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Health-related outcomes with supervised exercise and myofascial release versus only supervised exercise in subacromial pain syndrome: a randomized controlled single-blind study

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Abstract

Background Myofascial tissue plays a critical role in shoulder joint mobility disorders. Myofascial release therapy (MFR) is frequently utilized to restore the extensibility of fascial tissue and is considered beneficial for various clinical conditions such as low back pain and ankle injuries. However, no studies have yet evaluated the effects of MFR on periscapular muscles activation and shoulder mobility in patients with subacromial pain syndrome(SAPS).

Objective The purpose of this study was to compare the effectiveness of MFR combined with supervised exercise(SE) and SE alone in patients with SAPS.

Design Assessor-blinded randomized controlled trial.

Setting Sir Run Run Shaw Hospital, Zhejiang University School of Medicine.

Subjects Subacromial pain syndrome patients.

Methods Fifty participants were divided into two groups: SE group and MFR + SE group, each group 25 cases. Both treatment methods were performed 5 times a week for 4 weeks.

Main measures Shoulder pain severity was assessed by visual analog scale (VAS); shoulder range of motion (ROM) by a goniometer; functionality by shoulder Pain and Disability Index (SPADI); and periscapular muscles activation by sEMG. All measurements were evaluated both pre- and post-treatment.

Results An ANOVA analysis indicated no significant group by time interactions for flexion ROM and resting VAS ($p > 0.05$). However, significant group by time interactions were found for SPADI, abduction and external rotation ROM, and activity VAS ($p < 0.05$). Post-hoc tests revealed significant improvements in SPADI, abduction and external rotation ROM, and activity VAS in both groups compared to pre-treatment ($p < 0.05$). Additionally, there were significant group by time interactions for the sEMG values of the upper trapezius and serratus anterior ($p < 0.05$). Post-hoc tests showed

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that compared to pre-treatment, the MFR + SE group had decreased upper trapezius sEMG values and increased serratus anterior sEMG values($p < 0.05$), while the SE group showed increased serratus anterior sEMG values($p < 0.05$). After the 4-week intervention, there were significant between-group differences in SPADI, abduction and external rotation ROM, activity VAS, and sEMG values of the upper trapezius and serratus anterior($p < 0.05$).

Conclusion Four weeks of MFR combined with SE can increase shoulder ROM, improve pain, and thus enhancing functional activities in patients with SAPS. Additionally, it can further improve the balance between the upper trapezius and serratus anterior to improve the dynamics of the periscapular muscles.

Trial registry number ChiCTR2200061054. Date of registration 15/06/2022.

Keywords Subacromial pain syndrome, Myofascial release, Supervised exercise, Surface electromyography

Introduction

Subacromial pain syndrome (SAPS) is the most common clinical diagnosis which comprises impingement of the rotator cuff tendons, bursa, or ligaments and alterations in the subacromial space, with an annual prevalence of 48 cases/1000 persons [1]. SAPS is not caused by a single pathology, but rather by the co-occurrence of various potential pathologies, including anatomic abnormalities of the coracoacromial arch or humeral head; inflammation in the suprahumeral space; ischemia or degeneration of the rotator cuff tendons. In addition, abnormal shoulder movement due to joint overuse, sustained intensive work and poor posture are also common causes [2]. The common sequelae of SAPS include decreased quality of life, sleep disturbances, increased pain with arm elevation, inadequate rotator cuff strength, structural flexibility at the posterior of the shoulder and other soft tissue limitations, and changes in the scapular length–tension relationship.

Patients with SAPS often exhibit altered shoulder kinematics and scapular instability during humeral elevation, including excessive upward or anterior translations of the humeral head on the glenoid fossa [3], inadequate external humeral rotation [4], reduced upward rotation of the scapula and posterior tipping on the thorax [5]. At the same time, it is important to recognize altered scapular muscle activity problems in patients with SAPS [6], who have decreased serratus anterior and lower trapezius muscle activities, increased upper trapezius muscle activity, and greater variability in the onset-timing activation during shoulder elevation than that of healthy individuals [7, 8]. Muscle activity controls the direction of motion of the scapula and humerus and, in turn, changes in the position of the scapula and humerus can affect muscle activity by altering the muscle strain or rate of strain [9]. Therefore, effectively improving the abnormal activation patterns of the periscapular muscles and correcting the abnormal positioning of the scapula and humerus are among the primary goals in the treatment of patients with SAPS.

