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Original Article

The beneficial effects of conservative treatment with biofeedback and electrostimulation on pelvic floor disorders

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Abstract

Objectives: Pelvic floor disorders (PFDs) such as stress urinary incontinence (SUI) and pelvic organ prolapse (POP) can be managed through conservative treatments, such as conservative management involving biofeedback (BF) and electrostimulation. This study aimed to investigate the therapeutic effects of conservative treatments on PFDs. **Materials and Methods:** A retrospective cohort study was conducted. Women with PFD who underwent 1–3 months of BF and electrostimulation between January 1, 2020, and January 31, 2021, were included in the study. BF treatment was administered using three sensors to monitor pelvic floor muscle activity, providing patients with immediate feedback and guidance on muscle exercises. One session lasted for 5–10 min. Electrostimulation treatment utilized a specially made pelvic belt with electrode sheets to stimulate and contract pelvic floor muscles passively. One session lasted for 15 min. Six therapies in 1 month were prescribed. Pre- and post-treatment Pelvic Floor Distress Inventory (PFDI-20) scores, including POP distress inventory 6 (POPDI-6), colorectal-anal distress inventory (CRAD-8), and urinary distress inventory 6 (UDI-6) scores, were compared. Subgroup analysis by age, menopause, body mass index (BMI), and child delivery mode was performed. **Results:** The study included 51 women with PFDs (SUI, POP, frequency or urgency or nocturia, and pain) treated with BF and electrostimulation, with a mean age of 49.94 ± 13.63 years. Sixteen patients (37.1%) were menopausal, with a mean menopause age of 50 ± 5.20 years. Twenty-six patients (68.4%) had a history of normal vaginal delivery. The mean PFDI-20 scores before and after treatment were 32.67 (standard deviation [SD] 10.05) and 25.99 (SD 9.61), respectively ($P < 0.001$). This decrease in scores reflected an improvement in subjective perceptions of symptoms and quality of life. The POPDI-6, CRAD-8, and UDI-6 scores significantly decreased after treatment. Subgroup analysis of scores change regarding age, menopause, BMI, and child delivery mode was not statistically significant. **Conclusion:** The study demonstrated the effectiveness of BF and electrostimulation for treating women with PFDs. The findings contributed to the understanding of treatment duration, patient characteristics, and the potential benefits of a multimodal approach. Moreover, the study's diverse participant population and the use of validated outcome measures enhance the generalizability and scientific rigor of the findings.

Keywords: *Biofeedback, Electrostimulation, Pelvic organ prolapse, Pelvic pain, Stress urinary incontinence*

Introduction

Pelvic floor disorders (PFDs) affect many women throughout their lifetime [1]. PFDs considerably impact women's quality of life, affecting their physical, emotional, and social well-being [2]. While the prevalence of PFDs is reported to be lower in Asian women (6%), it is still a prevalent issue globally [3].

PFDs involve the dysfunction of the pelvic floor muscles and surrounding structures. These disorders include urinary

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incontinence, pelvic organ prolapse (POP), pelvic pain, and bowel dysfunction [4]. These symptoms can significantly impact a woman's daily life, making it essential to seek appropriate treatment. The risk factors of PFDs are variable, including older age, weight, parity, and a history of hysterectomy [5]. It is, therefore, essential to identify these risk factors and take appropriate measures to prevent or manage PFDs.

The two main treatment options for PFDs are conservative and surgical management. Conservative management involves noninvasive methods such as pelvic floor muscle training (PFMT), biofeedback (BF), and electrostimulation, which help train and strengthen the pelvic floor muscles [6].

BF is a technique commonly used in conjunction with PFMT. It involves using specialized devices or sensors to provide real-time information about muscle activity and function [7]. By visualizing or receiving auditory cues based on the measurements, patients can learn to identify and engage their pelvic floor muscles correctly [8]. BF helps individuals develop greater awareness and control over their muscles, optimizing the effectiveness of PFMT [9].

Electrostimulation, also known as electrical stimulation or neuromuscular electrical stimulation, is another adjunctive therapy often used alongside PFMT [10]. It involves the application of electrical currents to the pelvic floor muscles, causing muscle contractions. Electrostimulation can benefit individuals with difficulty voluntarily activating their pelvic floor muscles or those needing additional support in strengthening and retraining the muscles [11].

