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MR defecography: a diagnostic test for the evaluation of pelvic floor motion in patients with dyssynergic defecation after biofeedback therapy

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Abstract

Background: Dyssynergic defecation is a major cause of chronic functional constipation as a common digestive complaint. We clinically evaluated the effects of biofeedback therapy on the pelvic floor motion indices through magnetic resonance (MR) defecography, quality of life and depression in patients with dyssynergic defecation.

Methods: In this clinical trial study, among patients referring to the Colorectal Clinic of Hazrat Rasoul Hospital, 22 subjects were randomly assigned into two equal groups (n= 11) to receive either standard only or biofeedback and standard therapy. Dynamic changes of the pelvic floor were measured by MR defecography. During the simulated defecation, two MR defecography dynamic indices including abnormal anorectal angle change and perineal descent were measured before and after treatment. The effects of biofeedback therapy on patients' symptoms, quality of life and severity of depression were assessed and compared with the standard therapy. Statistical analysis was carried out using independent _t-test and Mann-Whitney test.

Results: Paradox index ($p< 0.001$), perineal descent index ($p< 0.001$), depression ($p< 0.1$), physical function ($p< 0.001$), vitality ($p< 0.001$) and role emotion ($p< 0.001$) significantly improved in the biofeedback therapy group in contrast to the standard therapy SDT group.

Conclusion: Biofeedback therapy appears to be effective in improving symptoms of functional constipation and dysfunction of pelvic floor motion as well as patient's quality of life and depression state. MR defecography is able to show the changes in dynamic indices of the pelvic floor through biofeedback therapy.

Keywords: Biofeedback Therapy, MR Defecography, Functional Constipation, Dyssynergic Defecation.

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Introduction

Chronic constipation is one of the most common digestive complaints, and a large population suffers from it. In Iran, the prevalence of dysfunction of defecation

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(outlet dysfunction) could be as high as 36.5% (1). Significant healthcare resources are often spent on chronic constipation, and it imposes a large socio-economic burden to the society (2). Primary constipation is due to colonic alteration and neuromuscular dysfunction; however, poor fiber intake, medication, drugs, endocrine, metabolic, neurological and other organic pathologies result in secondary constipation (3).

Chronic constipation has an adverse effect on psychological health and quality of life (QOL) of the patients. Psychological distresses and lower QOL are strongly comorbid with bowel dysfunction (4,5). Dyssynergic defecation (DD) or paradoxical puborectalis contraction syndrome, which is one of the most common functional defecation disorders, has been recognized as a major cause of chronic functional constipation , and it is observed in up to 50% of patients with chronic constipation (6).

During straining, the anorectal angle (ARA), (i.e., the angle between the posterior border of distal part of the rectum and the central axis of the anal canal) normally becomes more obtuse (15-20^{o}) due to the relaxation of the puborectalis muscle (7). In dyssynergic patients, the ability to coordinate the abdominal, anorectal and pelvic floor muscles during defecation is disturbed. In other words, puborectalis and anal external sphincter muscles contract paradoxically or are unable to relax during defecation. Furthermore, 30-50% of these patients have rectal hyposensitivity (8). The etiology of the dyssynergic pattern of defecation is unclear, but this abnormal muscle activity may be due to brain–bowel axis dysfunction or an acquired behavioral defecation disorder. The coordinated mechanisms of defecation may have never been learned during childhood (2), and it may be a result of sexual, physical or emotional abuse (9).

MR defecography can demonstrate multiplanar information about pelvic floor disturbances during real–time imaging of defecation. Moreover, good temporal resolution, high soft-tissue contrast and lack of radiation exposure, make it the preferred imaging approach to evaluate patients with pelvic floor dysfunction, which can be followed by a proper treatment plan (3, 7, 10, 11, 12).

MR defecography can reveal the decrease of ARA and the lack of descent of the pelvic floor motion during defecation in dyssynergic patients, which results in prolonged defecation and the feeling of incomplete evacuation, confirming paradoxical contraction of puborectalis. Also, the puborectalis muscle may become hypertrophic and make an indentation on the posterior wall of the rectum (7) (Fig. 1).

High dietary fiber and laxatives, as traditional treatments in patients with DD, have been proven unsuccessful and thus the symptoms get worse over time (13). In addition, consumption of laxatives over a long duration may cause serious adverse effects, such as headache, loss of appetite, diarrhea and dehydration (4). Thus, biofeedback therapy (BFT) is the best alternative treatment, which is now considered as a therapeutic approach with no side effects for patients with DD (2, 6, 14, 15, and 16).

