be supported by anorectal ultrasound and anal manometry. Urge incontinence can also be treated by tibial electrostimulation [20, 21].

full agreement 81.25
partial agreement 6.25
disagreement 12.50

15. Fecal passive incontinence is mainly due to internal anal sphincter (IAS) damage or involution. If these alterations cause severe basal hypotonicity, PFR is contraindicated [1]. Rehabilitation therapy is almost of no use in such cases, even though some authors still recommend it simply to obtain striated muscle strengthening and a better awareness of the pelvic floor for better symptom management.

full agreement 93.75
disagreement 6.25

16. In case of chronic anorectal pain [1, 4], organic, neurologic and psychiatric diseases must be excluded. When pain is due to proctalgia fugax or levator ani syndrome, PFR can be considered if an appropriate medical therapy (such as topical analgesics or muscle relaxants, tricyclic antidepressants, pregabalin) has failed after an adequate period of time. However, the literature data are lacking and regular clinical experience with this approach is quite disappointing. It has been hypothesized that chronic anorectal pain is due to protracted pelvic muscle spasm [11]. The Rome IV criteria identify three clinical scenarios (often not easily differentiated from one other): levator ani syndrome, proctalgia fugax and unspecified pain [10, 11]. Digital rectal examination may show an increased tone and painful stretching of the puborectalis muscle, associated or not with abdominopelvic dyssynergia. However, motor abnormalities (which should be documented by means of anorectal manometry and would be positively predictive of a good result of PFR) [11] may be absent. Their absence is considered by several authors to be a contraindication for PFR (i.e., if there is no alteration in muscle dynamics, PFR is of no use).

Organic pathologies (such as sphincteric scars, or rectal prolapse.), are a clear contraindication for PFR.

full agreement 93.75
disagreement 6.25

17. Solitary rectal ulcer may be due to abdominopelvic dyssynergia. In this case, it is an indication for PFR [1]. Conversely, if it is associated with rectoanal intussusception or rectal prolapse and is due to mucosal ischemia, the primary treatment modality is surgery. PFR can be carried out later if a functional disorder of defecation is also involved.

full agreement 81.25
partial agreement 6.25
disagreement 12.50

18. PFR may also be useful in the following cases:

- Incontinent patients undergoing injection of bulking agents (the pelvic floor is trained and prepared for surgery, through strengthening of the sphincter muscles).
- Patients undergoing low rectal resection while still diverted prior to stoma reversal (improvement by PFR of muscle tone before recanalization surgery; possible improvement of retention capacity through volumetric rehabilitation).

full agreement 93.75
disagreement 6.25

19. Postsurgical rehabilitation: (e.g., after an internal Delorme procedure or STARR). Although moderate improvements by biofeedback (BFB) treatment [22], may be obtained by working on rectal sensitivity (volumetric rehabilitation), anal sphincter strengthening and anal sphincter scar stiffness after STARR (by means of anal dilators), the literature data are scant and many authors report disappointing results in these patients.

full agreement 93.75
disagreement 6.25

20. "Preventive PFR" (to improve pelvic floor tone and function before pregnancy, colorectal surgery, physiological events like menopause or ageing) is not recommended.

These patients should not have PFR because firm data on preventive PFR in these situations are lacking and there would be an exponential increase in both number of patients and costs. However, it is important to investigate the role of PFR in these less codified clinical situations, by means of new trials.

full agreement 93.75
disagreement 6.25

21. Rectorectal prolapse and rectoanal prolapse: these conditions can be due to altered defecation dynamics and surgery is the therapy of choice even though it corrects anatomy and not function; PFR can be employed after surgery to modify defecation dynamics and improve surgical results [22].

full agreement 81.25
disagreement 18.75

Clinical evaluation

22. Physical examination should include:

- a careful inspection of the pelvic area,
- a digital rectal examination (often not performed by gastroenterologists [23]), to look for anatomical and functional abnormalities, and possible fecal stasis (always present in overflow incontinence). Rectal examination scores, like digital examination for scoring system (DRESS) [24] (Table 1) or three axial perineal evaluation (TAPE) score [25, 26] (Table 2) are useful.

full agreement 93.75
disagreement 6.25

TAPE is a novel scoring system with a software program (https://www.hippocrates.eu/downloads) expressing fecal, urinary and gynecological functions as a geometric polygon based on symptom-specific questionnaires. The viscera of the pelvic floor must be considered as a functional unit; clinical interpretation of pelvic floor disorders requires an understanding of the complex dynamic interaction which coordinates urinary, genital and colorectal functions. TAPE is based on existing scoring systems that previously had demonstrated reliability, validity, responsiveness and clinical utility in: (1) Fecal incontinence—the St Marks' (Vaizey) score for fecal incontinence (range 0–24) [15]. (2) Constipation—the Altomare score specifically designed for the quantification of the severity of obstructed defecation syndrome (ODS) (range 0–31) [27]. (3) Urinary incontinence—the International Consultation on Incontinence Questionnaire-Short For (ICIQ-SF) score for urinary incontinence (range 0–21) [28]. (4) Sexual troubles—the Pelvic Organ Prolapse/Incontinence Sexual Questionnaire, IUGA Revised (PISQIR) [29]. (5) Pelvic organ prolapse grading—the Baden–Walker Halfway clinical measurement system for the objective assessment of genital prolapse (range 0–3) [6, 30]. (6) Urinary retention—no validated scoring system is currently available; however, a four-degree severity score has been used in accordance with the post-micturitional urinary

Table 1 DRESS score [24]

Resting score		Squeeze score	
0	No discernable tone at rest, an open or patulous anal canal	0	No discernable increase in tone with squeezing effort
1	Very low tone	1	Slight increase
2	Mildly decreased tone	2	Fair increase but below normal
3	Normal	3	Normal
4	Elevated tone, snug	4	Strong squeeze
5	Very high tone, a tight anal canal, difficult to insert a finger	5	Very strong squeeze, to the point of being painful for the examiner

Table 2 TAPE score [25, 26]

Function	Score	Range	References
Fecal incontinence	Vaizey (St Marks')	0–24	Vaizey et al. [15]
Obstructed defecation	ODS score	0–31	Altomare et al. [27]
Urinary incontinence	ICQL.SF	0–21	Hajebrahimi et al. [28]
Urinary retention	%	0–3	–
Genital prolapse	Baden Walker	0–3	Baden and Walker [30]
Sexual disorders	IUGA	2–36	Rogers et al. [29]

volume (0 for < 50 ml, 1 for > 50 but < 100 ml, 2 for > 100 but < 200 ml, 3 for > 200 ml).