The Pelvic Floor Distress Inventory-20 (PFDI-20) is a validated questionnaire commonly used to assess and evaluate the symptoms and impact of PFDs. It focuses on three specific aspects of PFDs: POP, urinary, and fecal incontinence [12]. The PFDI-20 is a valuable tool in clinical and research settings to assess the symptoms and impact of PFDs, allowing health-care professionals to better understand and evaluate the effectiveness of interventions and treatment strategies for individuals with PFDs [13].

We hypothesized conservative treatment with BF and electrostimulation might have a positive therapeutic effect on PFD. Therefore, this study aimed to explore the therapeutic effects of conservative treatments, including BF and electrostimulation, on PFDs and evaluate them using the PFDI-20. By utilizing this approach, we can better understand the impact of conservative treatments on the physical and emotional well-being of women with PFDs.

Materials and methods

Ethics

This study was approved by the research ethics committee of our hospital (IRB 112–068-B) and conducted in accordance with the Declaration of Helsinki. We retrospectively analyzed the data of patients with PFD who underwent conservative treatment in our hospital between January 1, 2020, and January 31, 2021. The research ethics committee waived the requirement for informed consent because of the low risk to the patient's safety. All methods were implemented in compliance with the relevant guidelines and regulations.

Study population

A retrospective study design was employed to enroll women with the symptoms of PFDs who received conservative treatment with BF and electrostimulation.

Inclusion criteria

Women with PFD (stress urinary incontinence [SUI], frequency or urgency or nocturia, pelvic pain, and POP) received conservative treatment (BF and electrical stimulation). Women with PFD were diagnosed in the OPD by a gynecologist or urogynecologist. They were not treated before. They did not receive medication simultaneously, except for those with pelvic pain who may have received analgesics. SUI was diagnosed by the patient's symptoms or an urodynamic study. The patient's symptoms were diagnosed as frequent urination. A urine examination was performed to exclude urinary tract infections. Pelvic pain was diagnosed by the patient's symptoms and per vaginal examination (found pelvic muscle pain). POP was diagnosed by per vaginal examination to find a cystocele, uterine prolapse, or rectocele.

Exclusion criteria

Women with PFD could not receive conservative treatment, would not like to receive treatment, quit therapy, or lose follow-up. Patients with a cancer history, surgery, or radiotherapy over the pelvic cavity or relevant neurological history were also excluded from the study.

Patients' information was collected from their medical records, and patients were categorized into subgroups based on age, weight, menopausal status, body mass index (BMI), and type of delivery (vaginal, cesarean, or both) for further analysis.

Biofeedback and electrostimulation

During BF treatment (WPM M1E2; MMS, Enschede, Netherlands), three sensors were placed to detect the electrical activity of the pelvic floor muscles. Two sensors were placed laterally at the anus and one at the inner thigh to monitor muscle contraction and relaxation. Patients were taught the exercise technique and received immediate feedback on whether they were correctly exercising their muscles. An assistant monitored the patients' progress and provided feedback on whether they were using the correct muscles by observing the monitor. The treatment duration lasted for 5–10 min. If the patient could not contract the correct muscle, the treatment would be longer, 10–20 min. Patients without pain symptoms received combined electrostimulation treatment.

Pelvic muscle exercise was recommended to perform 15 exercises three times in 1 day [14]. The initial duration of each individual contraction was established by assessing the capabilities demonstrated by each patient during the initial training session. Throughout subsequent sessions, the duration of contractions was progressively extended, reaching a maximum of 10 s, followed by an equal duration of relaxation between contractions. Patients were encouraged to practice the exercises in different positions, such as lying, sitting, and standing, and were advised to incorporate them into their daily activities whenever feasible. In addition, they were instructed to actively engage their pelvic floor muscles during activities that previously caused incontinence and to practice interrupting or slowing the urinary stream during voiding at least once daily. The duration of self-pelvic muscle training was the same as the treatment duration, ranging from 1 to 3 months.

For electrostimulation, patients were instructed to wear a specially made "pelvic belt" containing four electrode sheets (WSB101C, SHINE ALPHA ELECTRONIC CO., LTD, Taoyuan, Taiwan). Two electrode sheets were placed on the lower abdomen and one on each posterior thigh. The electrode sheets directly contacted the skin and could provide six different types of current frequency. The protocol involved a 15-min session, during which electrical stimulation was administered for 10–15 s intermittently, stimulating and contracting the patient's pelvic floor muscles passively. Each patient received two different protocols for two types of frequency simultaneously. In addition, patients without pain symptoms received BF treatment in combination with electrostimulation.