Current guidelines strongly recommended Physical therapy as first-line treatment due to its clinical effectiveness, cost-effectiveness, and potential to improve pain, mobility, and function in patients with SAPS [10–12]. Physical therapy are used as non-pharmacological approaches to ensure proper healing of damaged tissue and to enable the patient to participate in activities of daily living for a short period [13]. In patients with SAPS, the delivery of supervised, progressive exercise therapy by a physiotherapist is more effective than providing advice or an exercise leaflet to optimize results [14].

Fascial tissue is described as a soft tissue component of the connective tissue system that permeates the human body, significantly influencing an individual's biomechanics, systemic and the bodily awareness [15]. Myofascial release therapy (MFR) is an effective manual soft tissue technique that facilitates the stretching of fascia constrained by muscle hyperactivity, significantly improving pain, reducing disability, enhancing muscle mechanical properties, and increasing range of motion (ROM) in the management of chronic musculoskeletal pain [16]. The efficacy of MFR for the shoulder has been demonstrated in various randomized controlled trials. Dash et al. investigated the immediate effects of MFR on pain and ROM in patients with shoulder impingement syndrome(SIS), showing significant immediate improvements in all outcomes [17].

Given the pathological characteristics of SAPS patients, such as abnormal joint movement patterns and periscapular muscle activation, and the impact of fascial tissue on systemic body awareness and biomechanics, this study hypothesizes that the combination of supervised exercise (SE) and MFR can further alleviate pain, improve ROM, and enhance function and muscle activity in SAPS patients. Therefore, the aim of this study was to investigate, compared to SE alone, the effectiveness of SE plus MFR on pain intensity, ROM, disability, and periscapular muscle activity in patients with SAPS.

Methods

Study design

This study was an assessor-blinded, parallel assigned randomized controlled trial following CONSORT statement guidelines. The trial design was parallel 1:1. Participants were recruited from November 2022 to December 2023 at the Department of Rehabilitation Medicine, Run Shaw Hospital. The study protocol was approved by the Ethics Committee at Run Shaw Hospital which is affiliated to the Medical College of Zhejiang University (protocol numbers: 2022-419-01). All participants provided written informed consent before commencing study-related procedures. The trial has been registered at the Chinese Clinical Trial Registry on 15/06/2022 as ChiCTR2200061054.

Participants

All consecutive eligible patients who attended the clinic for diagnosis and treatment of various shoulder disorders were enrolled in this study. A computer-generated series of random numbers in MS Excel was used to randomly allocate 50 participants, either to the MFR+SE group (n=25) or the SE group (n=25), prior to the start of study procedures. In this study, it was impossible to blind the participants and the therapists about allocation and treatment; only outcome assessors and statisticians were blinded. Patients were eligible for inclusion if they met the following criteria: (1) experiencing shoulder pain for 3 months or more; (2) No passive limitation of ROM suggestive of adhesive capsulitis; (3) aged between 18 and 65 years; (4) positive findings on at least three of the following: Neer impingement sign, Hawkins' sign, painful arch during arm elevation, and empty can test. Participants were excluded if they: (1) had cervical symptoms or a shoulder fracture; (2) had type 3 acromion; (3) rotator cuff tears great than 3 cm; (4) had tears to the long head of the biceps tendon; (5) any accompanying neurological problem, malignancy and pregnancy; (6) had a history of surgery to the affected shoulder; and (7) had received steroid injections or physical therapy during the preceding 6 months.

Primary outcomes

Disability index

Functional disability due to shoulder disorders was assessed using the shoulder Pain and Disability Index (SPADI) scale. The SPADI is a 13-item self-report questionnaire [18]. Each item is scored from 0 (no difficulty) to 10 (unable to perform task) points, and higher scores represent greater levels of pain and disability. The SPADI has good test–retest reliability and validity, and is sensitive to change [19].

Secondary outcomes

Shoulder pain

The intensity of shoulder pain was recorded at rest and on activity by using the visual analogue scale (VAS). This scale consists of a continuous horizontal 10-cm line, where the endpoints defining extreme limits for "no pain" and "maximum perceived pain intensity." This scale is a reliable and valid instrument that can assess changes in pain intensity, with a test–retest reliability between 0.95 and 0.97 [20].