The Association for Applied Psychophysiology and Biofeedback (AAPB) defines BFT as a process that provides real-time information from psychophysiological recordings about the levels at which physiological system are functioning (17). BFT is an assistive tool that makes patients aware of a physiological function of their bodies and enables them to self-regulate the incorrect pattern (17). BFT, as a conditioning treatment, is suitable when the concerned pathophysiological mechanisms are known and the voluntary control of the responses can be learned at a conscious level (6). By BFT, the correct defecation pattern is explained to the patients as a motor skill. The motor skills will be learned within repeated practice and feedback is an essential component of motor learning (18). The exact mechanism of action of BFT is unknown, but Rao et al. (19) have suggested that BFT modulates the neurobiological gut-brain

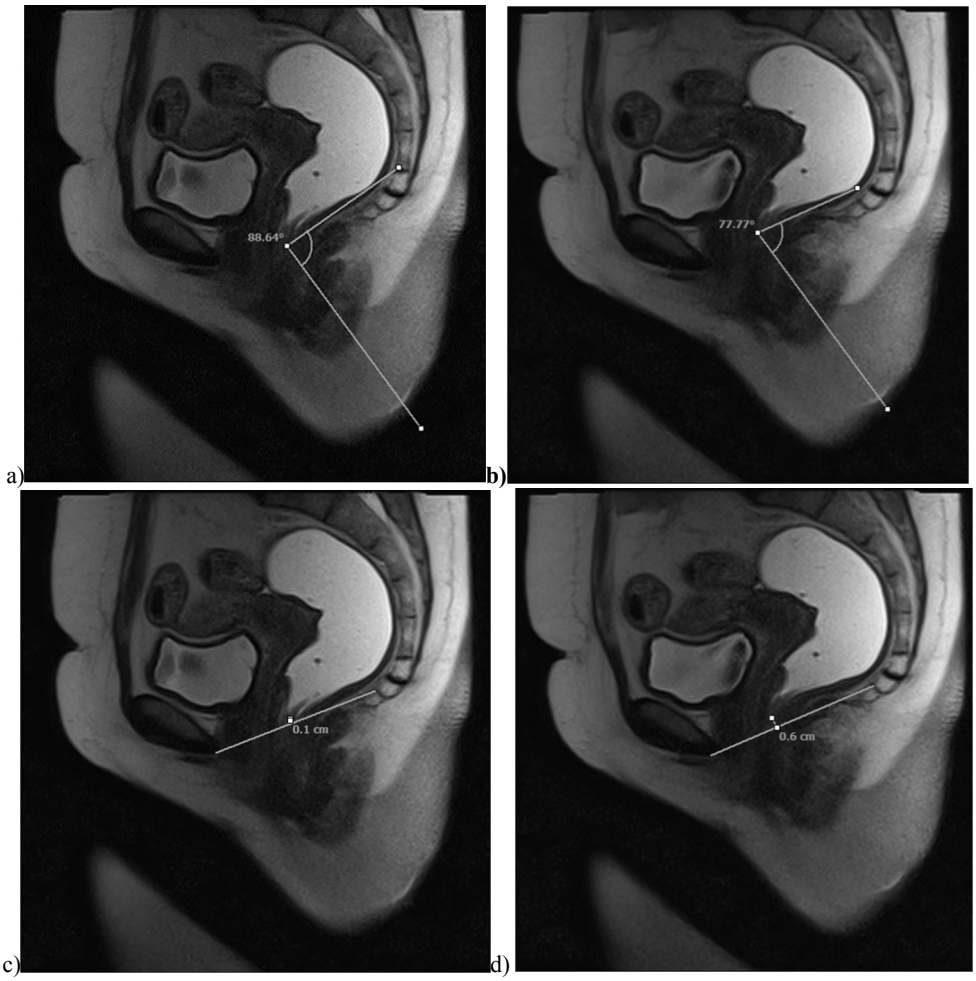

Fig. 1 An example of a 34-year old female patient with paradoxical puborectalis contraction in a resting state (a) and during defecation (b). As demonstrated in part (b), the anorectal angle (ARA) paradoxically decreases and the anal sphincter does not open due to the inappropriate contraction of the puborectalis muscle. Figure (d) illustrates the lack of descent of the pelvic floor due to inappropriate contraction of the puborectalis muscle of the same patient during defecation compared to the resting state (c).

axis, which is significantly disturbed bi-directionally, and thereby improves bowel function.