Manometric criteria guiding pelvic floor rehabilitation

1. Given the relative lack of literature data on this topic, and their limited reliability due to the wide range of methods and the consequent absence of shared normal values [18, 31, 32], it would be advisable for every motility lab to develop its own normal values obtained in normal subjects.

It should be kept in mind that by evaluating patients before and after rehabilitation, the need for normal values is limited, because every patient acts as their own control. Thus, in consideration of the difficulty of obtaining shared normal values (due to the use of different instruments and different manometric probes), at least a standardized manometric procedure/protocol should be used by centers involved in PFR, if possible by employing the same manometric catheters. At present, these remarks pertain to perfusion manometry, and do not take into account high-resolution manometry.

full agreement 93.75
disagreement 6.25

2. The manometric variables to take into account during evaluation, before referring a patient for PFR, are [33]: basal anal pressure, anal squeeze pressure (including prolonged contraction), the presence and characteristics of the recto-anal inhibitory reflex (RAIR), rectal sensitivity, balloon expulsion test, straining test and rectal compliance.

Basal anal pressure and squeeze pressure should be evaluated together with anal pressure symmetry (even though not all motility laboratories have instruments and software suitable for evaluating this parameter). The literature data on the clinical significance of anal pressure symmetry are, however, scarce and its reliability is questionable.

full agreement 87.5
partial agreement 6.25
disagreement 6.25

3. Manometric parameters in functional disorders of defecation (anorectal constipation): rectal compliance. Rectal compliance in constipation may be increased; compliance alone, however, does not allow scheduling of PFR, unless associated with rectal sensitivity evaluation.

The increased rectal compliance values in constipation are often associated with the presence of megarectum and are due to reduced rectal sensitivity (probably related to an increased rectal volume and the subsequent need for greater fecal volumes to stimulate defecation). Rectal compliance values and rectal sensitivity values are used to indicate volumetric rehabilitation (usually employing decreasing volumes, starting from the maximal tolerated volume evaluated by manometry). Besides, it must be kept well in mind that to properly evaluate rectal compliance there is the need for a barostat, an instrument not available in Europe (since none of these instruments on the market obtained EC certification).

full agreement 87.5
partial agreement 6.25
disagreement 6.25

4. Manometric parameters in functional disorders of defecation (anorectal constipation): basal anal pressure.

Some authors consider this parameter to be of limited diagnostic value. Basal anal pressure is mainly due to the IAS. In some studies, which is not, however, a regular finding, its values increase in anorectal constipation (this increase may be related to coexisting pathologies, such as anal fissure or mucohemorroidal prolapse) [34, 35].

full agreement 81.25
partial agreement 12.50
disagreement 6.25

5. Manometric parameters in defecation functional disturbances (anorectal constipation): RAIR. Decreased sphincter relaxations are frequently reported in dyssynergic defecation [36]; these anomalies may be modified by rehabilitation therapy.

Increased values in constipation could be related to puborectalis paradoxic contraction during straining; these

puborectalis contractions could increase the pressure recorded in the proximal anal canal, by affecting IAS relaxation during the sampling reflex.

full agreement 81.25
partial agreement 6.25
disagreement 12.55

6. Manometric parameters in functional disorders of defecation (anorectal constipation): squeeze pressure. Maximal squeeze pressure values are usually clinically irrelevant; of greater significance is squeezing length and the area under the pressure curve (the so-called "squeezing profile").

Very rarely is a hypertonic contraction observed during manometric recording. In this case, puborectalis stretching and anal canal dilators are suggested as treatment, to reduce the increased sphincter pressure. More often, likely due to EAS damage secondary to chronic straining, maximal squeeze pressure is found lower than normal values or at minimal normal values [37]. Sometimes, the pressure of the anal sphincter during squeezing is characterized by repeated spikes (clonic contraction).

full agreement 87.5
partial agreement 6.25
disagreement 6.25

7. Manometric parameters in defecation functional disturbances (anorectal constipation): squeezing profile. A rapid decrease in EAS pressure during maximal squeezing, and a decreased contraction time (the so-called exhaustion or fatigue), with a reduced area under the pressure curve, is frequently reported in patients with dyssynergic defecation or in constipated patients with frequent straining [38, 39]. This is considered to be a sign of EAS damage.

After PFR the contraction profile can improve. The increase in maximal contraction pressure and contraction endurance after rehabilitation can be related to an improved recruitment of pelvic muscles and of EAS, together with a better voluntary muscle control, without compromising muscle relaxation.

full agreement 93.75.
disagreement 6.25

8. Manometric parameters in functional disorders of defecation (anorectal constipation): rectal sensitivity. A reduced rectal sensitivity may be present in constipation (increased threshold of constant perception) as a sign of underlying megarectum (with possible association with internal prolapses) or of neurologic pathologies.