ROM of the glenohumeral joint

A universal goniometer was used to measure the ROM for shoulder flexion and external rotation with the patient in a supine position, hips and knees flexed. The ROM for shoulder abduction was measured with the patient in a seated position, back supported by a high-backed chair to prevent trunk compensation.

Evaluation of scapular muscle activity

The surface electromyography (sEMG) activity was recorded with a Umedstra biomedical acquisition system (Model AMT-4; common mode rejection ratio of 130 dB at 60 Hz, input impedance of 10 GΩ) with sampling at 1000 Hz with a 12-bit A/D converter (PCI 6024E, Shaoxing United Medical Instruments, Zhejiang, People's Republic of China). The sEMG data were digitally filtered by a 20- to 500-Hz band-pass, zero-lag, fourth-order Butterworth filter; collected by LabVIEW; and processed by Megawin3.1 (Math Works, Natick, MA). The testing movement assessed in this study was to raise the humerus in the scapular plane (30°anterior to the frontal plane) while holding a 2-kilogram load, guided by a wooden pole [21]. The dynamic sEMG data of the upper and lower trapezius, and the serratus anterior were extracted, in the windows of the rising stage of the scaption. Root mean square (RMS) averages were determined for each trial. For all sEMG variables, data from the three motion trials were collected, averaged, and used in subsequent analyses. The sEMG data were normalized by a 5-se reference voluntary isometric contraction (RVIC) against resistance at an arm elevation of 90° in the sagittal plane [6].

Interventions

Study flow

Patients in the SE group included three stretching exercises on both sides and three strengthening and three ROM exercises for the SAPS-affected side. The MFR+SE group underwent MFR treatment in addition to the applications in the SE group. Both treatment methods were performed in all applications for 5 sessions per week for 4 weeks. The two physiotherapists (1 for each group) in charge of the therapeutic procedures had 10 years of experience in physical therapy and execution of the MFR treatment.

SE treatment

The stretching exercises targeted the upper trapezius (Fig. 1A), the posterior region of the shoulder (Fig. 1B), and the pectoralis minor (Fig. 1C) [22]. Each stretch

Fig. 1 Illustration of the supervised exercise intervention: (**A**-**C**) stretching; (**D**-**F**) strengthening; (**G**-**I**) ROM.

consisted of 3 repetitions of 30 s each, with a 30-s interval between repetitions. The strengthening exercises targeted the external rotation of the shoulder (Fig. 1D), the lower trapezius muscle (Fig. 1E), and the serratus anterior muscle (Fig. 1F). For the standardization of the exercise performed with an elastic band (1-m color-coded elastic resistance bands, TheraBand; The Hygenic Corporation, Akron, OH), resistance was determined based on 10 repetitions of the exercise without pain, and the performance was individualized. The resistance was reevaluated at the end of each week, and the necessary adjustments were made. The ROM exercises targeted the shoulder lateral rotation (Fig. 1G), abduction(Fig. 1H), and forward elevation (Fig. 1I). They can engage in standing ROM exercises when it's comfortable. For all strengthening exercises and ROM exercises, perform 10 repetitions per set, with 2 sets each time.

MFR treatment

The MFR treatment protocol included two previously described techniques: (1) a manual application to the following fascia and muscles: the upper trapezius, the supraspinatus muscle, the deltoid muscle, the infraspinatus muscle, and the biceps tendon (Fig. 2A, the upper trapezius technique); (2) Gross stretching of the upper limb (Fig. 2B, gross stretch of the upper quarter) [23]. The physical therapist uses both hands to apply gentle, gradually increasing pressure from the superficial to the deep layers of the myofascial tissue in order to perform a three-dimensional fascial movement. This approach is repeated until a soft end-feel is reached in every direction and layer. For the gross stretch, the subject is in the supine position, the therapist comfortably grasps the subject's hand and keeps his shoulders relaxed and moves toward the subject's feet until the elbow is in full extension. The stretch is held until the fibers are released, and then, the stretch is reapplied by increasing traction. This sequence is repeated until an end feel is reached. One session of myofascial therapy lasted 30 min.