To the best of our knowledge, there is no randomized controlled trial study using MR defecography to assess the effects of BFT on objective dynamic parameters of anorectal function in patients with DD. Thus, in this study, our aim was to specifically compare the effects of BFT on pelvic floor motion indices i.e., angle change and vertical motion using MR defecography , as well as QOL and depression with standard therapy (SDT) in patients with DD.

Methods

Subjects

Twenty-two patients with chronic constipation, who fulfilled the Rome diagnostic criteria for functional constipation for at least 12 weeks, participated in this study. They were included if they needed to strain in defecation, had lumpy or hard stools, sensation of incomplete evacuation, or needed manual maneuvers to facilitate defecation in more than 1/4 of bowel movements (18). Also, they had a dyssynergic pattern of defecation i.e., paradoxical contraction or failure to relax the pelvic floor and anal muscles during defecation. The patients also had diagnostic testing evidence (anorectal manometry or defecography or balloon expulsion test) of dyssynergic defecation. Besides, the diagnosis of paradoxical contraction of the puborectalis muscle during straining was established by

digital rectal examination (DRE) (20).

This study was approved by the Ethics Committee of Iran University of Medical Sciences, and the patients were only included in the study if they provided an informed consent form. Patients were excluded from the study if they had previous anorectal surgery, anorectal tumors or structural anorectal disorders, which needed operation intervention. Other exclusion criteria were significant cardiovascular, respiratory, neurologic, psychiatric illnesses, sever psychological problems or endocrine and metabolic diseases that could cause constipation (6).

The patients were randomized into two study groups of BFT and SDT. Standard protocols were used for both groups to ensure that all patients received similar instructions to manage their constipation. In fact, BFT was the only different intervention among the two groups. Since patients with chronic constipation, particularly those with DD, exhibit significant psychological distress and impaired health-related QOL compared to healthy subjects (5,21), we planned a cognitive-behavioral therapy for all patients in the two groups.

Measures

Dynamic changes of the pelvic floor (i.e., anorectal angle), the angle between the central axis of the anal canal and the posterior wall of the distal part of the rectum (10), perineal descent (M Line), the shortest distance between the pubococygeal line (PCL) and anorectal junction (ARJ) (22) were measured at rest, during squeezing and straining by MR defecography.

Symptomatic changes were measured according to a constipation scoring system: Agachan Scoring System (23). In this study, all items of constipation scoring system were asked from the patients and were calculated to detect the total constipation scores. However, only four variables were considered for the rest of the calculations including frequency of bowel movements, feeling incomplete evacuation, time in lavatory per attempt and assistance or enema for defecation. Obtaining a higher score on this questionnaire represented the severity of constipation (minimum score 0, and maximum score 30) (23). DRE was used to assess anal sphincter strength and check the presence of paradoxical contraction of the pubrectalis muscle (20).

In order to assess the effects of BFT in relation to SDT on QOL and severity of depression, the culturally-adapted version of Short Form-36 (SF-36) and Beck Depression Inventory (BDI-II) questionnaires were used, respectively. The validity and reliability of the Persian translation of SF-36 questionnaire and BDI-II Persian have been confirmed (24,25).

SF-36 questionnaire contains 36 questions and assesses patients from eight different aspects of general health status, including physical functioning, physical role (lack of ability to perform daily routine activities), bodily pain, vitality (the threshold of fatigue and energy), social functioning (effect of emotional problems or somatic on social activities), role-emotion (lack of ability to perform daily life activities due to emotional problems) and mental health. A higher score on the SF-36 represented normal or better functioning; the scores ranged from 0 (poor health) to 100 (good health) (26, 24). BDI-II questionnaire is designed for individuals aged 13 and over, and it is composed of 21 questions related to symptoms of depression, such as hopelessness, irritability and a triad of negative cognitions about the world, future and self. The latter plays a major role in depression such as guilt or feeling of being punished, hypochondria, changes in body image, difficulty in working, changes in sleep and appetite, thoughts about suicide and less interest in sex. The selected cut-offs differed from 0-13 (minimal depression), 14-19 (mild depression), 20-28 (moderate depression) and 29-63 (severe depression). Higher total scores indicated more sever depressive symptoms (27,25).