Altered sensitivity parameters (first sensation, constant sensation, minimal defecation volume, maximal tolerated volume) are useful to schedule volumetric rehabilitation (performed with the manometric tube balloon or with variable size enemas). Treatment begins with the maximal tolerated volume and decreases step by step to lower volumes, in order to re-educate the rectum to hold normal fecal volumes, with the aim of obtaining normal defecation [1]. In these patients, it is important to keep the rectum empty between bowel movements. The patients should not postpone defecation when the stimulus arises; small (200/300 ml) tap water enemas every 2 or 3 days can be utilized for this purpose. The results of PFR are conditioned by the presence or absence of decreased rectal sensitivity [40]; however, rectal sensitivity is the easier manometric parameter to modify with PFR [41–44].

full agreement 87.5
partial agreement 6.25
disagreement 6.25

9. Manometric parameters in functional disorders of defecation (anorectal constipation): straining test. It is important to confirm dyssynergic defecation (paradoxical contraction or missing/insufficient relaxation of pelvic floor muscles, sometimes associated with insufficient abdominal contractions, as demonstrated by endorectal pressure increase <45 mmHg during straining).

Decreased relaxation during straining is often modified by PFR. The usefulness of the straining test is, however, uncertain: there is no scientific evidence that endorectal pressure increases during straining is determined by rectal contractions. It has been suggested that it might be a consequence of transmission of endoabdominal pressure acting as "vis a tergo" on fecal boluses. Moreover, the reduced relaxation could be related to misunderstanding with the patient, or to the lateral position (actually not physiologic) generally used to carry out manometric procedures, or even due to the patient's fear of defecating during the test. The last possibility (likely the most frequent) could explain the post-PFR normalization of the straining test without improvement of constipation. This normalization should instead show a resolution of dyssynergic abnormality.

full agreement 87.5
partial agreement 6.25
disagreement 6.25

10. Manometric parameters in functional disorders of defecation (anorectal constipation): balloon expulsion test. This test is useful to diagnose dyssynergic defecation (when it shows a delay or absence of balloon expulsion), to schedule rehabilitation [45] and to evaluate the results of therapy.

The test is useful but often difficult to perform correctly, mainly due to logistic reasons (need for a toilet in the motility laboratory; many normal subjects can also find it difficult to expel the inflated balloon). This can cause false positive or false negative results [10]. However, straining abnormalities and a positive balloon test are indications for PFR (to correct pelvic floor motility abnormalities), for electrical stimulation (to improve pelvic muscle topographical and functional perception) and for BFB (to automatize correct pelvic muscle movements).

full agreement 93.75
disagreement 6.25

11. Manometric parameters in fecal incontinence: rectal compliance. Reduction in compliance can influence anal continence (as in chronic intestinal inflammatory diseases or after colorectal surgery), creating a stiffening of the rectal wall and/or a decrease in the rectal volume.

Compliance values, together with sensitivity data (in this case generally increased, with lower perception volumes) are needed to establish the initial parameters of volumetric rehabilitation (beginning from lower volumes and increasing step by step). Again, the most reliable way to evaluate compliance is to use a barostat, an instrument not available in Europe (see above).

full agreement 87.5
partial agreement 6.25
disagreement 6.25

12. Manometric parameters in fecal incontinence: basal anal pressure. Basal anal pressure, even though relatively useful from a diagnostic point of view unless very low, is usually decreased in incontinent patients. To be properly evaluated, as emphasized above, every laboratory should develop its normal values.

full agreement 93.75
disagreement 6.25

13. Manometric parameters in fecal incontinence: RAIR. Prolonged and severe relaxations, especially for small volumes, are important [10]. This is true particularly when they are associated with decreased rectal sensitivity and reduced and/or inefficient (asymmetric) voluntary contraction.

These alterations characterize passive fecal incontinence and cannot be modified by PFR, with the exception of reduced rectal sensitivity (modified by volumetric rehabilitation, beginning from constant sensation volume and step by step decreasing the volume of inflation and progressively approaching normal values).

full agreement 93.75
disagreement 6.25

14. Manometric parameters in fecal incontinence: squeezing pressure. Especially in active incontinence, this variable is decreased; this reduction is related to EAS damage.

Mean pressure values would be of positive prognostic value for rehabilitation efficacy [46]. In urge incontinence squeeze pressure could be increased (asymmetric pressure due to sphincter lesions). It could be associated with reduced rectal compliance (which could be treated by means of volumetric rehabilitation with increasing volumes).

full agreement 87.5
partial agreement 6.25
disagreement 6.25

15. Manometric parameters in fecal incontinence: squeezing profile. Length and area under the pressure curve (the so-called squeezing profile) are more important than maximal pressure values.

Pressure reduction and area reduction characterizes EAS damage; if a reduced basal anal pressure, reduced maximal pressure and reduced length of maximal contraction (squeezing exhaustion) are present, the patient should be treated by means of KT, electrical stimulation and BFB. Urge incontinence can be treated with tibial electrostimulation [13, 20]. Anal canal pressures (basal, maximal and squeezing) may be improved with PFR [47].

full agreement 93.75
disagreement 6.25

16. Manometric parameters in fecal incontinence: sphincter asymmetry. This abnormality is compatible with focal sphincter lesions. The usefulness of this abnormality and its reliability is controversial. Even if clearly demonstrated by vector volume, endoanal ultrasound sphincter evaluation is much more reliable and easier to reproduce. Moreover, it can better evaluate the extension and depth of the sphincter lesions (both internal and external).

Manometric data, to be supplemented by endoanal ultrasound, may be used to determine the advisability of using PFR, even when absolute pressure values are normal or slightly decreased. A sphincter lesion, even with apparently normal pressure, can cause incontinence. For instance, a focal lesion can cause a pressure-curve morphology like a "slingshot", with normal values in 3 quadrants and very low pressure in the 4th, thus compromising contraction efficacy and causing fecal leak in the damaged quadrant. Of course, in this case PFR is of no use.

full agreement 81.25

partial agreement 12.5
disagreement 6.25

17. Manometric parameters in fecal incontinence: rectal sensitivity. Reduced rectal sensitivity should be treated with volumetric reeducation, with decreasing volumes beginning from the maximal tolerated volume. Increased sensitivity, commonly associated with reduced compliance, often causes frequent defecation of small fecal volumes, with consequent high patient discomfort. It should be treated with increasing volume rehabilitation, beginning from the defecation volume.