Treatment protocol

The intervention protocol was six times in 1 month (or 1–2 times in 1 week). The duration of treatment ranged from 1 month to 3 months, depending on the patient's preference. Patients with pelvic pain received electrostimulation treatment only.

Posttreatment evaluation

We utilized the PFDI-20 as a self-reported questionnaire to assess disease severity before the intervention and the subjective improvement after the intervention. The PFDI-20 consists of three distinct parts: the POP distress inventory-6 (POPDI-6), the Colorectal-Anal Distress Inventory-8 (CRAD-8), and the urinary distress inventory-6 (UDI-6). The questionnaire consisted of 20 items, each scored from 0 to 4, and aimed to measure the degree to which the symptoms had affected the patients. The lower scores mean a better outcome. The questionnaire was collected before and immediately after completing conservative treatment.

Outcomes

The primary outcome of this study was the improvement of pre- and post-treatment PFDI-20 scores collected after patients had received at least five treatment courses. The score difference was used to assess the extent of clinical improvement before and after the intervention. Secondary outcomes included subgroup analysis of score change regarding age, menopause status, BMI, and child delivery modes.

Statistical analysis

The primary outcome was analyzed using the paired *t*-test to compare the pre- and post-treatment PFDI-20 scores. The differences in the extent of average changes in the PFDI-20, POPDI-6, CRAD-8, and UDI-6 scores between subgroups were compared using the exchangeable generalized estimating equations (GEEs) model. The GEE model was also used to find the variables associated with various scores (outcome: PFDI-20, POPDI-6, CRAD-8, and UDI-6 and covariates: age, menopause, parity, indication, and treatment). All statistical analyses were performed using SPSS 24.0 (IBM Corp., Armonk, NY, USA), and statistical significance was set at $P < 0.05$.

Results

Demographic characteristics

Fifty-one women with PFDs who underwent conservative treatment between January 1, 2020, and January 31, 2021, were included in this study. The demographic characteristics of the patients are summarized in Table 1. The mean age of the patients was 49.94 ± 13.63 years, with ages ranging from 25 to 81 years. Sixteen patients (37.1%) were menopausal, and the mean menopause age was 50 ± 5.20 years. In addition, 26 patients (68.4%) had a history of normal vaginal delivery. The dominant PFD symptom was SUI, followed by pelvic pain, frequency or urgency or nocturia, and POP [Table 1]. POP stages were cystocele, Stage 2 ($n = 2$); cystocele, Stage 1 ($n = 1$); and uterine prolapse, Stage 3 ($n = 1$). One patient with POP received a pelvic reconstruction surgery 2 years after conservative treatment.

Changes in the Pelvic Floor Distress Inventory-20 score before and after treatment

The mean PFDI-20 score before the intervention was 32.67 (standard deviation [SD] 10.05), and the mean score after the intervention was 25.99 (SD 9.61) [Table 1, $P < 0.001$]. This indicates an improvement in subjective perceptions of symptoms and quality of life. Similar results were observed for the POPDI-6, CRAD-8, and UDI-6 scores [Table 2]. The percentage of decrease in various scores is illustrated in Figure 1.

Subgroup analyses

We performed a subgroup analysis for age and menopause status [Table 3]. The scores of all scales significantly decreased after the intervention regardless of the patient's age

Table 1: Patient characteristics

Characteristic	Mean±SD, *n* (%), or median (Q1, Q3)
Age (years) (*n*=51)	49.94±13.63
BMI (kg/m^2) (*n*=13)*	26.28±6.44
Menopause (*n*=43)*	
No	27 (62.79)
Yes	16 (37.21)
Age at menopause*	50±5.20
Parity	40 (78.4)
NSD	26 (68.42)
C/S	6 (15.79)
NSD+C/S	6 (15.79)
Number of childbirths	2 (2, 3)
Nulliparity	8 (15.6)
Indications	
Stress urinary incontinence	21 (41.2)
Frequency or urgency or nocturia	10 (19.6)
Pelvic organ prolapse	4 (7.8)
Pelvic pain	16 (31.3)

*Some patients were missing data. NSD: Normal spontaneous delivery, C/S: Cesarean section, BMI: Body mass index, SD: Standard deviation, Q1: First quartile, Q3: Third quartile

