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ORIGINAL ARTICLE

Effectiveness of self-myofascial release combined with biofeedback and electrical stimulation for the management of myofascial pelvic pain: A randomized controlled trial

Jingyun Xu[1] | **Kai Chen**[2] | **Bo Ding**[1] | **Mingyue Zhu**[3] | **Shanshan Yao**[1] | **Mulan Ren**[1] | **Yang Shen**[1]

[1]Department of Obstetrics and Gynecology, Zhongda Hospital, School of Medicine, Southeast University, Nanjing, Jiangsu, China

[2]Section of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, Howard University Hospital, Howard University College of Medicine, Washington, District of Columbia, USA

[3]Department of Obstetrics and Gynecology, School of Medicine, Southeast University, Nanjing, Jiangsu, China

Correspondence
Yang Shen, MD, PhD, Department of Obstetrics and Gynecology, Zhongda Hospital, School of Medicine, Southeast University, No.87, Hu South Road, Nanjing, Jiangsu 210009, People's Republic of China.
Email: shenyang0924@sina.cn.

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Abstract

Background: Myofascial pelvic pain (MFPP) caused by myofascial trigger points (MTrPs) is a major contributor to chronic pelvic pain in women. However, the effect of the patient's self-myofascial release (SMFR) is unclear. This study aimed to investigate the effect of SMFR combined with biofeedback and electrical stimulation (BES) therapy in comparison with BES alone in patients with MFPP.

Methods: A prospective randomized controlled study was conducted. Sixty-eight patients were randomly allocated into BES-SMFR group ($n = 34$) and BES group ($n = 34$). Every patient received 4 weeks of treatment, evaluated at baseline (T0), 4 weeks post-intervention (T4) and 12-week follow-up (T12). The primary outcome was pain intensity. The secondary outcomes were degree of activation of MTrPs, surface electromyography (sEMG) levels and Patient Global Impression of Improvement (PGI-I).

Results: Compared with the effect of BES, BES-SMFR treatment significantly decreased pain intensity and the degree of activation of MTrPs in the levator ani ($p = 0.02$) and obturator internus ($p = 0.03$), as well as the sEMG levels of the pre-test resting baseline and post-test resting baseline (all $p < 0.01$). The degree of activation of MTrPs in the piriformis and coccygeus (all $p > 0.05$) and the sEMG levels of the quick flicks and endurance contraction were not significantly different. The BES-SMFR treatment improved the PGI-I scale at T4 ($p = 0.02$) but not at T12 ($p = 0.40$).

Conclusions: This study confirmed that the addition of SMFR to BES treatment resulted in superior outcomes compared with those with BES alone in patients with MFPP.

Significance statement: Myofascial pelvic pain (MFPP) is a major contributor of female chronic pelvic pain. Myofascial release has been used commonly for better pain release; however, poor therapeutic effect due to poor patient compliance is common in clinical practice. Therefore, in future research, there is a need to investigate the effect of patient's self-myofascial release (SMFR) technique, which can eliminate the need for frequent office visits and improve patient compliance to some extent, in patients with MFPP.

1 | INTRODUCTION

Chronic pelvic pain is the pain that occurs in the abdomen, lower back or groin, which lasts for 6 or more months (Jarrell et al., 2011). As many as 15% of women aged 15–50 years suffer from chronic pelvic pain in the United States, resulting in significant economic, social and personal costs (Gunter, 2003; Paulson & Delgado, 2005). Myofascial pelvic pain (MFPP) has been identified as a major component of both causative and associated factors responsible for chronic pelvic pain (Levesque et al., 2021; Tu et al., 2006). Up to 23% of women with chronic pelvic pain have MFPP (Tu et al., 2006), which is characterized by myofascial trigger points (MTrPs), tender points or bands in the pelvic floor musculature (Pastore & Katzman, 2012; Tu et al., 2006). MTrPs are defined as hard, discrete hyperirritable areas that are palpable (usually within taut bands of skeletal muscle or in the muscle fascia) and tender on compression or stretching of the muscles, eliciting a referred distant pain (Cojocaru et al., 2015). The mechanism is unclear, and one theory suggests that it is caused by an abnormal release of acetylcholine because of damage to the motor endplate within a muscle fibre, resulting in sustained muscle fibre contractions and development of MTrPs (Cojocaru et al., 2015). MTrPs can cause hyperalgesia and allodynia via central sensitization (Hoffman, 2011). Therefore, a patient with MFPP can present with complex clinical findings occurring in conjunction with the urinary, genital, colorectal or musculoskeletal systems, or no concomitant medical pathology (Pastore & Katzman, 2012).

MFPP is inadequately diagnosed and treated because of its elusive aetiology and insufficient training and knowledge of practitioners in this area (Kavvadias et al., 2011). Previous studies investigated multimodal approaches to treat MFPP, including pelvic floor physical therapy (FitzGerald et al., 2012), biofeedback (Cornel et al., 2005), electrical stimulation (Srinivasan et al., 2007), relaxation training (Desai et al., 2013), medication, injection therapy (Adelowo et al., 2013) and MTrPs dry needling (Ay et al., 2010) with inconsistent results.