Statistical analysis

Sample size calculation

Sample size calculation was achieved by power analysis that was performed using G*Power 3 software based on a previous study that reported standard deviations in the SPADI score between 9.65 [24]and 19.2 [25], for determining statistically significant intergroup differences. With a power of 85% and an α level of 0.05, the total sample size was estimated to be 50 (25 participants per group), considering a 20% dropout rate.

Analysis

The SPSS (version 25.0) was used for all statistical analyses. All variables were presented as mean ± standard deviation. Baseline differences between groups were assessed using independent samples t-tests for continuous data and chi-square tests for categorical data. The Levene test was used to assess homogeneity of variances. Two-way

Fig. 2 Illustration of the myofascial release treatment intervention: (**A**) the upper trapezius technique; (**B**) gross stretch of the upper quarter

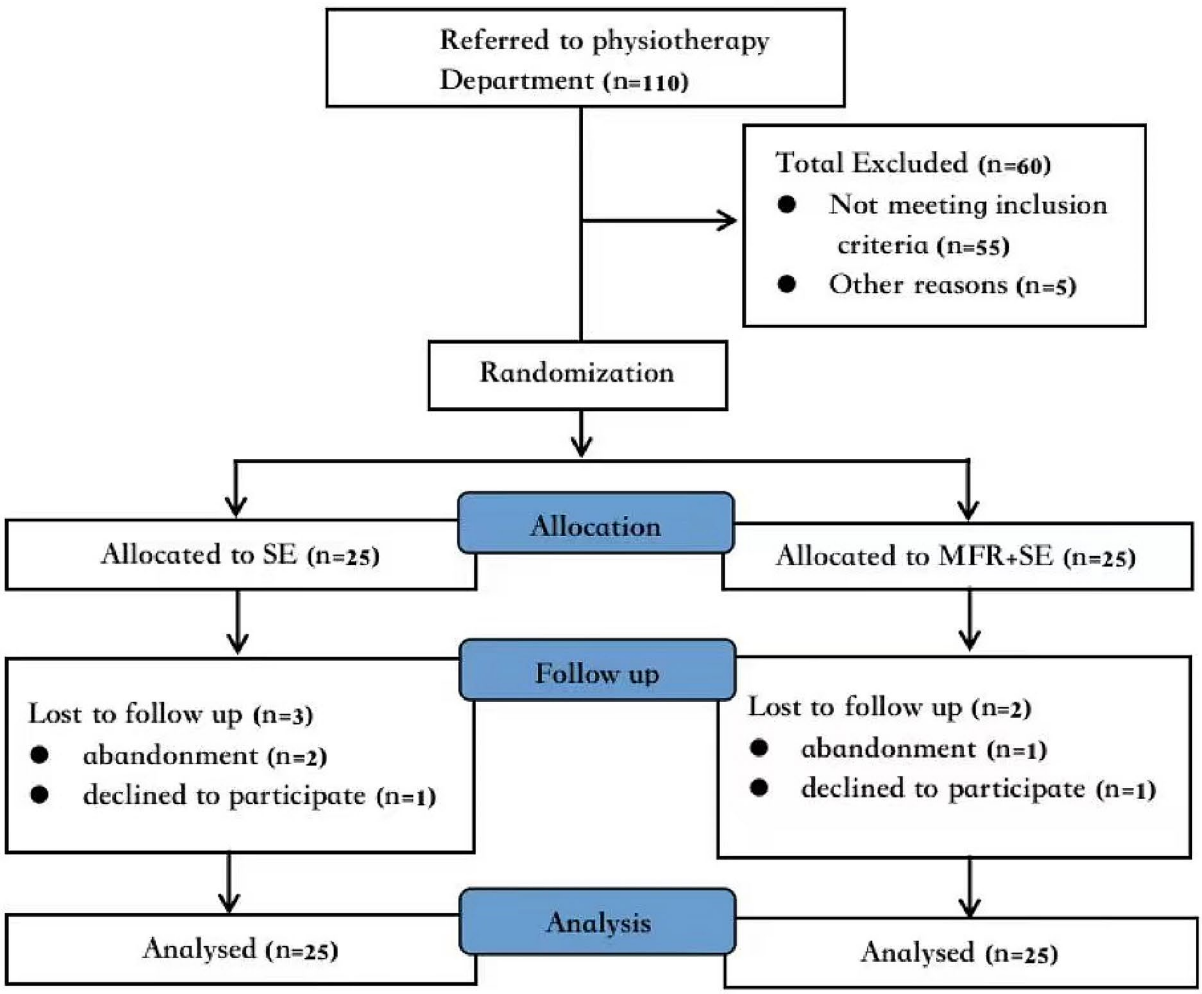

Fig. 3 Study flowchart

repeated measures analysis of variance (ANOVA) was employed to analyze the main effects of group and time, and their interaction effects on the variables. In the event of a significant group by time interaction, the Bonferroni method was used for post-hoc comparisons. Partial eta-squared (η^2) was used as the effect size(ES) in the ANOVA results. Within-group ES were calculated using the Cohen's d statistic. According to Hopkins' criteria, the magnitudes of ES were classified as trivial (<0.2), small (0.2–0.6), moderate (0.6–1.2), and large (1.2-2.0) [26]. A p-value of <0.05 was considered statistically significant.

Table 1 Participants' characteristics

Characteristics	MFR + SE Group(n = 25)	SE Group(n = 25)	*P*
Age (years)	46.20 ± 10.98	52.12 ± 16.07	0.135
Gender (male/female %)	(40/60)	(28/72)	0.370
Height (cm)	169.16 ± 8.22	167.36 ± 7.83	0.432
Weight (kg)	62.04 ± 10.81	60.68 ± 9.90	0.645