Table 2: PFDI-20 scores before and after treatment

Item	*n*	Mean±SD			Percentage of pretreatment, *n* (%)	*P*
		Before treatment	After treatment	Difference		
PFDI-20	51	32.67±10.05	25.99±9.61	−6.68±5.04	−20.45	<0.001
POPDI-6	51	10.08±3.93	7.74±3.23	−2.34±1.95	−23.21	<0.001
CRAD-8	51	11.67±4.89	9.86±4.45	−1.80±2.36	−15.51	<0.001
UDI-6	51	10.92±3.38	8.39±3.19	−2.53±2.22	−23.17	<0.001

SD: Standard deviation. PFDI-20: Pelvic Floor Distress Inventory-20, POPDI-6: Pelvic organ prolapse distress inventory-6, CRAD-8: Colorectal-Anal Distress Inventory, UDI-6: Urinary distress inventory 6

Table 3: Pre- and post-treatment : Pelvic Floor Distress Inventory-20 scores were stratified by age, menopausal status, and body mass index

Item	*n*	Mean±SD			Within-group *P*	Between-group *P*
		Before treatment	After treatment	Difference		
AGE ≤50 years	26	33.12±10.53	26.35±10.63	−6.77±5.07	<0.001	0.876
AGE >50 years	25	32.20±9.73	25.62±8.62	−6.58±5.11	<0.001	
Not menopausal	27	33.11±11.52	25.96±10.82	−7.15±5.57	<0.001	0.501
Menopausal	16	30.81±9.38	24.59±9.48	−6.22±5.10	<0.001	
BMI <25 kg/m^2	7	40.00±6.73	33.29±2.29	−6.71±5.62	0.018	<0.001
BMI ≥25 kg/m^2	6	30.50±15.96	21.33±15.78	−9.17±6.91	0.028	

BMI: Body mass index, SD: Standard deviation, PFDI-20: Pelvic Floor Distress Inventory-20

or menopausal status. There was no significant difference in the extent of score improvement between patients younger and older than 50 years and between those who had undergone menopause and those who had not.

We also performed a subgroup analysis based on BMI [Table 3]. We divided the patients into BMI <25 kg/m^2 (n = 7) and ≥25 kg/m^2 (n = 6). We observed a significant improvement in the PFDI-20 scores after treatment compared to scores before treatment in the two groups. A significant difference in the PFDI-20 scores was also noted between the two groups.

Next, we performed a subgroup analysis based on the mode of delivery [Table 4]. The patients were divided into vaginal delivery (VD), cesarean section (C/S), and mixed (VD + C/S) subgroups after conservative treatment; PFDI-20, POPDI-6, and UDI-6 scores were significantly decreased in all groups [Table 4]. However, there was no significant reduction in the CRAD-8 score in C/S and NSD + C/S after treatment. No significant difference in the extent of improvement in scores among all the subgroups [Table 4].

Finally, the GEE model was employed to identify factors linked with the different scores [Table 5]. Notably, scores for various parameters were notably higher in the C/S group compared to the nulliparity group.On adjusting for several variables (age, menopause, mode of delivery, and indications), there was a significant enhancement in scores (PFDI-20, POPDI-6, CRAD-8, and UDI-6) after treatment compared to before treatment. In conclusion, women experiencing PFD exhibited symptom improvement following BF and electrostimulation interventions.

Discussion

PFD is a common condition that affects women of all ages. It can cause various symptoms, including urinary and fecal incontinence, POP, and sexual dysfunction [15]. Conservative treatments for PFD, including BF and electrostimulation, have gained attention in recent years as effective options [16]. Our study aimed to investigate the effectiveness of PFMT combined with electromyography BF (EMG-BF) and electrostimulation therapy in women with PFD. We found that conservative treatments, including BF and electrostimulation, significantly reduced PFD symptoms in the entire cohort, as measured by the PFDI-20 questionnaire, which includes the POPDI-6, CRAD-8, and UDI-6 subscales. Our results are supported by a systematic review and meta-analysis of 21 studies, which suggested that PFMT combined with EMG-BF achieved better outcomes than PFMT alone for managing SUI or PFD [16].