Electrical stimulation is a non-invasive pain-relief method that uses electrical current to stimulate nerves or muscles through surface electrodes or internal probes. Previous studies have shown that electrical stimulation provides effective pain relief in patients with primary dysmenorrhea and vestibulodynia (Lee et al., 2015; Murina et al., 2008).

Biofeedback is considered an important adjunct to support patients and therapists in visualizing the actions of the pelvic floor muscles (PFMs) (Masterson et al., 2017). It can be used as a supplement to electrical stimulation or pelvic floor physical therapy in a variety of pain symptoms, including rectal, vaginal and levator pain (Arnouk et al., 2017).

Myofascial release techniques include manual physical therapy for the soft tissues with the aim of relieving muscle tension and related pain by eliminating MTrPs, most of which are operated passively by the therapist (Kalichman and Ben David, 2017). Self-myofascial release (SMFR) is a relatively new technique for soft tissue mobilization. It is a self-massage program with special tools, including foam rollers, therapeutic balls, trigger point wands, dilators and even the fingers can be used for MTrP pressure release (Hanten et al., 2000; Kalichman and Ben David, 2017; Schroeder & Best, 2015). A previous study showed improvement in urologic chronic pelvic pain with the use of self-administered internal trigger points wand (Anderson et al., 2011).

Recently, to enhance the analgesic efficacy of MFPP, more attention has been focused on the combination of different therapeutic techniques in the clinic. However, the effect of adding SMFR using the patient's own fingers with traditional management, such as biofeedback and electrical stimulation (BES) treatment, has not been investigated. The current study was designed to compare the effectiveness of BES combined with SMFR and BES alone in patients with MFPP.

2 | METHODS

2.1 | Participants

A randomized controlled trial (RCT) was conducted. A total of 68 women with MFPP were recruited from the Zhongda Hospital affiliated to the Southeast University between September 2017 and December 2019. The protocol was approved by the Clinical Research Ethics Committee of Zhongda Hospital (ID: 2019ZDSYLL142-P01) and registered in the ClinicalTrials. gov database (ID: NCT04746352). Participants who were willing to participate and had signed informed consent were assessed for eligibility. This study was performed following the CONSORT guideline and in accordance with the Declaration of Helsinki.

Inclusion criteria were as follows: (1) age between 18 and 70 years; (2) presence of persistent chronic pelvic pain ≥4 points on a 10-point numeric rating scale (NRS) for at least 3 months and (3) at least one active MTrP in one of the muscle groups, including the obturator internus, levator ani, piriformis and coccygeus on pelvic examination.

Exclusion criteria were as follows: (1) disease of the urinary, genital and colorectal systems; (2) prolapse of the pelvic organ; (3) a history of pelvic rehabilitation within the 3 months prior to the study; (4) psychiatric disorders; (5) pregnancy; (6) breastfeeding and (7) fibromyalgia.

2.2 | Sample size calculation

Sample size calculation was performed using G Power version 3.1.9.2. The pain intensity with a power of 80% and an alpha level of 0.05 (2-tailed) were used to find a difference between groups of effect size = 0.30. Considering a 10% attrition rate, a total of 68 participants were needed ($n = 34$ for each group) for the current study.

2.3 | Study protocol

Participants who met the inclusion criteria were randomly allocated to two groups: (1) BES-SMFR group and (2) BES only group. Randomization was performed using a random number table generated by online computer software (https://www.randomization.com). The information was then sequentially numbered and placed in an opaque sealed envelope, which was deposited by an investigator without clinical involvement and randomly allocated to participants in a 1:1 ratio. The outcome assessments were performed by two physicians (B.D. and S.S.Y.), the interventions were applied by two physiotherapists (M.L.R. and Y.S.), and all data analyses were performed by one physician (M.Y.Z.). Because of the nature of the interventions, it was not possible to blind the participants and physiotherapists. Blinding was only in place for the physicians involved outcome assessments and data analyses.

2.4 | Outcome measures

Participants were evaluated at three time points: (1) baseline before intervention (T0), (2) 4 weeks post-intervention (T4) and (3) 12-week follow-up (T12) (Figure 1). The primary outcome was pain intensity, which was relieved by intervention. The secondary outcomes included the degree of activation of MTrPs, surface electromyography (sEMG) levels of the PFMs, and Patient Global Impression of Improvement (PGI-I). Pain intensity and MTrPs examination was conducted by the same trained physician and the sEMG testing procedure by another one.

Pain intensity was calculated using the visual NRS, which is an 11-point rating scale ranging from '0' (no pain) to '10' (worst pain imaginable) (Price et al., 1994). For each patient, the NRS referred to the pain elicited while palpating bilaterally in each PFM group and was averaged across all the muscles. Upon palpation, the patient was asked to sit in a resting, semi-recumbent position with legs supported by a pillow to prevent excessive tension in the PFMs.