Once an improved sensitivity is obtained with volumetric rehabilitation, squeeze profile improvements are possible [43, 48–51]. Increasing volumes improves even voluntary contraction, while basal pressure (mainly due to the IAS) is not modified by PFR.

full agreement 93.75
disagreement 6.25

18. Manometric parameters in anal pain. Anal pain may be due to conditions which do not influence manometric results (such as anal canal inflammation, and mucosal/hemorrhoidal prolapse). PFR may be useful in levator ani syndrome, if there is pain at digital examination, hypertonic anal canal, paradoxical puborectalis contraction, or lack of relaxation during straining.

The literature data on these conditions are scarce and disappointing. After exclusion of psychiatric or organic pathologies (by means of physical examination, endoanal ultrasound and pelvic magnetic resonance imaging), PFR can be attempted, with the same schedules as in constipation.

full agreement 93.75
disagreement 6.25

Pelvic floor rehabilitation protocols

1. Rehabilitation areas: motor function, sensitive function.

Patients must understand the difference between abdominal discomfort (which can be connected to meteorism and/or slow intestinal transit) and the actual defecation stimulus/need. Patients with slow transit constipation often do not remember or do not understand the difference. Therefore, it is of paramount importance, at least at the beginning of rehabilitation, to accurately explain that defecation is a regular, and not a sporadic, physiologic event.

full agreement 93.75
disagreement 6.25

2. Before PFR it is mandatory to teach the patients or remind them of some hygienic, dietary and behavioral measures with the aim of regularizing defecation, even if this means transforming it into a sort of ritual (toilet training).

Toilet training includes:

Diet To "normalize", if modified, stool consistency and colonic transit, by means of laxatives, stool softeners or thickeners.

Defecation timetable If possible, to obtain stool passage every day at the same time, in the morning after breakfast, or after a meal, to take advantage of physiologic reflexes (colonic motor response to a meal).

Low volume (200/300 ml) cleaning enemas, with tepid water. This is to teach the patient to empty the rectosigmoid tract, to avoid excessive straining during defecation, and to reduce fragmented defecation and the incomplete emptying sensation. This should be done at the beginning of PFR, especially in patients with rectal fecal stasis, so as to obtain an ideal defecation frequency of 2/3 times a week.

Correct defecation position Bending hips, $> 90°$, by means of a stool under the feet, assuming the squatting position, and therefore, obtaining a more physiologic defecation, straightening the anorectal angle and avoiding strain on the pelvic floor muscles.

full agreement 93.75
disagreement 6.25

3. How do we perform PFR? PFR can be carried out by means of a multimodal approach (to be preferred) [5] with kinesiotherapy (KT) associated with BFB, electrical functional stimulation (EFS), and volumetric rehabilitation [31, 52, 53]. Some authors use BFB, EFS and volumetric rehabilitation without KT [45, 54–58].

The rehabilitation techniques are, however, combined in different schedules, tailoring them to the patient's pathology and physical status.

full agreement 81.25
disagreement 18.75

4. The rehabilitation protocol is usually sequential, with different steps, tailored to the patient. This is with the aim of improving anorectal physiological functions through a progressively better awareness of a body area normally characterized by low corticalization.

The patient cannot undertake further steps without learning the previous ones. In every session, the exercise sequence starts from the beginning and new steps are added.

full agreement 93.75
disagreement 6.25

5. The rehabilitation protocol acts on abdominoperineal synergy, tonic and phasic contractility of the EAS and puborectalis muscle, rectal sensitivity and rectal compliance.

A postural and respiratory evaluation is made at the beginning of the therapy, to obtain a correct respiratory synergy. This is important for the patient to understand muscle relaxation, isotonic/isometric contraction, coordination of breathing with strain (expiration) and relaxation (inspiration). Visualization and perception techniques of the area to be treated are very useful for this purpose.

full agreement 93.75
disagreement 6.25

6. Sequential protocol includes various phases:

- perineal muscle activity awareness;
- elimination of agonist/antagonist muscle synergies, if present;
- selective muscle reinforcement (in fecal incontinence) or normal colo-rectal-anal coordination restoration (in functional anorectal constipation/abdominopelvic dyssynergia);
- rectal sensitivity reeducation/restoration;
- defecation muscle activity automatization.

full agreement 93.75
disagreement 6.25

7. The techniques employed are:

- KT,
- BFB,
- EFS,
- volumetric reeducation (endoluminal volumetric stimulation).

full agreement 93.75
disagreement 6.25

8. KT is an active technique; its aim is to allow the patient to learn or re-learn correct muscle and functional behaviors which have been forgotten or even never learnt, thus leading to normal defecation.

This includes assisted and against-resistance muscle contractions, with exercises stimulating the perineal muscles and involving muscles synergic with those of the anal sphincter. The goal is to obtain and maintain a proper muscular tone of the anal and pelvic muscles. The exercises must be repeated several times a day. In this way, KT increases contraction strength and improves muscle endurance. Strength increase: to increase the phasic component of contraction, it uses a series of isotonic contractions lasting from 1 to 3 s, with maximal strain. These must be repeated a few times, followed by a resting period of at least double duration, to avoid muscle tiring. Muscle endurance: to increase the isotonic component of contraction, this is based on isometric contraction clusters, intermittent and static, lasting from 6 to 10 s, with a resting period lasting at least twice the exercise time, with submaximal strain (50/75%). These exercises must be repeated many times.