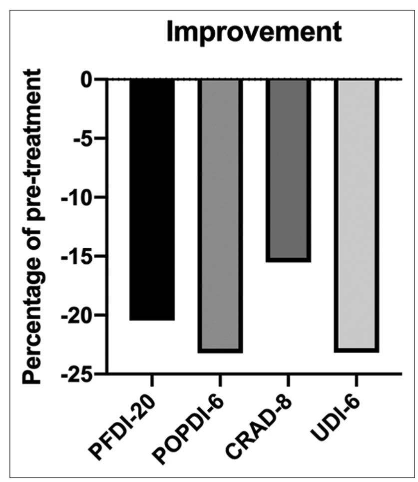

Figure 1: Changes (percentage of pretreatment) in the Pelvic Floor Distress Inventory-20, pelvic organ prolapse distress inventory-6, Colorectal-Anal Distress Inventory-8, and urinary distress inventory-6 scores after conservative treatment with biofeedback and electrostimulation for pelvic floor disorders. PFDI-20: Pelvic Floor Distress Inventory-20, POPDI-6: pelvic organ prolapse distress inventory-6, CRAD-8: colorectal-Anal Distress Inventory, UDI-6: urinary distress inventory 6

Table 4: Pre- and post-treatment pelvic floor distress inventory-20 scores stratified by mode of delivery (*n*=40)

Item	*n*	Mean±SD			Within-group *P*	Between-group *P*
		Before	After	Difference		
PFDI-20						
NSD	26	30.46±11.33	24.85±10.87	−5.62±4.68	<0.001	0.744 (vs. C/S)
C/S	6	38.17±8.66	30.00±5.59	−8.17±5.64	<0.001	>0.99 (vs. both)
NSD+C/S	6	37.50±9.87	29.08±9.75	−8.42±4.43	0.0277	0.617 (vs. NSD)
POPDI-6						
NSD	26	8.89±3.94	7.04±3.34	−1.85±2.07	<0.001	>0.99 (vs. C/S)
C/S	6	11.83±2.64	9.33±1.51	−2.50±1.22	0.0256	>0.99 (vs. both)
NSD+C/S	6	13.17±4.62	9.58±4.57	−3.58±1.74	0.0277	0.164 (vs. NSD)
CRAD-8						
NSD	26	11.04±5.29	9.50±4.97	−1.54±2.08	0.001	0.846 (vs. C/S)
C/S	6	12.83±7.31	10.17±5.56	−2.67±2.94	0.0656	>0.99 (vs. both)
NSD+C/S	6	13.00±3.03	11.00±2.61	−2.00±2.45	0.0656	>0.99 (vs. NSD)
UDI-6						
NSD	26	10.54±3.67	8.31±3.47	−2.23±2.12	<0.001	>0.99 (vs. C/S)
C/S	6	13.50±2.26	10.5±1.64	−3.00±2.53	0.0422	>0.99 (vs. both)
NSD+C/S	6	11.33±3.67	8.50±2.66	−2.83±2.14	0.0269	>0.99 (vs. NSD)

PFDI-20: Pelvic floor distress inventory-20, POPDI-6: Pelvic organ prolapse distress inventory-6, CRAD-8: Colorectal-Anal Distress Inventory, UDI-6: Urinary distress inventory 6, SD: Standard deviation, NSD: Normal spontaneous delivery, C/S: Cesarean section

Table 5: Factors associated with various scores through the Generalized estimating equations model