BMI(kg/m^2)	21.50 ± 1.92	21.58 ± 2.55	0.903
Pain duration(M)	5.32 ± 3.2	6.32 ± 4.3	0.354
Shoulder involved (right/left %)	(52/48)	(52/48)	1.000

cm: centimeter, Kg: Kilograms, M: month, n: number, m: meter, BMI: Body Mass Index

Results

Initially, 110 individuals were screened for eligibility, and 60 were excluded (55 did not meet the inclusion criteria and 5 were excluded for other reasons). The remaining 50 individuals were included and randomized. Three participants in the SE and two participants in the MFR+SE group did not attend the post-intervention assessment because of lack of time. Finally, the study was completed with 22 and 23 patients in the SE and MFR+SE groups, respectively (Fig. 3, Study flowchart). In both groups, the participants had similar baseline characteristics (p > 0.05; Table 1).

As indicated in Table 2, Two-way repeated measures ANOVA indicated significant main effects of time for flexion ROM (p < 0.001, ES = 0.543, small) and resting

Table 2 Results on the outcomes measured at baseline, and post- intervention (mean ± SD)

Variables	MFR + SE		SE		Time		Group		Time×Group	
	Pre	post	Pre	post	*P*	ES	*P*	ES	*P*	ES
SPADI(score)	57.32 ± 13.8	33.12 ± 11.1*#	55.20 ± 12.0	42.44 ± 9.9*	0.000	0.390	0.130	0.024	0.017	0.058
VAS(cm)										
rest	3.60 ± 1.1	1.36 ± 0.8	3.80 ± 1.1	1.96 ± 0.5	0.000	0.569	0.030	0.048	0.272	0.013
activity	4.64 ± 1.0	1.32 ± 0.9*#	4.76 ± 1.0	2.24 ± 0.9*	0.000	0.721	0.006	0.076	0.033	0.046
ROM(°)										
flexion	98.76 ± 19.7	144.60 ± 19.2	87.88 ± 21.6	124.20 ± 16.1	0.000	0.543	0.000	0.147	0.219	0.016
abduction	60.80 ± 13.4	110.00 ± 14.9*#	62.44 ± 13.9	97.28 ± 12.4*	0.000	0.711	0.046	0.041	0.010	0.067
external rotation	36.40 ± 11.9	68.00 ± 10.7*#	38.16 ± 14.7	55.40 ± 13.1*	0.000	0.491	0.035	0.045	0.006	0.077

cm: centimeter; °:degree; *Denotes significant difference compared with the baseline value within each group; # Denotes significant difference compared with the SE group