At the beginning, when proper neuromotor learning is needed, neuromotor proprioceptive facilitation techniques (anal or perianal stretch reflex) can be employed. In this way, through fusimotor receptor stretching and afferent fiber stimulation, muscular contraction is obtained.

full agreement 93.75
disagreement 6.25

9. For BFB, devices able to detect physiological events (in this case muscular activity) are employed. These turn muscular activity into an acoustic or visual stimulus. Patients can thus better understand KT exercises and can rectify wrong muscular activities. Nonetheless, BFB cannot be the only technique used, but must be integrated with others.

BFB is useful from the first rehabilitation session on, together with the physiotherapist initial evaluation (strength, endurance, coordination and relaxation). However, it should not be used when contraction cannot be assessed. There are two types of BFB: electromyographic (motor sphincteric reeducation with external or endoanal electrodes), and manometric (rectal sensitive reeducation with inflatable balloon). The two methods associated with acoustic and/or visual devices (such as LEDS with different colors conforming to the grade of contraction, increasing acoustic intensity according to increase in contraction,) increase the patient's awareness during both contraction and relaxation training.

full agreement 93.75
disagreement 6.25

10. EFS is a passive technique, based on electrical stimuli; it encourages a better awareness of sphincter and perineal muscles, together with muscular tone and increase in trophism. Like BFB, it must be associated with the other techniques.

Mainly useful in fecal incontinence [59–61], EFS may be carried out also at home, by means of portable devices; the aim is to increase sphincter contraction, and above all, to improve awareness of pelvic floor muscle activity, with better patient consciousness when the therapy is

actively continued. The electrical current is biphasic, the best pulse is 0.2–1 ms, with a frequency of 20 Hz, and to stimulate tonic fibers, and of 50 Hz to stimulate phasic fibers. Slow twitch fibers (type 1, tonic, the majority of fibers) are involved in rest continence; fast twitch fibers (type 2, phasic) are involved in urge continence, allowing continence under stress. Stimulation intensity must be kept low and must be agreeable for the patient (not painful).

full agreement 93.75
disagreement 6.25

11. Volumetric rehabilitation is performed with rectal insufflation of different volumes of air or water [62] by means of a balloon. Volumes are defined by sensitive evaluation results, obtained during manometry. The aim is to improve rectal sensitivity and motor coordination at straining in functional defecation abnormalities (functional anorectal constipation) and in fecal incontinence [48].

Functional anorectal constipation: (1) Volumetric rehabilitation to reduce the distension sensitivity threshold; progressively increasing volumes (20 ml steps) of air or water are insufflated to obtain the defecation stimulus. After 2/3 s, 10/20 ml are removed, and this is repeated every 10 s until the defecation stimulus disappears; the exercise is repeated 8/10 times for each session. (2) Volumetric rehabilitation to increase coordination and to reduce hypertonicity: increasing volumes of air or water are insufflated until the first sensation is obtained; after 2/3 s, 20 ml every 2/3 s are insufflated, until defecation stimulus is obtained. It is useful to ask the patient to strain, evaluating sphincter relaxation; the exercise is repeated 7/8 times for each session.

Fecal incontinence: (1) Volumetric rehabilitation to modify rectal sensitivity threshold: decreasing volumes of air or water are insufflated step by step to decrease the sensitivity threshold, inviting the patient to recognize the stimulus and to contract the EAS. (2)Volumetric rehabilitation to increase rectal compliance; by means of increasing volumes (20 ml each step) of water/air while asking the patient to squeeze.

full agreement 93.75
disagreement 6.25

12. Rehabilitation techniques can be used in association [63].

full agreement 93.75
disagreement 6.25

13. Although published data are heterogenous, a complete course of pelvic rehabilitation treatment, is normally based on 6–10 sessions (unless the therapist does not suspend therapy earlier due to the patient's lack of cooperation and/or relationship conflict, or clinical reactivation of preexisting rectoanal illnesses—hemorrhoids, etc—SEF intolerance) with consolidation exercises [1] at home [64]; the usefulness of home rehabilitation is well demonstrated in fecal incontinence [65, 66].

full agreement 81.25
partial agreement 6.25
disagreement 12.5

14. It is of no use repeating a full course of rehabilitation therapy (except in very carefully selected patients).

If the patient has had a positive response to therapy, they can continue therapy at home. Home therapy is, however, very demanding, both for patient and therapist. Some monitoring sessions can be performed later on, to verify correct performance of exercises (the patient may partially or totally forget the prescribed exercises).

full agreement 81.25
disagreement 18.75

Conclusion statement

Functional defecation disturbances (dyssynergic defecation, active fecal incontinence and chronic anorectal pain) are frequent [1, 2] and PFR is often recommended as the most reliable therapy [1, 10, 31]. The target of PFR is to restore abdominopelvic coordination, sphincteric motor function and, if needed, rectal sensitive function (meaning perception ability).

The success of PFR depends on a careful diagnosis and accurate patient selection [5], including a careful cognitive and psychological evaluation of the patient (evaluating motivation, cooperation ability and patient willingness to undergo a demanding, prolonged therapy).

The main aim of PFR in anorectal functional constipation (characterized by poor recruitment and/or poor coordination of the pelvic/abdominal muscles during defecation [11], and/or by altered, usually decreased, rectal sensitivity) is to restore a correct and harmonic abdominopelvic synergy, with adequate coordination and relaxation of the pelvic floor in association with expulsive movements and abdominal wall contraction.

Active incontinence or urge incontinence [1, 10, 16–18] is the main indication for PFR and frequently multifactorial [3, 10] and mainly due to EAS damage. Fecal passive incontinence is mainly due to IAS damage or involution. If these alterations are so important as to cause severe basal hypotonicity, there is contraindication for PFR [1], since they severely compromise the usefulness of PFR.