Predictor	PFDI-20		POPDI-6		CRAD-8		UDI-6	
	β (95% CI)	*P*	β (95% CI)	*P*	β (95% CI)	*P*	β(95% CI)	*P*
Intercept	33.40 (23.57–43.23)	<0.001*	10.06 (6.24–13.88)	<0.001*	14.48 (8.93–20.02)	<0.001*	8.86 (5.69–12.03)	<0.001*
Age	−0.11 (−0.32–0.11)	0.343	−0.04 (−0.12–0.04)	0.336	−0.09 (−0.21–0.02)	0.121	0.03 (−0.04–0.10)	0.478
Menopause (yes versus. no)	−0.35 (−10.35–9.66)	0.946	0.19 (−2.94–3.32)	0.905	0.32 (−4.65–5.30)	0.898	−0.86 (−4.34–2.62)	0.627
Parity								
Nulliparity	Reference		Reference		Reference		Reference	
NSD	4.12 (−4.74–12.98)	0.362	0.82 (−1.97–3.61)	0.565	1.46 (−2.77–5.69)	0.499	1.84 (−0.51–4.19)	0.124
C/S	10.75 (3.56–17.95)	0.003*	2.58 (0.60–4.57)	0.011*	4.44 (0.73–8.15)	0.019*	3.73 (1.57–5.89)	0.001*
NSD+C/S	9.19 (−4.75–23.12)	0.196	4.17 (−2.33–10.66)	0.208	2.63 (−1.31–6.58)	0.191	2.39 (−1.84–6.61)	0.269
Indication								
Stress urinary incontinence	Reference		Reference		Reference		Reference	
Frequency or urgency or nocturia	1.78 (−5.95–9.52)	0.651	0.80 (−1.72–3.31)	0.535	0.64 (−3.01–4.30)	0.730	0.34 (−2.53–3.22)	0.814
Pelvic organ prolapse	−6.51 (−21.03–8.01)	0.380	−1.18 (−7.76–5.40)	0.725	−1.64 (−6.04–2.77)	0.466	−3.69 (−8.25–0.87)	0.112
Pelvic pain	−3.93 (−12.42–4.55)	0.363	−0.43 (−3.22–2.35)	0.760	−1.49 (−5.50–2.51)	0.465	−2.01 (−4.44–0.43)	0.107
Treatment (after versus before)	−6.74 (−8.37–−5.12)	<0.001*	−2.30 (−2.91–−1.70)	<0.001*	−1.76 (−2.46–−1.05)	<0.001*	−2.68 (−3.39–−1.98)	<0.001*

*$P<0.05$ was considered statistically significant after the test. CI: Confidence interval, PFDI-20: Pelvic floor distress inventory-20, POPDI-6: Pelvic organ prolapse distress inventory-6, CRAD-8: Colorectal-Anal Distress Inventory, UDI-6: Urinary distress inventory 6, NSD: Normal spontaneous delivery, C/S: Cesarean section

Although the previous research has suggested that menopause may increase the incidence of PFD [17], other studies, such as one conducted by Quiroz *et al*., have found no significant association between menopause and PFD [18]. However, biological evidence supports the notion that menopause can cause PFD through a decrease in estrogen, which is known to affect estrogen receptor expression in the female genital tract and surrounding muscle and connective tissue [19,20]. The previous studies have demonstrated the effectiveness of PFMT with or without BF in improving the quality of life for postmenopausal women with SUI [21], as well as the benefits of combining PFMT with estrogen therapy for perimenopausal women who have received hysterectomies [22]. Our study found that menopause status was not significantly associated with the effectiveness of PFMT plus EMG-BF combined with electrostimulation therapy for PFD in women. However, we found that PFMT plus EMG-BF therapy effectively improved PFD symptoms for all women, regardless of menopause status.

The prevalence of PFD may increase with age, and several studies suggest that age is a significant risk factor for developing PFD. For instance, one study found that the prevalence of urinary incontinence (a common form of PFD) increased with age in women, with postmenopausal women being more likely to experience urinary incontinence than premenopausal women [23]. Another study identified age as a significant risk factor for developing POP, another form of PFD, with women over the age of 40 years being more likely to develop POP than younger women [24]. In addition, a study reported a reverse relationship between age and pelvic floor muscle strength, with increased age associated with weaker pelvic muscle strength [25]. Overall, there is evidence suggesting that age may affect PFD. However, we found no significant association between age and the effectiveness of PFMT plus EMG-BF combined with electrostimulation therapy for PFD in women. Regardless of age, PFMT plus EMG-BF therapy effectively improved PFD symptoms for all women.

We found no significant difference in the extent of CRAD-8 score improvement in patients with different BMIs. We hypothesize that this is because fecal incontinence may not be strongly associated with obesity [26]. Although some studies suggest that anal sphincteroplasty may be less successful in obese patients [27], a large-scale study examining the relationship between fecal incontinence and obesity is needed to understand this association better.

A study by van Veelen *et al*. found that pelvic floor distensibility increased after the first childbirth, which could contribute to pelvic floor dysfunction, regardless of the delivery mode [28]. We found no significant difference in the extent of score improvement between women who delivered through CS and those who had a VD (P = 0.744, >0.99, 0.846, and > 0.99 for the PFDI-20, POPDI-6, CRAD-8, and UDI-6 scores, respectively). Therefore, our findings suggest that EMG-BF combined with electrostimulation therapy may be effective in improving pelvic floor function regardless of the mode of delivery.