MR imaging was acquired on a 1.5 Tesla scanner (Magnetom Avanto, Siemens, Erlangen, Germany) with a closed configura-

tion by a 4-element phased-array coil, which was placed around the pelvis of the patient. The positioning of the patients was supine, and the knees and hips were flexed in order to simulate a physiologic defecation position. Despite the greater laxity of the pelvic floor muscle and more widening of ARA defecation was facilitated in the sitting position, but MRI in this position is not superior to the standard supine MRI (28). It was not necessary to prepare the patients to perform MR defecography (29).

Before MRI acquisition, 120 ml of ultrasound gel was instilled into the rectum, while the patient was lying in the lateral position (10). Then, in the supine position, coronal and axial fast spin-echo (FSE) T2 -weighted images were obtained to assess any anatomical abnormalities in the pelvic floor. The imaging was followed by an interactive single-shot fast spin-echo T2 imaging technique, with images acquired in the sagittal plane, at rest, during squeezing (maximal voluntary contraction of anal sphincter and puborectalis muscles) and during straining every 1.5-2 seconds (30). Real-time image reconstruction could help to monitor the examination and monitor the patient to do the tasks correctly; then the accuracy of the maneuvers were investigated (10). The dynamic images were acquired with the following specifications: field of view (FOV), 25 mm^2; matrix size, 256×256; repetition time (TR), 896 ms; echo time (TE), 83ms; rectangular FOV, 84.4 -100 cm^2 (depending on the size of each patient); section thickness, 6 mm; interslice gap, 20%; bandwidth, 416 kHz; and flip angle, 150°. The patients were asked to have 12 seconds of contraction (squeeze) and then 12 seconds of rest. Straining was continued up to 55 seconds with a 20- second break (10 seconds in 2 intervals) between each until defecation occurred in the rectum.

Image Analysis

The images were inspected as a cine loop and were independently analyzed on separate workstations by two independent radiologists. The ARA and location of ARJ, or M-Line at rest, during squeezing and simulated defecation were measured. ARA changes between the rest and straining time were calculated as [(ARA at straining)-(ARA at rest)] (31) . Normally, the ARA increases between rest and straining due to the relaxation of the puborectalis muscle and widening of ARA in evacuation. Thus, during the experiments, if the puborectalis muscle contracted paradoxically, and ARA decreased from rest to straining, it was defined as “paradox index” (abnormal ARA change (31)). Vertical motions of the ARJ (i.e., perineal motion) during squeezing and simulated defecation were quantified by measuring the ascending or descending of ARJ from PCL. Descent below the M-Line was represented as a negative value. Perineal descent between rest and straining was calculated as [(M-Line at defecation)-(M-Line at rest)]. During normal defecation, M-Line decreases between rest and defecation, and a normal perineal descent is diagnosed (10). However, if paradoxical contraction of the anal sphincter and puborectalis muscle caused the perineal descent to decrease during straining, an abnormal perineal descent was diagnosed (31). Normally, perineal ascent should be observed during squeezing. Perineal ascent was calculated with [(M-Line at squeeze)-(M-Line at rest)]. Thus, we measured two MR defecography dynamic indices: Paradox index (abnormal ARA-change) and perineal descent index during simulated defecation, before and after treatment.

Treatment

During the first session of the SDT, a pelvic floor specialist physiotherapist provided the patients with a package of instructions about bowel habit, daily exercise (for example, walking for 20 minutes every day), and diaphragmatic breathing exercises (daily for 15 minutes, three times a day), dietary fiber and fluid intake, toilet timing (patients were taught to attempt having a bowel movement at least twice a day, 30 minutes after meals or walking and they

were consulted to avoid straining more than 5 minutes during defecation).The patients were advised not to use digital maneuvers to facilitate defecation. If patients had no bowel movement for more than 48 hours, they were guided to use laxatives such as polyethylene glycol (14). Also, the patients were trained about the correct position of defecation (32). The duration of SDT was 3 months and the patients were supervised at least once a week over the phone.