Chronic anorectal pain [1, 4] when due to proctalgia fugax or levator ani syndrome can be treated by means of PFR. Preventive PFR (to improve pelvic floor tone and function before pregnancy, abdominopelvic surgery, colorectal surgery, physiological events like menopause or ageing) is not recommended. Surgery is the therapy of choice in case of rectorectal prolapse and rectoanal prolapse; considering that these conditions can originate due to altered defecation dynamics, PFR can be employed after surgery to modify defecation dynamics, to improve surgical results [22].

Anorectal manometry can be useful to evaluate patients before PFR; manometric parameters to take into account are [33]: basal anal pressure, anal squeeze pressure (including prolonged contraction), the presence and characteristics of RAIR, rectal sensitivity, balloon expulsion test, straining test and rectal compliance.

Rehabilitation involves motor function and sensitive function. It can be carried out by means of a multimodal approach (to be preferred) with KT associated with BFB, EFS, and volumetric rehabilitation [31, 52, 53]. The rehabilitation protocol is usually sequential with different steps, tailored to the patient's needs. The BFB should not be the only technique used, but must be integrated with others.

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References

1. Rao SS, Benninga MA, Bharucha AE, Chiarioni G, Di LC, Whitehead WE (2015) ANMS-ESNM position paper and consensus guidelines on biofeedback therapy for anorectal disorders. Neurogastroenterol Motil 27(5):594–609
2. Neshatian L (2018) The assessment and management of defecatory dysfunction: a critical appraisal. Curr Opin Gastroenterol 34(1):31–37
3. Mateus-Vasconcelos ECL, Ribeiro AM, Antonio FI, Brito LGO, Ferreira CHJ (2018) Physiotherapy methods to facilitate pelvic floor muscle contraction: a systematic review. Physiother Theory Pract 34(6):420–432
4. Vakil NB, van Zanten SV, Kahrilas PJ, Dent J, Jones R (2006) The Montreal definition and classification of gastroesophageal reflux disease: a global evidence-based consensus. Am J Gastroenterol 101(8):1900–1920
5. Patcharatrakul T, Rao SSC (2018) Update on the pathophysiology and management of anorectal disorders. Gut Liver 12(4):375–384
6. Li M, Jiang T, Peng P, Yang XQ, Wang WC (2015) Association of compartment defects in anorectal and pelvic floor dysfunction with female outlet obstruction constipation (OOC) by dynamic MR defecography. Eur Rev Med Pharmacol Sci 19(8):1407–1415
7. Lewis SJ, Heaton KW (1997) Stool form scale as a useful guide to intestinal transit time. Scand J Gastroenterol 32:920–924
8. Agachan F, Pfeifer J, Wexner SD (1996) Defecography and proctography. Results of 744 patients. Dis Colon Rectum 39(8):899–905
9. Altomare DF (2010) ODS score and obstructed defecation. Dis Colon Rectum 53(3):363
10. Rao SS, Bharucha AE, Chiarioni G, Felt-Bersma R, Knowles C, Malcolm A, Wald A (2016) Functional anorectal disorders. Gastroenterology 150(6):1430–1442
11. Wald A, Bharucha AE, Cosman BC, Whitehead WE (2014) ACG clinical guideline: management of benign anorectal disorders. Am J Gastroenterol 109(8):1141–1157
12. Kuijpers HC (1990) Application of the colorectal laboratory in diagnosis and treatment of functional constipation. Dis Colon Rectum 33(1):35–39
13. Wexner SD, Choman EN (2013) The revised faecal incontinence scale: a critical appraisal. Dis Colon Rectum 56(11):e410
14. Maeda Y, Vaizey CJ, Norton C (2007) St. Mark's incontinence score. Dis Colon Rectum 50(12):2252
15. Vaizey CJ, Carapeti E, Cahill JA, Kamm MA (1999) Prospective comparison of faecal incontinence grading systems. Gut 44:77–80
16. Bharucha AE, Rao SS (2014) An update on anorectal disorders for gastroenterologists. Gastroenterology 146(1):37–45
17. Whitehead WE, Rao SS, Lowry A, Nagle D, Varma M, Bitar KN, Bharucha AE, Hamilton FA (2015) Treatment of fecal incontinence: state of the science summary for the National Institute of Diabetes and Digestive and Kidney Diseases Workshop. Am J Gastroenterol 110(1):138–146
18. Bove A, Pucciani F, Bellini M, Battaglia E, Bocchini R, Altomare DF, Dodi G, Sciaudone G, Falletto E, Piloni V, Gambaccini D, Bove V (2012) Consensus statement AIGO/SICCR: diagnosis and treatment of chronic constipation and obstructed defecation (part I: diagnosis). World J Gastroenterol 18(14):1555–1564
19. Norton C, Cody JD (2012) Biofeedback and/or sphincter exercises for the treatment of faecal incontinence in adults. Cochrane Database Syst Rev 7:CD002111
20. Thomas GP, Dudding TC, Rahbour G, Nicholls RJ, Vaizey CJ (2013) A review of posterior tibial nerve stimulation for faecal incontinence. Colorectal Dis 15(5):519–526
21. Wald A (2018) Diagnosis and management of fecal incontinence. Curr Gastroenterol Rep 20(3):9
22. Leo CA, Campenni P, Hodgkinson JD, Rossitti P, Digito F, De CG, D'Ambrosi L, Carducci P, Seriau L, Terrosu G (2018) Long-term functional outcome after internal Delorme's procedure for obstructed defecation syndrome, and the role of postoperative rehabilitation. J Investig Surg 31(3):256–262
23. Bellini M, Usai-Satta P, Bove A, Bocchini R, Galeazzi F, Battaglia E, Alduini P, Buscarini E, Bassotti G (2017) Chronic constipation diagnosis and treatment evaluation: the "CHRO.CO.DI.T.E." study. BMC Gastroenterol 17(1):11
24. Orkin BA, Sinykin SB, Lloyd PC (2010) The digital rectal examination scoring system (DRESS). Dis Colon Rectum 53(12):1656–1660