A previous study examining why BF has a significant effect on PFDs found that patients who responded to BF had a significant deactivation of the dorsal anterior cingulate cortex (dACC)/supplementary motor area (SMA), which is located in the prefrontal area [29]. When there is a threat of leakage in a patient with urinary incontinence, the dACC/SMA are further activated, and the patient has urinary urgency along with sphincter tightening [29], which does not occur in healthy individuals. Therefore, the deactivation of the dACC/SMA improves the symptoms of individuals with urinary incontinence [29].

Limitations

The major limitation of our study is the small number of participants, which limits the generalizability of our findings. Further randomized controlled trials with larger sample sizes should be performed to confirm our results. Second, the current study solely assessed outcomes through questionnaires, without delving into objective parameters such as bladder volume and POP stage. Third, the inquiry into the sustainability of the therapeutic effect was omitted from this study. In addition, patients with PFD commonly manifest a combination of lower urinary tract symptoms, pelvic pain, POP, and bowel issues, which may stem from distinct underlying pathophysiology. Aggregating such diverse cases could impede robust clinical judgment. Furthermore, certain participants in our study did not undergo an adequate treatment duration (the recommended 3 months), and there might have been a placebo effect in play. Finally, due to the limited cases with a low BMI, cautious interpretation of the data is warranted.

Conclusions

The study's implications for the scientific community and clinical practice lie in its demonstration of the effectiveness of BF and electrostimulation for treating women with PFDs. The findings contribute to understanding treatment duration, patient characteristics, and the potential benefits of a multimodal approach. Moreover, the study's diverse participant population and the use of validated outcome measures enhance the generalizability and scientific rigor of the findings. Further large-scale prospective trials are required to substantiate the findings of our study.

Data availability statement

The dataset is not available for public access but is available from the corresponding author upon reasonable request.

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Conflicts of interest

Dr.Dah-Ching Ding, an editorial board member at Tzu Chi Medical Journal, had no role in the peer review process of or decision to publish this article. The other authors declared no conflicts of interest in writing this paper.

References

1. Wu JM, Vaughan CP, Goode PS, Redden DT, Burgio KL, Richter HE, et al. Prevalence and trends of symptomatic pelvic floor disorders in U.S. Women. Obstet Gynecol 2014;123:141-8.
2. Benti Terefe A, Gemeda Gudeta T, Teferi Mengistu G, Abebe Sori S. Determinants of pelvic floor disorders among women visiting the gynecology outpatient department in Wolkite University Specialized Center, Wolkite, Ethiopia. Obstet Gynecol Int 2022;2022:6949700.
3. Kenne KA, Wendt L, Brooks Jackson J. Prevalence of pelvic floor disorders in adult women being seen in a primary care setting and associated risk factors. Sci Rep 2022;12:9878.
4. Hallock JL, Handa VL. The epidemiology of pelvic floor disorders and childbirth: An update. Obstet Gynecol Clin North Am 2016;43:1-13.
5. Beketie ED, Tafese WT, Assefa ZM, Berriea FW, Tilahun GA, Shiferaw BZ, et al. Symptomatic pelvic floor disorders and its associated factors in South-Central Ethiopia. PLoS One 2021;16:e0254050.
6. Friedman B. Conservative treatment for female stress urinary incontinence: Simple, reasonable and safe. Can Urol Assoc J 2012;6:61-3.
7. Kopańska M, Torices S, Czech J, Koziara W, Toborek M, Dobrek Ł. Urinary incontinence in women: Biofeedback as an innovative treatment method. Ther Adv Urol 2020;12:1756287220934359.
8. Cho ST, Kim KH. Pelvic floor muscle exercise and training for coping with urinary incontinence. J Exerc Rehabil 2021;17:379-87.
9. Herderschee R, Hay-Smith EJ, Herbison GP, Roovers JP, Heineman MJ. Feedback or biofeedback to augment pelvic floor muscle training for urinary incontinence in women. Cochrane Database Syst Rev 2011;7:CD009252.