Table 3 Normalized sEMG muscle activity expressed as percentage of the reference contraction during shoulder flexion between the MFR group and SE group at baseline, and post- intervention

sEMG	MFR + SE		SE		Time		Group		Time×Group	
	Pre	post	Pre	post	*P*	ES	*P*	ES	*P*	ES
Upper Trapezius	50.26 ± 9.5	36.64 ± 8.1*#	47.89 ± 13.4	46.35 ± 14.1	0.001	0.101	0.116	0.026	0.010	0.066
Lower Trapezius	31.51 ± 10.8	48.92 ± 11.9	27.77 ± 8.2	37.65 ± 10.7	0.000	0.307	0.001	0.118	0.075	0.033
Serratus Anterior	35.25 ± 10.2	55.76 ± 8.0*#	33.95 ± 10.9	44.64 ± 9.1*	0.000	0.407	0.002	0.098	0.012	0.064

*Denotes significant difference compared with the baseline value within each group; # Denotes significant difference compared with the SE group

VAS ($p<0.001$, ES = 0.569, small). A significant group by time interaction was observed for SPADI($p=0.017$, ES = 0.058, trivial), abduction ROM($p=0.010$, ES = 0.067, trivial), external rotation ROM($p=0.006$, ES = 0.077, trivial), and activity VAS($p=0.033$, ES = 0.046, trivial). Post-hoc comparisons revealed that compared with baseline, significant within-group differences were found in SPADI($p<0.001$, ES = 1.944, large), abduction ROM($p<0.001$, ES = 3.477, large), external rotation ROM($p<0.001$, ES = 2.796, large), and activity VAS($p<0.001$, ES = 3.495, large) in the MFR + SE group. Meanwhile, SPADI($p=0.001$, ES = 1.165, moderate), abduction ROM($p<0.001$, ES = 2.649, large), external rotation ROM($p<0.001$, ES = 1.240, large), and activity VAS($p<0.001$, ES = 2.653, large) in the SE group after the four weeks of interventions. Significant between-group differences were found in SPADI($p=0.038$, ES = 0.888, moderate), abduction ROM($p=0.008$, ES = 0.932, moderate), external rotation ROM($p=0.004$, ES = 1.059, moderate), and activity VAS($p=0.004$, ES = 1.022, moderate) at Week 4.

As indicated in Table 3, Two-way repeated measures ANOVA indicated significant main effects of time for Lower Trapezius ($p<0.001$, ES = 0.307, small). A significant group by time interaction was observed for Upper Trapezius($p=0.010$, ES = 0.066, trivial) and Serratus Anterior ($p=0.012$, ES = 0.064, trivial). Post-hoc comparisons revealed that compared with baseline, significant within-group differences were found in Upper Trapezius($p<0.001$, ES = 1.548, large) and Serratus Anterior ($p<0.001$, ES = 2.254, large) in the MFR + SE group. Meanwhile, Serratus Anterior($p=0.001$, ES = 1.069, moserate) in the SE group after the four weeks of interventions. Significant between-group differences were found in Upper Trapezius($p=0.023$, ES = 0.875, moderate) and Serratus Anterior ($p=0.001$, ES = 1.301, large) at Week 4.

Discussion

In this study, we investigated the effectiveness of SE plus MFR compared with SE alone in patients with SAPS. We demonstrated that both interventions improved pain, ROM, and disability. Moreover, we found that the effects were greater in the MFR + SE group compared with SE group. The findings also suggest that MFR combined with SE can reduce the upper trapezius muscle activity and increase the serratus anterior muscle activity, and normalize the co-activation ability of the periscapular muscles.

Multiple studies have demonstrated the significant efficacy of MFR in alleviating pain and improving function. Elsayyad et al. utilized MFR techniques in post-lumbar fusion surgery patients and found that, compared to core stability training alone, MFR combined with core stability training more effectively enhanced lumbar function and alleviated pain [27]. Additionally, numerous reports have shown that MFR can improve functional disability and pain in patients with lower back pain (LBP) [28, 29]. In patients with shoulder pain, Dash et al. conducted a comparative study using MFR and joint mobilization for treating SIS, revealing that MFR was significantly superior to joint mobilization in pain relief [17]. Groef et al. performed MFR on post-breast cancer treatment patients and discovered that 12 sessions of MFR treatment significantly reduced arm pain intensity in breast cancer survivors at three months [30]. Cathcart et al. applied MFR to the thoracic spine of healthy adults and found that the pressure pain threshold increased both locally and distally after MFR treatment, but not under sham and control conditions, indicating that MFR induced systemic effects [31]. These non-local neurological responses are suggested to be triggered via autonomic reflexes. The findings of the present study are consistent with the results reported in the literature, as both groups reported statistically significant reductions in the pain and disability, with the MFR+SE group showing a more significant decrease than the SE group in the VAS and SPADI scores. The underlying mechanism for this effect could be that MFR stimulates the Golgi reflex arc and mechanoreceptors that are located in the soft tissues, stimulates afferent pathways, and activates descending pain-inhibiting systems, which can result in pain and shoulder function modulation [32]. The reduction in pain, increased ROM, and enhanced muscle strength could be the potential reasons for the improvement in functionality and reduction in disability.