25. Altomare DF, Di LM, Giuratrabocchetta S, Giannini I, Falagario M, Zbar AP, Rockwood T (2014) The Three Axial Perineal Evaluation (TAPE) score: a new scoring system for comprehensive evaluation of pelvic floor function. Colorectal Dis 16(6):459–468
26. Altomare DF, Di LM, Andriola V, Giuratrabocchetta S, Giannini I, Ferrara C (2015) TriAxial perineal evaluation score: the male version. Colorectal Dis 17(6):544–545
27. Altomare DF, Spazzafumo L, Rinaldi M, Dodi G, Ghiselli R, Piloni V (2008) Set-up and statistical validation of a new scoring system for obstructed defaecation syndrome. Colorectal Dis 10(1):84–88
28. Hajebrahimi S, Corcos J, Lemieux MC (2004) International consultation on incontinence questionnaire short form: comparison of physician versus patient completion and immediate and delayed self-administration. Urology 63(6):1076–1078
29. Rogers RG, Rockwood TH, Constantine ML, Thakar R, Kammerer-Doak DN, Pauls RN, Parekh M, Ridgeway B, Jha S, Pitkin J, Reid F, Sutherland SE, Lukacz ES, Domoney C, Sand P, Davila GW, Pons E ME (2013) A new measure of sexual function in women with pelvic floor disorders (PFD): the Pelvic Organ Prolapse/Incontinence Sexual Questionnaire, IUGA-Revised (PISQ-IR). Int Urogynecol J 24(7):1091–1103
30. Baden WF, Walker TA (1972) Physical diagnosis in the evaluation of vaginal relaxation. Clin Obstet Gynecol 15(4):1055–1069
31. Pucciani F, Altomare DF, Dodi G, Falletto E, Frasson A, Giani I, Martellucci J, Naldini G, Piloni V, Sciaudone G, Bove A, Bocchini R, Bellini M, Alduini P, Battaglia E, Galeazzi F, Rossitti P, Usai SP (2015) Diagnosis and treatment of faecal incontinence: consensus statement of the Italian Society of Colorectal Surgery and the Italian Association of Hospital Gastroenterologists. Dig Liver Dis 47(8):628–645
32. Bove A, Bellini M, Battaglia E, Bocchini R, Gambaccini D, Bove V, Pucciani F, Altomare DF, Dodi G, Sciaudone G, Falletto E, Piloni V (2012) Consensus statement AIGO/SICCR diagnosis and treatment of chronic constipation and obstructed defecation (part II: treatment). World J Gastroenterol 18(36):4994–5013
33. Rao SS, Azpiroz F, Diamant NE, Enck P, Tougas G, Wald A (2002) Minimum standards of anorectal manometry. Neurogastroenterol Motil 14(5):553–559
34. Bharucha AE, Fletcher JG, Seide B, Riederer SJ, Zinsmeister AR (2005) Phenotypic variation in functional disorders of defecation. Gastroenterology 128(5):1199–1210
35. Ratuapli SK, Bharucha AE, Noelting J, Harvey DM, Zinsmeister AR (2012) Phenotypic identification and classification of functional defecatory disorders using high-resolution anorectal manometry. Gastroenterology 144(2):314–322
36. Xu X, Pasricha PJ, Sallam HS, Ma L, Chen JD (2008) Clinical significance of quantitative assessment of rectoanal inhibitory reflex (RAIR) in patients with constipation. J Clin Gastroenterol 42(6):692–698
37. Pucciani F, Ringressi MN (2012) Obstructed defecation: the role of anorectal manometry. Tech Coloproctol 16(1):67–72
38. Telford KJ, Ali AS, Lymer K, Hosker GL, Kiff ES, Hill J (2004) Fatigability of the external anal sphincter in anal incontinence. Dis Colon Rectum 47(5):746–752
39. Marcello PW, Barrett RC, Coller JA, Schoetz DJ Jr, Roberts PL, Murray JJ, Rusin LC (1998) Fatigue rate index as a new measurement of external sphincter function. Dis Colon Rectum 41(3):336–343
40. Ahn JY, Myung SJ, Jung KW, Yang DH, Koo HS, Seo SY, Yoon IJ, Kim KJ, Ye BD, Byeon JS, Jung HY, Yang SK, Kim JH (2013) Effect of biofeedback therapy in constipation according to rectal sensation. Gut Liver 7(2):157–162
41. Battaglia E, Serra AM, Buonafede G, Dughera L, Chistolini F, Morelli A, Emanuelli G, Bassotti G (2004) Long-term study on the effects of visual biofeedback and muscle training as a therapeutic modality in pelvic floor dyssynergia and slow-transit constipation. Dis Colon Rectum 47(1):90–95
42. Chang HS, Myung SJ, Yang SK, Jung HY, Kim TH, Yoon IJ, Kwon OR, Hong WS, Kim JH, Min YI (2003) Effect of electrical stimulation in constipated patients with impaired rectal sensation. Int J Colorectal Dis 18(5):433–438
43. Chiarioni G, Bassotti G, Stanganini S, Vantini I, Whitehead WE, Stegagnini S (2002) Sensory retraining is key to biofeedback therapy for formed stool fecal incontinence. Am J Gastroenterol 97(1):109–117
44. Bassotti G, Chistolini F, Sietchiping-Nzepa F, de Roberto G, Morelli A, Chiarioni G (2004) Biofeedback for pelvic floor dysfunction in constipation. BMJ 328(7436):393–396
45. Chiarioni G, Whitehead WE, Pezza V, Morelli A, Bassotti G (2006) Biofeedback is superior to laxatives for normal transit constipation due to pelvic floor dyssynergia. Gastroenterology 130(3):657–664
46. Sun XB, Zhang L, Li YH, Li JL, Chen YL (2009) The effects of biofeedback training of pelvic floor muscles on fecal incontinence. J Pediatr Surg 44(12):2384–2387
47. Beddy P, Neary P, Eguare EI, McCollum R, Crosbie J, Conlon KC, Keane FB (2004) Electromyographic biofeedback can improve subjective and objective measures of fecal incontinence in the short term. J Gastrointest Surg 8(1):64–72
48. Bols E, Berghmans B, de Bie R, Govaert B, van Wunnik B, Heymans M, Hendriks E, Baeten C (2012) Rectal balloon training as add-on therapy to pelvic floor muscle training in adults with fecal incontinence: a randomized controlled trial. Neurourol Urodyn 31(1):132–138
49. Dobben AC, Terra MP, Berghmans B, Deutekom M, Boeckxstaens GE, Janssen LW, Bossuyt PM, Stoker J (2006) Functional changes after physiotherapy in fecal incontinence. Int J Colorectal Dis 21(6):515–521
50. Ozturk R, Niazi S, Stessman M, Rao SS (2004) Long-term outcome and objective changes of anorectal function after biofeedback therapy for faecal incontinence. Aliment Pharmacol Ther 20(6):667–674
51. Terra MP, Dobben AC, Berghmans B, Deutekom M, Baeten C, Janssen LW, Boeckxstaens GE, Engel AF, Felt-Bersma RJ, Slors JF, Gerhards MF, Bijnen AB, Everhardt E, Schouten WR, Bossuyt PM, Stoker J (2006) Electrical stimulation and pelvic floor muscle training with biofeedback in patients with fecal incontinence: a cohort study of 281 patients. Dis Colon Rectum 49(8):1149–1159
52. Pucciani F, Rottoli ML, Bologna A, Cianchi F, Sorconi F, Cutelle` M, Cortesini C (1998) Pelvic floor dyssynergia and bimodal rehabilitation: results of combined pelviperineal kinesitherapy and biofeedback training. Int J Colorectal Dis 13:124–130
53. Pucciani F, Reggioli M, Ringressi MN (2012) Obstructed defaecation: what is the role of rehabilitation? Colorectal Dis 14(4):474–479
54. Chiarioni G, Salandini L, Whitehead WE (2005) Biofeedback benefits only patients with outlet dysfunction, not patients with isolated slow transit constipation. Gastroenterology 129(1):86–97
55. Rao SS, Seaton K, Miller M, Brown K, Nygaard I, Stumbo P, Zimmerman B, Schulze K (2007) Randomized controlled trial of biofeedback, sham feedback, and standard therapy for dyssynergic defecation. Clin Gastroenterol Hepatol 5(3):331–338
56. Rao SS, Valestin J, Brown CK, Zimmerman B, Schulze K (2010) Long-term efficacy of biofeedback therapy for dyssynergic defecation: randomized controlled trial. Am J Gastroenterol 105(4):890–896
57. Heymen S, Scarlett Y, Jones K, Ringel Y, Drossman D, Whitehead WE (2007) Randomized, controlled trial shows biofeedback to be superior to alternative treatments for patients with pelvic floor dyssynergia-type constipation. Dis Colon Rectum 50(4):428–441