MTrPs were considered active when the following criteria (Simons & Mense, 2003) were met: (1) presence of a palpable taut band in the muscle; (2) presence of a hypersensitive spot in the taut band; (3) local twitch response elicited by snapping palpation; (4) reproduction of the typical referred pain pattern in response to the compression of tender spots and (5) spontaneous presence of the typical referred pain pattern. Active MTrPs localized mainly in the bilateral obturator internus, levator ani, piriformis and coccygeus were assessed by pelvic floor manual palpation. Using the inclusion criterion of having at least one active MTrP in the bilateral muscles as a cut-off point, the outcome was dichotomized into 'Activation' and 'Inactivation' at T0, T4 and T12, respectively.

sEMG is a method for real-time assessment of neuromuscular activity by collecting EMG signals derived from muscles during a series of contractions and relaxations. We performed the sEMG assessment for the PFMs based on the Glazer protocol using the Vishee neuro-muscle stimulator (MyoTrac Infiniti, model SA9800, Thought Technology Ltd.). The Glazer protocol is an sEMG assessment method that has been widely used as it is easily accessible, painless and non-invasive (Aukee et al., 2003; Lahrmann et al., 2001). Briefly, the patients were asked to lie in a supine position with their feet rolling outwards naturally and a pear-shaped vaginal probe (serial number DYS180610, type VET-A, produced by Nanjing Vishee Medical Technology, Ltd.) was placed into the vagina following the application of a small amount of lubricant, and an electrode was positioned on the abdominal muscles to detect unwanted muscle signals. The mean values of the sEMG amplitude based on Glazer protocols (Glazer et al., 1999) for selected tasks were follows: 60-s pre-test resting baseline assessing the resting amplitude of the PFM before the test sequence, 5 rapid contractions (quick flicks) assessing fast muscle function, 60-s endurance contraction assessing slow muscle function and 60-s post-test resting baseline assessing the resting amplitude of PFM after the test sequence.

The PGI-I is a patient self-reporting evaluation that assesses the overall perception of response to treatment according to a 7-point scale, including very much worse, much worse, a little worse, no change, a little better, much better, or very much better, with lower scores indicating more favourable outcomes (Busner & Targum, 2007). PGI-I score <3 (very much better or much better) indicated a better response to the treatment.

2.5 | Interventions

Interventions were performed by two different physiotherapists, with one performing the BES procedure and the other performing SMFR.

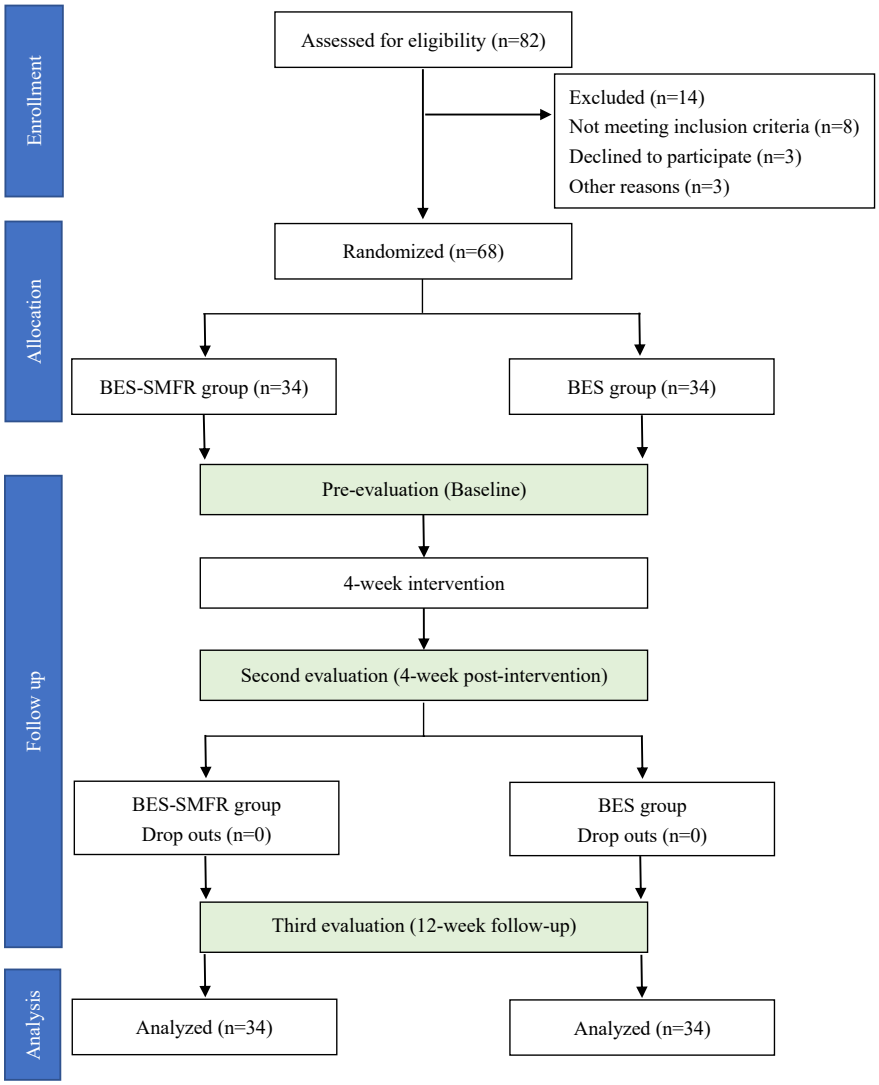

FIGURE 1 CONSORT flow diagram.