Furthermore, Çelik et al. utilized proprioceptive neuromuscular facilitation (PNF) combined with MFR for patients with SIS, administering treatments three times per week for four consecutive weeks [15]. They found a significant reduction in both resting and activity-related pain in both groups compared to PNF alone. However, when comparing the immediate and cumulative effects of pain treatment between the two groups, no difference was found in immediate resting pain. Only the PNF group showed improvement in activity pain after the first treatment session, while the addition of MFR did not produce a similar effect. In our study, although we did not observe pain levels immediately after the first treatment session, we found a significant main effect of time on resting pain after four weeks of treatment. Additionally, the MFR+SE group showed significant improvement in activity pain compared to the SE group. While the overall treatment duration was consistent, our study had a higher treatment frequency, with sessions five times per week. We believe this higher frequency more effectively demonstrates the cumulative effects of MFR.

Another important issue affecting the functionality and quality of life of patients with SAPS is the limitation of shoulder joint ROM. In most shoulder movements, such as abduction or forward flexion, internal/external glenohumeral rotation is important for shoulder function [33]. Abnormal shoulder motion, including limited ROM of the scapula and shoulder joints, as well as significant glenohumeral joint external rotation restriction during shoulder elevation, are common problems in patients with SAPS [34]. The external rotation angle was negatively correlated with pain intensity, and pain was significantly reduced when the external rotation angle increased. Godges et al. studied the immediate effects of PNF combined with soft tissue mobilization on overhead extension and glenohumeral external rotation, and explored the acute impact of combined therapy on the subscapularis muscle [35]. They concluded that PNF exercises combined with soft tissue mobilization significantly increased shoulder external rotation after a single treatment session. Merve et al. demonstrated that PNF exercises combined with MFR significantly increased shoulder ROM in all directions both after a single treatment session and after 4 weeks of treatment [15]. Laura et al. conducted a study on healthy individuals applying MFR to the lumbar region twice a week for a total of 10 sessions, finding that MFR significantly increased lumbar flexibility [32]. Similarly, Ellie et al. observed changes in interoceptive sensitivity (IS) when applying MFR to the thoracic fascia in healthy individuals, noting a positive correlation between IS and ROM [31]. They suggested that higher IS may enhance hypothalamic response, further reducing sympathetic activity and promoting a more relaxed parasympathetic state, thereby allowing greater ROM. Additionally, other studies have reported that MFR, as an adjunct to back school programs along with exercises and workstation adjustments, can improve lumbar flexion ROM [36]. Our results are consistent with previous reports, demonstrating that SE combined with MFR has a more significant effect on improving the ROM of shoulder joint after 4 weeks of intervention. Improved ROM may be attributed to MFR breaking the scar matrix and intermolecular cross-linkages through mechanical action, redistributing internal fluids, remodeling of collagen and elastin through a piezoelectric effect, increasing viscoelasticity and thixotropy, improving the ductility of collagen, reducing tissue tension and stiffness, and enhancing the flexibility of fascia [37, 38]. MFR may also improve ROM and reduce pain through neuroreflex inhibition of pain and muscle tension, local and systemic changes in blood and lymphatic circulation, and relaxation of fascial tension, thereby providing more adequate biomechanical function [15].