The BFT was provided by a physiotherapy specialist in pelvic floor dysfunction. During the first session, the normal function of the concerned muscles in defecation was explained for each patient. Then, dysfunction of the muscles of the pelvic floor and the concept of dyssynergic defecation were completely clarified by the dynamic images of MR defecography. This step was followed by explanation of the objectives of BFT to correct the dyssynergic pattern of defecation (i.e., the patients had to learn how to appropriately contract or relax anal and pelvic floor muscles) by the visual feedback of their muscle activities. For BFT relaxation training, the patients received contraction-relaxation training for more available muscles such as Hamstrings, Biceps and Gluteals.

If there was rectal sensory impairment, the patients were trained to enhance rectal sensation by repeated inflations and deflations of a rectal balloon. Rectal sensory perception is important for adjusting rectal capacity and normal defecation (33).

During a simulated defecation, the patients were trained to synchronize the increase of intra-abdominal pressure with relaxation of the puborectalis and external anal sphincter muscles. A surface electrode on abdominal muscles and an interarectal pressure probe were used to monitor the activity of the muscles. While the subjects were lying in a left lateral position and watching the EMG tracing on a computer monitor, they received visual and verbal feedback to correct dyssynergia. Simultaneous with the increase of intra-abdominal pressure, the patients had to relax their external anal and puborectalis muscles voluntarily. Thus, the decrease of the muscle activity caused a decrease of pressure on the probe, which was displayed on the monitor (Abdominal Recto Anal Coordination Training). Each BFT session was 60 minutes, consisting of 15 minutes for contraction of the pelvic floor and anal muscles (this parameter was selected due to the weakness of these muscles on DRE in patients with DD), 15 minutes for relaxation training, and finally 30 minutes for training and also practicing an array of exercises such as strengthening, coordinating, and stabilizing the lumbopelvic region. The patients were instructed to perform the exercises three times a day for ten minutes, within 3 months of the treatment period. The BFT session was performed twice a week for 12 sessions; then once a week for 6 sessions (18 sessions over 3 months). Also, home-training devices for BFT were used. Periodic reinforcement trainings were started after the end of the treatment, at 6 weeks, 3 months, 6 months and 12 months according to the Lowa protocol (2, 14, and 34).

Statistical Analysis

Statistical analysis was carried out using SPSS software. The level of statistically significant difference was 0.05 or less ($p \leq 0.05$). To show improvement (post-treatment value; pre-treatment value), paired t-test was used for normal variables and Wilcoxon sign rank test was utilized for non-normal variables; and independent t-test was used to compare BFT and SDT groups. Normal variables were not observed for improvement variables. The interobserver agreement between the two independent readers was determined by calculating ICC.

Results

Between April 2012 and May 2014, 22 constipated patients (5 (23%) males and 17 (77%) females) with the mean ± SD age of 37±13.6 years (age range of 19-63 years) with symptoms of obstructed defecation

Table 1. Within and between Group Improvement Comparisons (Pelvic Floor Motion)

MRI Variables	BFTgroup-Improvement (Mean±SD)	P-Value Paired t-test	SDTgroup-Improvement (Mean±SD)	P-Value Paired t-test	Between- Group improvement Comparison(BFT-SDT) (Mean±SD)	Independent t-test p-value
Paradox Index	21.0±20.86	0.007	-1.3±11.90	0.716	22.4±7.24	0.006
Perineal Descent Index	-12.8±13.62	0.011	-2.4±8.17	0.355	-10.4±3.79	0.042

BFT= Biofeedback Therapy, SDT =Standard Therapy, improvement = after (value)-before (value)

and dyssynergic defecation were included in the study. We randomly assigned 22 dyssynergic defecation subjects to receive either standard only (SDT= 11) or biofeedback and standard treatment (BFT= 11). All the patients were scheduled for cognitive-behavioral therapy.

Assessment of within- and between-Group improvement values

MRI within and between group analysis:

Paired t-test showed that both paradox and perineal descent indices improved significantly within BFT group (P-value = 0.007 and 0.011, respectively) although there was no improvement within SDT group. Better improvements of paradox and perineal descent indices were observed in the BFT group compared to the SDT group (Table1) and (Fig. 2).