2.5.1 | Biofeedback and electrical stimulation

The BES intervention was performed using the same Vishee neuromuscular stimulator as the sEMG assessment, with a vaginal probe inserted into the vagina and placed close to the PFMs. Three standardized programs were used in our study: (1) tens electricity (first program): 5 min of 50–280 Hz frequency and a pulse duration of 50 μs; (b) endorphin electricity (second program): 5 min of 1–10 Hz frequency and pulse duration of 200 μs and (c) spasmolytic electricity (third program): 5 min of 1–2 Hz frequency and pulse duration of 300 μs. Simultaneously, the patients could learn about their neuromuscular activity through the biofeedback instrument; abdominal breathing for 5 s was necessary when PFMs were overactive. BES was performed once every 2 days for 4 weeks.

2.5.2 | Self-myofascial release therapy

The intervention protocol of the SMFR was as follows: first, a standardized and structured vaginal examination was performed by digital palpation to identify pelvic floor active MTrPs, and pain mapping was developed for the patient's use; second, patients were required to participate in intensive training regarding myofascial release techniques. They were trained to locate the MTrPs associated with pelvic muscle tension and instructed to use their own fingers to perform a myofascial release protocol comprising the following exercises. (I) Pressing: Specific MTrP was pressed directly with slow, gentle pressure (2 kg/cm^2) using flat palpation. The pressure was sustained until the participant perceived a decrease in pain; thereafter, the taut band was released and gradually increased to the previous level of MTrPs tension and maintained until a reduction

of pain was experienced again. The process was usually repeated 3–5 times for 90 s. (II) Stretching: stretching was performed parallel to the direction of the myofascial pain to facilitate elongation of the contracted muscle. (III) Strumming: stroking and strumming of the affected muscle region was performed with fingertips to aid in tension release of the MTrPs; the initial pressure was small and increased gradually until the patients adapted. Following the training, SMFR was regularly performed at home for 5 min daily for 4 weeks. SMFR was confirmed in the patients at all follow-up visits.

2.6 | Statistical analyses

Statistical analysis was performed using SPSS v.23.0 (SPSS) for Windows software. The Kolmogorov–Smirnov test showed a normal distribution of the data ($p > 0.05$). Demographic data and clinical baseline variables were compared between the two groups using independent t-tests for continuous data and χ^2 tests for categorical variables. Two-way repeated measures analysis of variance (rANOVA) was used to analyse the effect of the interventions on pain intensity and sEMG levels at T0, T4 and T12, respectively. For the degree of activation of MTrPs with a dichotomous outcome variable, a generalized estimation equation (GEE) using a binary logistic model was employed to estimate differences across the three time points (T0, T4 and T12) by groups (BES-SMFR, BES). The PGI-I scale was compared between the groups using the χ^2 test. Statistical significance was set at $p < 0.05$.

3 | RESULTS

Eighty-two patients were screened for inclusion in the study. A total of 14 patients were excluded because of various reasons, including not meeting the inclusion criteria, declining to participate and other reasons. A total of 68 patients were included and randomized to the BES-SMER and BES groups, with 34 patients in each group without any participant withdrawing or dropping off from the study. Figure 1 shows a CONSORT flow diagram.

The demographic and clinical variables of the participants are presented in Table 1. There were no significant differences between the groups for any variable. Table 2 shows the changes in the degree of activation of the MTrPs of the PFMs. Figures 2–4 show the changes in pain intensity, sEMG levels and PGI-I scale, respectively.

3.1 | Changes in pain intensity (NRS)

Group ($F = 58.51, p < 0.01$) and time ($F = 250.45, p < 0.01$) effects were noted for pain intensity. Both BES-SMFR and BES significantly reduced pain intensity at both T4 and T12 compared with T0 (all $p < 0.01$). Meanwhile, BES-SMFR reduced pain intensity more than BES alone at both

TABLE 1 Demographic and clinical variables for both groups

Variables	BES-SMFR group (n=34)	BES group (n=34)	*P*-Value
Age, mean ± SD (y)	49.7 ± 8.2	51.0 ± 8.3	0.49
BMI, mean ± SD (kg/m ^{2})	24.6 ± 2.2	23.8 ± 2.3	0.77
Gravity, median [IQR]	3 [2, 3]	3 [2, 4]	0.14
Parity, median [IQR]	1 [1, 2]	2 [1, 2]	0.42
Menopausal status, *n* (%)			0.14
Pre-menopausal	22 (64.7)	16 (471.)	
Post-menopausal	12 (35.3)	18 (52.9)	
Duration of pain, mean ± SD (y)	17.5 ± 6.4	15.7 ± 7.2	0.23
Prior surgery for pelvic floor disorders, *n* (%)	7 (20.6)	11 (32.4)	0.27
Dysmenorrhea, *n* (%)	8 (23.5)	12 (35.3)	0.29
Dyspareunia, *n* (%)	16 (47.1)	22 (64.7)	0.14
Urinary incontinence, *n* (%)	7 (20.6)	4 (11.8)	0.32
Recurrent urinary tract infections, *n* (%)	18 (52.9)	14 (41.2)	0.33
Constipation, *n* (%)	12 (35.3)	8 (23.5)	0.29

Abbreviations: BES, biofeedback and electrical stimulation; BMI, body mass index; IQR, interquartile range; SD, standard deviation; SMFR, self-myofascial release.