The pain and clinical symptoms of SAPS lead to muscular inhibition and altered neuromuscular patterns that reduce and delay muscle activation. Multiple authors have repeatedly confirmed the reliability of the immediate impact of MFR on patients with LBP. Arguisuelas et al. conducted a study involving four sessions of MFR on chronic LBP who did not exhibit myoelectric silence at baseline [37]. The results indicated a bilateral reduction in the flexion relaxation ratio (FRR) in individuals receiving MFR treatment. Ożóg P et al. explored the immediate changes in muscle activity in LBP patients following a single MFR session. MFR significantly reduces muscle activity between maximum trunk flexion during flexion–relaxation; normalizes the erector spine muscle activity bilaterally; and further reduces back muscle activity in the resting position in patients with low back pain [39]. The reduction in the FRR observed in the MFR group following the intervention may be attributed to the stimulation of fascia mechanoreceptors, which leads to alterations in the neural control inputs to the spinal stabilizing system. Ultimately, facilitates relaxation of the erector spinae during the full flexion phase. Additionally, Çelik et al. demonstrated that PNF combined with MFR significantly increased shoulder flexion and abduction muscle strength compared to the PNF-only group with regard to acute effects. They suggested that MFR could reduce trapezius activation while enhancing deltoid muscle activity [15]. This study is the first to use sEMG to evaluate the improvement in periscapular muscle activity in SAPS patients following MFR. Our study suggests that MFR combined with SE significantly reduced upper trapezius muscle activity and increased serratus anterior muscle activities. By employing both global and local myofascial techniques and leveraging the proximal-distal connectivity of fascial tissues, the treatment effectively reduced upper trapezius activation and simultaneously increased serratus anterior activation. MFR stimulates mechanoreceptors that are located within soft tissue and whose activity continuously provides neuroreflex muscle activation to the central nervous system; thus, MFR induces the central nervous system by balancing the activity of these receptors and reestablishing dynamic control to achieve a more significant improvement in the co-activation ability of the periscapular muscles [36]. Although no significant changes in activation levels were observed in the lower trapezius, this may be attributed to the overall short duration of the treatment or the assessment methods used not adequately capturing the changes in lower trapezius activation.

Study limitations

Some limitations of this study should be mentioned. First, the lack of blinding of the investigators and participants owing to the nature of the treatment interventions confers the possibility of bias. Second, the absence of sham therapy in the control group may be considered a limitation of this study with regard to the comparison of our results. Third, there was no follow-up and no observation of long-term efficacy, which may detract from the relevance of the findings. Fourth, the lack of assessment of the psycho-emotional aspect, which may have a potential impact on periscapular muscle activity, constitutes a limitation of this study.

Conclusion

The study indicates that, for patients with SAPS, incorporating MFR into conventional exercise can be a more effective and safe treatment strategy. The combination of MFR and SE demonstrated better pain sensitivity reduction, improved ROM, and enhanced shoulder function over a 4-week period. Furthermore, combining MFR with SE can reduce the activation of the upper trapezius, increase the activation of the serratus anterior, and thereby improve the dynamics of the periscapular muscles. Therefore, it is recommended to integrate manual therapy with conventional treatment methods. Further studies, including those with larger sample sizes, may reveal more about this potential effect.

Abbreviations

SAPS	Subacromial pain syndrome
MFR	Myofascial release
SE	Supervised exercise
SPADI	Shoulder pain and disability index
sEMG	Surface electromyography
VAS	Visual analogue scale
ROM	Range of motion
RVIC	Reference voluntary isometric contraction
RMS	root-mean-square
SIS	Shoulder impingement syndrome
ES	Effect size
LBP	Low back pain
PNF	Proprioceptive neuromuscular facilitation
IS	Interoceptive sensitivity
FRR	Flexion relaxation ratio

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

Study design: Yongzhong Li; Data collection: Xuan Li, Qian Fang; Data analysis: Haixin Song; Manuscript writing: Yongzhong Li; Final approval: Yiqun Shou.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

We confirm that all methods were carried out in accordance with relevant guidelines and regulations.The study was approved by the Research Ethics Committee of the Sir Run Run Shaw Hospital, Zhejiang University School of Medicine (protocol numbers: 2022-419-01). Written informed consent obtained from all patients recruited to this study.

Consent for publication
The patient images and evaluation data involved in the paper were published with the consent of the patients or their legal guardian(s) and "written informed consent to" was obtained to publish the data.

Competing interests
The authors declare no competing interests.

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