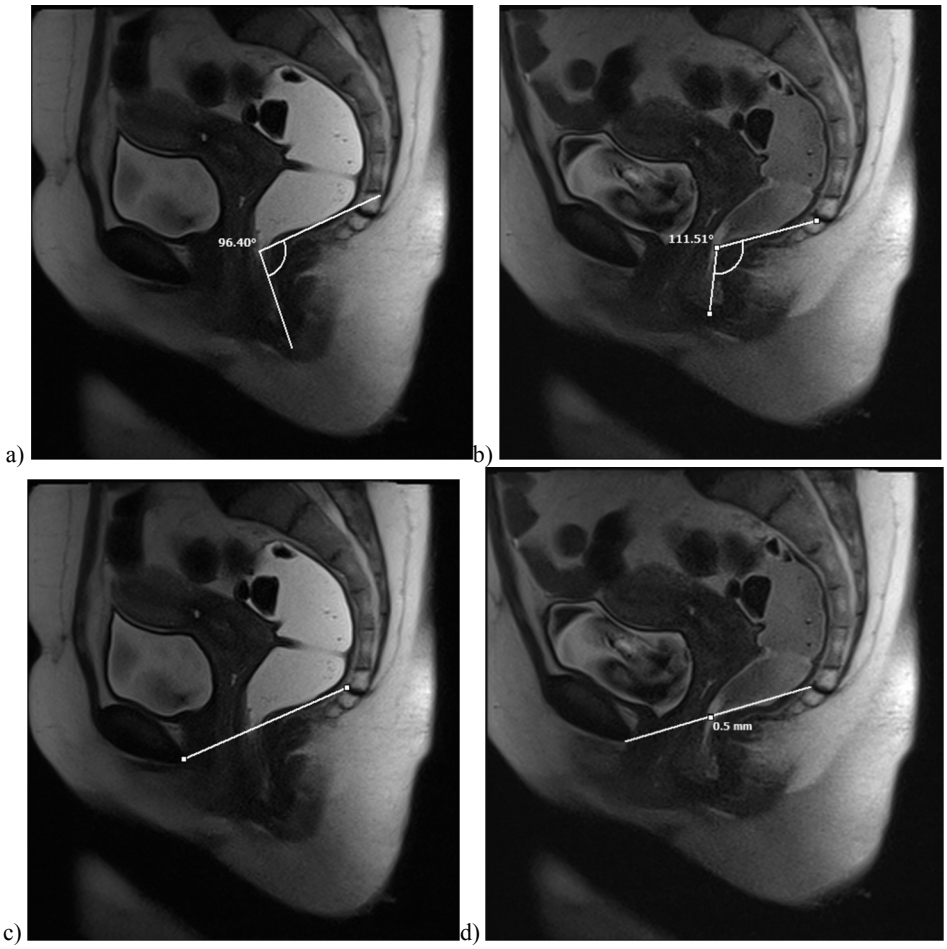

Fig. 2. The same patient as in figure 1, after Biofeedback Therapy in a resting state (a,c) and during defecation (b,d). The ARA increases due to relaxation of the anal sphincter and puborectalis muscles during defecation (b) as compared to the resting state (a). The minimum descent of the pelvic floor during defecation is illustrated in figure (d) showing the relaxation of the puborectalis muscle.

Table 2. Within and between Group Improvement Comparisons (QOL and Depression)

Subscales SF-36	BFTgroup-Improvement* (Mean±SD)	P-Value Paired t-test	SDTgroup-Improvement (Mean±SD)	P-Value Paired t-test	Between- Group improvement Comparison(BFT-SDT) (Mean±SD)	Independent t-test p-value
Physical Functioning	10±12.04	0.020	-3.64±21.5	0.586	13.64±7.4	0.085
Physical Role	11.36±36.0	0.320	-22.73±23.6	0.01	34.09±13.0	0.016
Bodily Pain	2.91±29.0	0.750	5.64±20.0	0.37	-2.73±10.6	0.800
Vitality	17.27±16.5	0.006	7.73±23.7	0.31	9.54±8.7	0.286
Role Emotion	51.45±37.7	0.007#	±42.84 -12.0	0.38#	63.45±17.2	0.001
Mental Health	6.91±11.0	0.062	8.36±16.2	0.12	-1.46±5.9	0.810
Social Function	8.00±21.9	0.250	14.45±34.8	0.2	6.64±12.4	0.610
General Health	9.36±17.3	0.103	1.82±15.5	0.71	7.54±7.0	0.290
Depression	-7.09±6.5	0.005	-2.92±6.6	0.17	-4.18±2.8	0.150

#p-values for Role emotion are from Wilcoxon signed ranks test for related groups
* Improvement = after (value)- before (value)

QOL and Depression, within and between Group Analysis: Based on the results of the paired t-tests , depression and the following three out of eight QOL subscales significantly improved in the BFT: functioning (p= 0.020), vitality (p= 0.006) and role emotion (p= 0.007). However, only the improvement of physical role was statistically significant in the SDT group (p= 0.010). Furthermore, physical role and role emotion factors were improved in the BFT group (Table 2).