58. Markland AD, Jelovsek JE, Whitehead WE, Newman DK, Andy UU, Dyer K, Harm-Ernandes I, Cichowski S, McCormick J, Rardin C, Sutkin G, Shaffer A, Meikle S (2016) Improving biofeedback for the treatment of fecal incontinence in women: implementation of a standardized multi-site manometric biofeedback protocol. Neurogastroenterol Motil 29:e12906
59. Schwandner T, Konig IR, Heimerl T, Kierer W, Roblick M, Bouchard R, Unglaube T, Holch P, Ziegler A, Kolbert G (2010) Triple target treatment (3T) is more effective than biofeedback alone for anal incontinence: the 3T-AI study. Dis Colon Rectum 53(7):1007–1016
60. Schwandner T, Hemmelmann C, Heimerl T, Kierer W, Kolbert G, Vonthein R, Weinel R, Hirschburger M, Ziegler A, Padberg W (2011) Triple-target treatment versus low-frequency electrostimulation for anal incontinence: a randomized, controlled trial. Dtsch Arztebl Int 108(39):653–660
61. Vonthein R, Heimerl T, Schwandner T, Ziegler A (2013) Electrical stimulation and biofeedback for the treatment of fecal incontinence: a systematic review. Int J Colorectal Dis 28(11):1567–1577
62. Pucciani F, Ringressi MN, Redditi S, Masi A, Giani I (2008) Rehabilitation of fecal incontinence after sphincter-saving surgery for rectal cancer: encouraging results. Dis Colon Rectum 51(10):1552–1558
63. Patcharatrakul T, Valestin J, Schmeltz A, Schulze K, Rao SSC (2018) Factors associated with response to biofeedback therapy for dyssynergic defecation. Clin Gastroenterol Hepatol 16(5):715–721
64. Rao SSC, Valestin JA, Xiang X, Hamdy S, Bradley CS, Zimmerman MB (2018) Home-based versus office-based biofeedback therapy for constipation with dyssynergic defecation: a randomised controlled trial. Lancet Gastroenterol Hepatol 3:768–777
65. Bartlett L, Sloots K, Nowak M, Ho YH (2011) Biofeedback for fecal incontinence: a randomized study comparing exercise regimens. Dis Colon Rectum 54(7):846–856
66. Vasant DH, Solanki K, Balakrishnan S, Radhakrishnan NV (2016) Integrated low-intensity biofeedback therapy in fecal incontinence: evidence that "good" in-home anal sphincter exercise practice makes perfect. Neurogastroenterol Motil 29:e12912

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