TABLE 2 Results of GEE using the form of MTrPs dichotomous degree (activation vs. inactivation) as dependent variable, with treatment group and time as fixed factors. Because no significant interaction effects between treatment condition and time were observed in levator ani, obturator internus, piriformis and coccygeus, only main effects are presented here.

Muscles	Parameter	B	OR (95% Cl)	Wald Chi-square	*P*-value
Levator ani	Intercept	0.66	1.94 (0.94~4.00)	3.19	0.07
	Treatment group				
	BES-SMFR	−1.07	0.34 (0.14~0.86)	5.20	**0.02**
	BES=reference	-	1	-	-
	Time				
	T12	−1.66	0.19 (0.10~0.35)	28.64	**<0.001**
	T4	−1.22	0.30 (0.18~0.49)	22.22	**<0.001**
	T0= reference	-	1	-	-
Obturator internus	Intercept	0.76	2.13 (1.03~4.40)	4.21	0.40
	Treatment group				
	BES-SMFR group	−1.01	0.36 (0.15~0.89)	4.86	**0.03**
	BES=reference	-	1	-	-
	Time				
	T12	−1.42	0.24 (0.14~0.42)	26.74	**< 0.001**
	T4	−0.97	0.38 (0.24~0.6)	17.70	**< 0.001**
	T0= reference	-	1	-	-
Piriformis	Intercept	−0.28	0.76 (0.38~1.50)	0.63	0.43
	Treatment group				
	BES-SMFR	−0.55	0.58 (0.21~1.55)	1.20	0.27
	BES=reference	-	1	-	-
	Time				
	T12	−0.82	0.44 (0.28~0.69)	12.58	**< 0.001**
	T4	−.49	0.61 (0.44~0.87)	7.68	**0.01**
	T0= reference	-	1	-	-
Coccygeus	Intercept	0.76	2.15 (1.11~4.16)	6.02	**0.01**
	Treatment group				
	BES-SMFR	0.23	1.26 (0.46~3.47)	0.19	0.66
	BES=reference	-	1	-	-
	Time				
	T12	−0.57	0.57 (0.36~0.90)	5.78	**0.02**
	T4	−0.57	0.57 (0.34~0.95)	4.62	**0.03**
	T0= reference	-	1	-	-

Abbreviations: 95% CI, 95% confidence interval; B, beta coefficient; BES, biofeedback and electrical stimulation; GEE, generalized estimation equation; OR, odds ratio; SMFR, self-myofascial release; T0, baseline; T4, 4-week post-intervention, T12, 12-week follow-up.

T4 and T12 (between group $p < 0.01$ at T4 and $p < 0.01$ at T12) (Figure 2).

3.2 | Changes in the degree of activation of the MTrPs

The results of the analysis of parameter estimates with GEE showed that the degree of activation of MTrPs was significantly lower in the BES-SMFR group than in the BES group in the levator ani ($p = 0.02$), as well as the obturator internus ($p = 0.03$). The differences between the piriformis and coccygeus were not significant (Table 2).

For changes across the three time points, the degree of activation of MTrPs was significantly lower at T4 compared with that at T0 in levator ani ($p = 0.00$), obturator internus ($p < 0.001$), piriformis ($p = 0.01$) and coccygeus

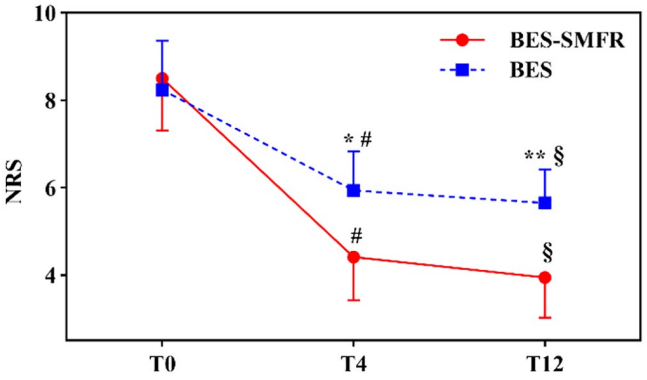

FIGURE 2 The trend of pain intensity in both groups over time. Pain intensity in both BES-SMFR and BES decreased at T4 ($^{\#}$ $p < 0.01$ vs. T0) and T12 (§ $p < 0.01$ vs. T0). BES-SMFR had lower pain intensity compared with that in BES alone at T4 (* $p < 0.01$) and T12 (** $p < 0.01$).

($p = 0.03$), as well as at T12 compared with that at T0 in the four muscles ($p < 0.001$, $p < 0.001$, $p < 0.001$ and $p = 0.02$, respectively) (Table 2).