Constipation Symptoms: within and between group Analysis: Based on the results of the non-parametric Wilcoxon signed ranks test, only frequency improvement was not significant in the BFT group (Frequency; p= 0.102; Completeness; p= 0.003; Time; p= 0.008); (Assistance; p= 0.014), while no significant improvement was observed in the SDT group. Feeling incomplete evacuation and time in lavatory per attempt (Completeness and Time variables) may be considered as marginally significant (p= 0.059). Total constipation score improvement, subscales of completeness improvement and assistance improvement were better in the BFT group (Table 3).

To compare BF and SD groups for constipation symptom and its subscales improvements, independent t-test and non-parametric Mann-Whitney tests were used depending on the variables, as some of the variables showed no normality distribution. After therapy, the biofeedback treated group had greater reduction in all mentioned constipation symptoms, except for the "frequency of bowel movement". This is because almost all frequency values for biofeedback group were zero (the best grade), one was 3 before treatment which changed to 1 (showing progress) and one person remained 3, showing no improvement.

Manual muscle testing (MMT) during DRE showed notable enhancement in 9 of 11 patients (82%) in the biofeedback group, and 4 of 11 patients (36.4%) in standard group. According to the Chi-square value, there was a remarkable difference between the two treatment groups with respect to the muscle strength (MMT) after treatment (p= 0.03).

Inter-Observer Agreement

All six MRI parameters which were used to construct our main measuring indices (i.e., M-Line and anorectal angle, each one at rest, squeeze and defecation position) were measured by two independent radiologists. All calculated ICC values were more than 0.9, indicating a high agreement between the two observers.

Discussion

MR defecography (Dynamic pelvic MRI) was shown as a potential tool to objectively

Table 3. Within and between Group Improvement Comparisons (Constipation Symptoms)

Parameter	BFT Group Improvement Mean ± SD	P-Value Paired t-test	SDT Group-Improvement Mean ± SD	P-Value Paired t-test	Between- Group Improvement Comparison (BFT-SDT) Mean ± SD	Independent t-test p-value
Frequency	-0.45±0.8	0.102#	-0.09±0.3	.317#	-0.36±0.3	0.438##
Completeness	-2.64±0.9	۰,۰۰۳#	-0.64±0.9	0.059#	-2.00±0.4	< 0.001
Time	-1.18±1.2	0.008#	0.45±0.7	0.059#	-73±0.4	0.176##
Assistance	-1.09±1.0	0.014#	0±0∗		-1.09±0.3	0.028##
Total score	-8.27±4.7	< 0.001	-1.27±2.1	0.078	-7.00±1.6	0.001

p-values are from Wilcoxon signed ranks test for related groups
##p-values are from Mann-Whitney test for independent groups
∗ No change was observed between, before, and after conditions assistance variable.
Improvement = after (value)- before (value)

determine the improvement of pelvic floor motion dysfunction after BFT. Similar to the study by Rao et al. (33), we did not consider slow transit constipation as an exclusive criteria because at least two-thirds of the patients with DD have also this problem (especially in recto-sigmoid colon region). In fact, the slow transit of colon is secondary to DD. Furthermore, Rao et al. observed a significant improvement in the colonic transit time in subjects with BFT and SDT, but not in subjects with sham BFT. Additionally, Chiarioni et al. (35) found that BFT was effective for patients with DD and for slow transit constipation, but not for patients with slow transit constipation alone. Excluding patients with slow transit constipation could decrease our sample size.

In accordance with a previous study (36), our findings showed that the more negative paradox index (severe paradox) may be a predictor of the less satisfactory outcome of BFT. Thus, the frequency and intensity of BFT should be determined according to the severity of defecatory dysfunctions and duration (37). Therefore, we applied some alterations in our general BFT program based on the needs of the patients.