10. Li W, Hu Q, Zhang Z, Shen F, Xie Z. Effect of different electrical stimulation protocols for pelvic floor rehabilitation of postpartum women with extremely weak muscle strength: Randomized control trial. Medicine (Baltimore) 2020;99:e19863.
11. Sarmento AL, Sá BS, Vasconcelos AG, Arcanjo DD, Durazzo A, Lucarini M, et al. Perspectives on the therapeutic effects of pelvic floor electrical stimulation: A systematic review. Int J Environ Res Public Health 2022;19:14035.
12. Wiegersma M, Panman CM, Berger MY, De Vet HC, Kollen BJ, Dekker JH. Minimal important change in the pelvic floor distress inventory-20 among women opting for conservative prolapse treatment. Am J Obstet Gynecol 2017;216:397.e1-7.
13. Utomo E, Blok BF, Steensma AB, Korfage IJ. Validation of the pelvic floor distress inventory (PFDI-20) and pelvic floor impact questionnaire (PFIQ-7) in a Dutch population. Int Urogynecol J 2014;25:531-44.
14. Burgio KL, Goode PS, Locher JL, Umlauf MG, Roth DL, Richter HE, et al. Behavioral training with and without biofeedback in the treatment of urge incontinence in older women: A randomized controlled trial. JAMA 2002;288:2293-9.
15. Nygaard I, Barber MD, Burgio KL, Kenton K, Meikle S, Schaffer J, et al. Prevalence of symptomatic pelvic floor disorders in US women. JAMA 2008;300:1311-6.
16. Wu X, Zheng X, Yi X, Lai P, Lan Y. Electromyographic biofeedback for stress urinary incontinence or pelvic floor dysfunction in women: A systematic review and meta-analysis. Adv Ther 2021;38:4163-77.
17. Alperin M, Burnett L, Lukacz E, Brubaker L. The mysteries of menopause and urogynecologic health: Clinical and scientific gaps. Menopause 2019;26:103-11.
18. Quiroz LH, White DE, Juarez D, Shobeiri SA. Age effects on pelvic floor symptoms in a cohort of nulliparous patients. Female Pelvic Med Reconstr Surg 2012;18:325-8.
19. Blakeman PJ, Hilton P, Bulmer JN. Oestrogen and progesterone receptor expression in the female lower urinary tract, with reference to oestrogen status. BJU Int 2000;86:32-8.
20. Miyagawa S, Iguchi T. Epithelial estrogen receptor 1 intrinsically mediates squamous differentiation in the mouse vagina. Proc Natl Acad Sci U S A 2015;112:12986-91.
21. Bertotto A, Schvartzman R, Uchôa S, Wender MC. Effect of electromyographic biofeedback as an add-on to pelvic floor muscle exercises on neuromuscular outcomes and quality of life in postmenopausal women with stress urinary incontinence: A randomized controlled trial. Neurourol Urodyn 2017;36:2142-7.
22. Jin J, Wang M. Effects of pelvic floor muscle training combined with estriol on pelvic floor dysfunction after total hysterectomy applied in perimenopause. Appl Bionics Biomech 2022;2022:6962542.
23. Sensoy N, Dogan N, Ozek B, Karaaslan L. Urinary incontinence in women: Prevalence rates, risk factors and impact on quality of life. Pak J Med Sci 2013;29:818-22.
24. Obsa MS, Worji TA, Kedir NA, Kute NG. Risk factors of pelvic organ prolapse at Asella teaching and referral hospital: Unmatched case control study. Front Glob Womens Health 2022;3:833823.
25. Fang J, Ye J, Huang Q, Lin Y, Weng Y, Wang M, et al. Risk factors of pelvic floor muscle strength in South Chinese women: A retrospective study. BMC Pregnancy Childbirth 2022;22:624.
26. Burgio KL, Richter HE, Clements RH, Redden DT, Goode PS. Changes in urinary and fecal incontinence symptoms with weight loss surgery in morbidly obese women. Obstet Gynecol 2007;110:1034-40.
27. Greer WJ, Richter HE, Bartolucci AA, Burgio KL. Obesity and pelvic floor disorders: A systematic review. Obstet Gynecol 2008;112:341-9.
28. van Veelen GA, Schweitzer KJ, van der Vaart CH. Ultrasound imaging of the pelvic floor: Changes in anatomy during and after first pregnancy. Ultrasound Obstet Gynecol 2014;44:476-80.
29. Griffiths D, Clarkson B, Tadic SD, Resnick NM. Brain mechanisms underlying urge incontinence and its response to pelvic floor muscle training. J Urol 2015;194:708-15.