3.3 | Changes in the sEMG levels of the pelvic floor muscles

There were group ($F = 14.66$, $p < 0.01$) and time (F = 76.93, $p < 0.01$) effects in the pre-test resting baseline (Figure 3, Panel A). Compared with the findings at T0, the pre-test resting baseline decreased significantly in both the BES-SMFR and BES groups at T4 (both $p < 0.01$ vs. T0) and T12 (both $p < 0.01$ vs. T0), with a greater decrease in the BES-SMFR group than that in the BES group at both T4 and T12 (both $p < 0.01$).

There was a time ($F = 68.05$, $p < 0.01$) but not a group ($F = 0.02$, $p = 0.89$) effect in quick flicks (Figure 3, Panel B). Quick flicks increased significantly in both groups at T4 (both $p < 0.01$ vs. T0) and T12 (both $p < 0.01$ vs. T0) compared with that at T0; however, no between-group differences were noted at T4 ($p = 0.36$) and T12 ($p = 0.45$).

Endurance contraction (Figure 3, Panel C) showed time ($F = 62.82$, $p < 0.01$) but not group ($F = 0.49$, $p = 0.50$) effects. Compared with T0, Endurance contraction increased in both groups at T4 (both $p < 0.01$ vs. T0) and

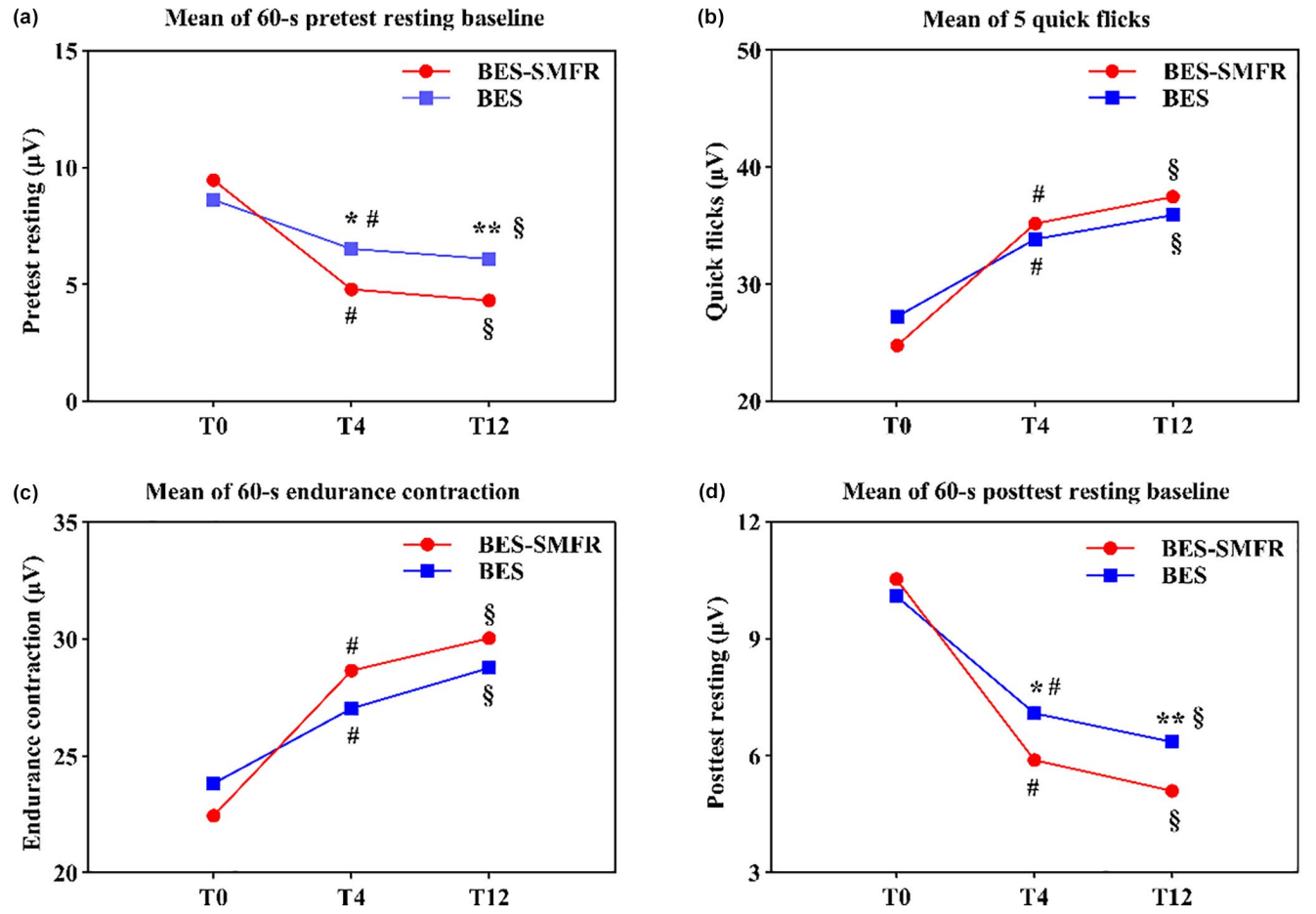

FIGURE 3 The changes in the pre-test resting baseline (a), 5 quick flicks (b), 60-s endurance contraction (c) and post-test resting baseline (d). * between-group difference at T4; ** between-group difference at T12; $^{\#}$ difference at T4 versus T0; § difference at T12 versus T0.