To achieve better outcome, we combined core-stabilization, coordination and stretching exercises with BFT to correct all aspects of motional dysfunction of pelvic floor. There are reasonable evidences to advocate the efficacy of BFT for dyssynergic defecation. According to this study, BFT appears to be effective in improving the symptoms of constipation and dysfunction of the pelvic floor motion as well as patient's QOL and depression. The effectiveness of BFT in DD patients in this study is consistent with the previous studies (33, 35, 36, 38)

Similar to what we observed, recent studies have suggested that the majority of the patients with functional constipation often suffer from excessive straining and feeling incomplete evacuation rather than infrequent bowel movements (33).

In the present study, the symptoms of constipation advanced significantly after BFT, which was in agreement with previous studies (14, 15, and 33). However, we found that feeling of incomplete evacuation had considerable alteration in both treatment groups.

The paradoxical puborectalis contraction is mainly due to behavioral and psychological effects, specifically depression, anxiety and psychological distress do co-occur with dyssynergic pelvic floor (5, 21); however, it is unknown whether they are the cause or the effect (39). Thus, we planned a cognition behavioral therapy for both groups to achieve the best outcome with BFT and SDT. In our study, one of the important principles in this area was found to be the necessity to establish a friendly therapeutic relationship among the patient and therapist. Moreover, the patients need to be constantly supervised to be motivated to cooperate (21).

In a study by Turnbull and Ritvo (40), psychotherapy was incorporated with a

treatment plan for dyssenergic patients, besides BFT; however, no obvious change was observed in the success rate compared to the previous studies. Lestar et al. (41) suggested that the effect of the therapy does not depend on psychotherapy because nearly one-half of the patients showed improvement just after the first session of BFT.

Zhu FF et al. (26) suggested that all subscales of SF-36 except for the general health showed improvement after BFT. In this study, the SF-36 measures in the BFT group were enhanced, but only three subscales of physical function, vitality, role emotion and depression were significantly higher in the BFT group after treatment. In the SDT group, only the physical role subscale (limitation in the ability to work or perform daily activities due to emotional problems) showed significant differences before and after treatment. In fact, further researches are needed to precisely define and explore whether each of the BFT and cognition behavioral therapy, or both could improve QOL, depression and the symptoms of constipation.

One of the limitations of this study was the relatively small sample size which is mainly because most patients with pelvic dyssnergy have structural disorders of the pelvic floor such as rectocell, rectal intussusceptions and salitary rectal ulcer syndrome (39), and they do not refer to tertiary care centers unless they reach the stage of surgery for their structural disorder. Thus, it was difficult to find a DD patient who did not need surgery.

Defecation in the supine position may also be considered as a limitation to imaging anorectal and pelvic floor motion by MR defecography. This is because supine is not a physiological position for defecation, and the ARA does not normally increase in simulated defecation in patients or even healthy subjects. Nonetheless, Bertschinger et al. found few differences in the detection of pelvic floor motion between supine MRI and seated MRI (open-configuration) (10).

There are four randomized clinical trials evaluating the use of BFT in patients with DD, which all showed that BFT is superior to laxative, sham BF, SDT, placebo and diazepam (37). Our study confirms previous studies on the effect of neuromuscular conditioning therapy for correcting dyssynergic pattern of defecation (33). We found a significant difference between the two treatment groups with respect to the objective parameters of anorectal function, with MR defecography. Our outcome measures were assessed 3 months after the initiation of the treatment (a short-term assessment). Rao et al. (14) showed that the effects of BFT are long lasting. They also suggested that one year BFT can better create normal bowel function than SDT in DD patients. It seems that further studies with a large sample size and long-term observation are required to assess sustained improvements in pelvic floor motion indices. In accordance with the results of previous studies (10, 31), the inter-observer agreement for the parameters of anorectal motion as a main component of measurement was shown to be excellent in this study (ICC$\geq$ 0.9).

Conclusion

In this work, we confirmed the effectiveness of biofeedback therapy in improving symptoms of constipation and dysfunction of the pelvic floor motion as well as patient's quality of life and depression state. Likewise, it was indicated that MR defecography can show the differences between dynamic indices of the pelvic floor before and after biofeedback therapy.

The patients with DD could become aware of their pelvic floor dysfunction By MR defecography. In other words, the paradox function of their puborectalis and anal muscles during simulated defecation could be demonstrated to them. This visual explanation enhances their imagination of the correct pattern when they concentrate on the pelvic floor muscle relaxation during BF training. Also, we could objectively recognize the severity of dysfunction by MR defecography, which may lead to proper clinical decision making, choosing

suitable treatments and achieving better clinical outcome.

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