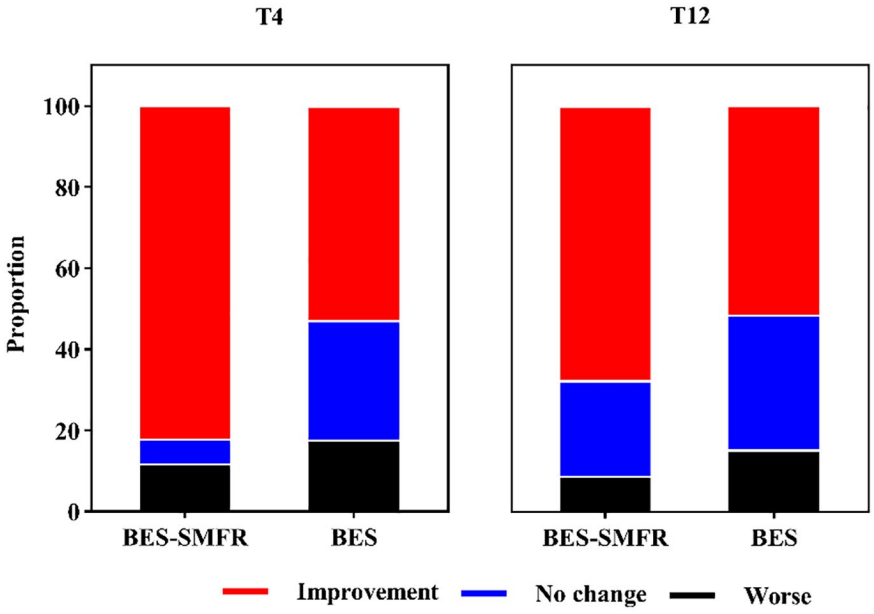

FIGURE 4 Patient Global Impression of Improvement (PGI-I) at T4 and T12.

T12 (both $p < 0.01$ vs. T0) compared with that at T0 and no between-group differences were found at T4 ($p = 0.13$) and T12 ($p = 0.11$).

Group ($F = 13.02$, $p < 0.01$) and time ($F = 201.15$, $p < 0.01$) effects were noted at the post-test resting baseline (Figure 3, Panel D). The post-test resting baseline decreased significantly in both groups at T4 (both $p < 0.01$ vs. T0) and T12 (both $p < 0.01$ vs T0) compared with that at T0, with a greater decrease in the BES-SMFR group than that in the BES alone group at both T4 and T12 (both $p < 0.01$).

3.4 | Changes in patient global impression of improvement (PGI-I)

More patients in the BES-SMFR group (82%) reported improvement in their symptoms compared with the patients in the BES group (53%) at T4 ($p = 0.02$), but no difference was observed at T12 ($p = 0.40$) (Figure 4).

4 | DISCUSSION

Our study confirmed that both interventions significantly decreased the pelvic pain intensity and degree of activation of MTrPs and improved the neuromuscular activity in the PFMs. Importantly, adding SMFR to BES was associated with greater pain relief compared with a stand-alone BES in patients with MFPP.

The underlying aetiology of MFPP might be associated with spasm of the PFMs or MTrPs, which results in local tissue ischemia (Cojocaru et al., 2015). The relationship between MTrPs and myofascial pain syndrome and clinical soft tissue pain syndromes has also been confirmed in a previous study (Wheeler, 2004). MTrPs can develop in any of the PFMs, but the levator ani and obturator internus muscles are the most frequently involved (Sanses et al., 2016). The number of active MTrPs has also been shown to be significantly associated with pain intensity (Pastore & Katzman, 2012). Travell and Simons proposed that deactivating the MTrPs is an essential component of a comprehensive approach to the successful treatment of musculoskeletal pain (Wheeler, 2004).

MTrPs therapy can be divided into invasive (dry needling and acupuncture) therapy and non-invasive techniques (electrotherapy and manual therapy) (Zhuang et al., 2014). The myofascial release technique includes manual manipulation directed towards relaxation, stretching and massaging of tightened musculature. Studies have suggested that this technique might relieve pain through anatomical, neurophysiological and psychological therapeutic effects (FitzGerald et al., 2012; Grinberg et al., 2019). A non-randomized study using the myofascial release technique showed pain relief in the PFMs of the patients (Oyama et al., 2004). In a retrospective study, 63% of the patients with MFPP who completed pelvic floor physical therapy reported significant pain relief (Bedaiwy et al., 2013). The efficacy of myofascial release physical therapy in treating pelvic floor dysfunction was approved, but the compliance rates of patients with therapy were low and ranged from 29% to 46% (Shannon, Adams, et al., 2018; Shannon, Genereux, et al., 2018), likely because of the need for more frequent hospital visits. It is well known that adherence is the key to maintaining therapy effectiveness and increasing therapy compliance could significantly improve the outcomes of patient treatment (Dumoulin et al., 2015). SMFR is a self-guided treatment program that has an obvious benefit by

eliminating the need for frequent office visits. The simplicity and portability of SMFR tools allow it to be easily implemented by anyone at home or even at the workplace (if possible). Patient adherence to the self-administered home therapy regimen significantly increased the success rate of long-term improvement in pain (FitzGerald and Kotarinos, 2003). Anderson et al. (Anderson et al., 2011) proved that it is safe and efficient for patients to perform their own internal myofascial trigger point release with an internal therapeutic wand to treat urologic chronic pelvic pain. Another study also documented a voluntary reduction in medication use in patients with chronic pelvic pain syndrome using a protocol of self-treatment of internal myofascial release with an internal trigger point wand and paradoxical relaxation (Anderson et al., 2015). In our study, SMFR had no effect on the coccygeus and piriformis muscle MTrPs, which may be because they were too deep to be reached by the patient's fingers.

Hyperactivity of the pelvic floor muscles is a characteristic of myofascial pain (Gyang et al., 2013). The hyperactive status of the pelvic floor muscles can be evaluated quantitatively using electrophysiological analysis. This information is important for clinicians to select appropriate therapeutic methods and evaluate the effect of treatment (Yu & Kim, 2015). In our study, higher PFM EMG activities, including pre-test resting baseline and post-test resting baseline, were observed significantly in patients with MFPP, suggesting the prevalence of pelvic floor muscle spasm or contracture. More recently, the concept of 'downregulation' has emerged as an essential approach towards pelvic muscle pain associated with hyperactive PFMs (Arnouk et al., 2017). Kegel exercise is the most well-known form of pelvic floor physical therapy, which attempts to improve the function and strength of pelvic floor muscles; however, it can be counterproductive when muscles are already in a hypertonic state (Kegel, 1948). In such cases, therapeutic techniques to relax the PFMs are needed to address the pain and dysfunction (Kotarinos, 2012). Myofascial release techniques have been considered as an effective option for pelvic pain relief, probably because the stretching of muscles would lengthen the sarcomere and decrease the need for ATP, breaking the cycle of the 'energy crisis' (2014), further promoting the devitalization of MTrPs, relaxation of the PFMs and longer-lasting reduction in pain.

It is well known that long-term pain relief is very critical for patients with chronic pelvic pain. Until now, the symptom-free duration of myofascial release therapy for MFPP has not been well established. The effects of physical therapy appeared to be limited and transient. Oyama et al. (2004) found that in patients with interstitial cystitis and high-tone pelvic floor dysfunction, physical therapy could significantly decrease their coccygeus muscle tone. However, this decreased muscle tone was not persistent and returned to the pre-treatment level in approximately 4.5 months after physical therapy. Our study showed that at 12 weeks after treatment, the patients in the BES+SMFR group still had lower pain sensitivity compared with those in the BES only group, but their PGI-I scale was the same. However, the underlying mechanism for this is unclear. Psychosocial factors may also play a role in patients with chronic pelvic pain syndrome (Riegel et al., 2014). Healy et al. (Healy et al., 2015) showed in a sample of 71 patients with myofascial pain that physiotherapeutic treatment effects might be influenced by psychosocial factors. Studies have shown the effect of adding psychological counselling and cognitive behavioural therapy to physical therapy in patients with myofascial pain syndrome (Meltzer-Brody & Leserman, 2011; Till et al., 2017). Further studies are needed to investigate the effect of adding psychological intervention to BES+SMFR to prolong the duration of pain relief in patients with MFPP.

Because of the nature of the interventions, it was not possible to blind the participants and physiotherapists. Therefore, blinding was only in place for the physicians involved in the outcome assessments and data analyses. The advantage of this blind method is that the physiotherapists can better observe and understand the participants, and when necessary, can promptly and appropriately deal with the unexpected problems that may occur to the participants. Thus, the safety of the participants can be guaranteed. Nevertheless, this blinding method has the disadvantage of subjective bias, which might lead to unbalanced treatment between groups.

5 | STUDY LIMITATIONS

The current study had some limitations. First, potential selection bias might have occurred because patients were recruited from the same medical unit. Second, there was no placebo or sham group; instead, two different types of treatment protocols were compared. Although the selection of two often used treatment protocols might be considered a methodological flaw, it was more consistent with real clinical practice. Third, blinding was only in place for the physicians involved in the outcome assessments and data analyses. Another limitation of this study was the short-term evaluation of the efficacy of these treatment modalities, and a longer follow-up period may be needed to detect long-term changes.

6 | CONCLUSIONS

The study suggested that adding SMFR to BES therapy is superior to using BES alone in patients with MFPP and

can be considered a prime treatment plan. However, future studies with longer follow-up periods are required to evaluate the efficacy of long-term effects.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest and nothing to disclose.

AUTHOR CONTRIBUTIONS

JYX, BD, SSY and YS were involved with the concept and study design. Data analysis was performed by ZMY. Drafting the manuscript and critical revisions was performed by JYX, KC, MLR and YS. All authors have seen and approved the final version of the article.

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