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Title: Investigating the Impact of Massage and Self-Myofascial Release on Shoulder Pain and Mobility in Patients with Trapezius Trigger Points: A Clinical Trial

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Abstract

Introduction: Myofascial pain syndrome caused by trigger points (TPs) can lead to complications such as hyperalgesia, limited range of motion (ROM), stiffness, weakness, proprioceptive interference, and coordination disorder The trapezius muscle is among the most common areas of TPs so that inactive TPs are reported by 78.8% of healthy people. the trapezius muscle needs special attention due to its area and function .A large number of methods have been proposed to release TPs, among which self-myofascial release (SMR) and massage have been considered as the most popular ones. The present study aims to assess the effect of the above-mentioned methods in reducing complications created by TPs in the trapezius.

Method: Totally, 45 women with TPs in the trapezius muscle were randomly divided into two experimental and one control group. The experimental group underwent intervention for five days. During the pre- and post-test, the shoulder ROM was measured by a goniometer. In addition, the pain level was evaluated by the visual analog pain scale (VAS), and the quality of hand and shoulder function was examined using the disability of the arm, shoulder and hand questionnaire (DASH).

Results: pain significantly reduced in both groups (p>0/001) as well as improvement in DASH score(p>0/001). when it's come to ROM massage led to better improvement of the ROM in internal and external rotation of the shoulder (p>0/001). the ROM in flexion and abduction showed more improvement in the SMR group (p>0/001). None of the interventions affected the ROM in extension significantly (p=0.420).

Conclusion: The results indicated that both interventions can reduce the pain and improve the quality of shoulder motion. However, when it's come to ROM different result was obtained. Accordingly, massage can be more effective in internal and external rotation, while SMR exhibits more effectiveness in abduction and flexion due to the muscle connections in the trapezius.

Keywords: Massage, Myofascial release, Myofascial Pain Syndrome, Trigger Points, Shoulder

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Highlight:

Self-myofascial release (SMR) can be more effective when it's come to shoulder girdle range of motion.

Both massage and SMR can have positive effects on reducing pain score and overall quality of daily life activity using arm and hands.

Plain language summary:

The present study aims to compare the effect of two popular methods on releasing one of the most common musculoskeletal pain syndromes in nowadays life. The results of study shows that even though massage can have effects in some of shoulder girdle aspects but after all SMR not only can reduce the complications of TPs in this era but also can be more cheap and easier to be used.

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Introduction

Myofascial pain syndrome (MPS) is among the most common musculoskeletal disorders (1)created by hypersensitive spots in the muscle fiber and fascia called trigger points (TPs)(2) which have attracted a lot of attention due to their great impact on people's quality of life and performance. MPS can be related to other painful disorders (3). For instance, myofascial pelvic pain, which is created by the presence of TPs in pelvic areas (3), can cause various problems such as bladder pain, anxiety, and endometriosis. Some studies reported an increase in MPS and TPs among patients with migraines and tension-type headaches (4). Some others argued that the TPs commonly occur after whiplash injuries, lumbar disc protrusion, idiopathic neck pain (5). In addition, MPS is known as a pain, which can imitate other painful conditions and musculoskeletal disorders (6). For example, the TPs in the upper angle of the scapula in the joint area with the posterior wall of the chest can create a pain similar to angina pectoris while occurring on only one side without symmetry (6). Even though that MPS is among one of the most known pain syndrome but yet its exact initial reason which can cuse the TPs to first appear is still under research(2) .this must be clarify that TPs can occur in different areas with various suspected reasons. Studies have shown that, 85% of the people would experience the presence of TPs at least once through their life. The trapezius muscle is among the most common areas of TPs so that inactive TPs are reported by 78.8% of healthy people(7). Apart from the high prevalence of TPs, the complications arising from their presence such as hyperalgesia, limited range of motion (ROM), stiffness, weakness, proprioceptive interference, and coordination disorder(7). the trapezius muscle needs special attention due to its area and function. The trapezius muscle is regarded as a key muscle in the shoulder girdle, which provides the required stability of the scapula through its joints. The location of the scapula plays a critical role in the optimal function of the glenohumeral joint (8). Considering impaired normal muscle function in the presence of trigger points(9) and the muscle's role in the shoulder girdle treating trigger points in this muscle is crucial . The high prevalence of TPs In addition to the complications arising from their presence such as hyperalgesia, limited range of motion (ROM), stiffness, weakness, proprioceptive interference, and coordination disorder(7)this actually put the decision of chosen the right treatment method in highly important position.

Several researchers seek to find effective strategies in releasing TPs, as well as evaluating invasive and non-invasive methods. Invasive methods include injection of non-steroidal anti-inflammatory drugs or botulinum toxin, dry needling, and acupuncture(2) , while non-invasive ones include massage, SMR, tai chi, pressure and stretching techniques, biofeedback and meditation (10). Non-invasive methods are preferred to manage conditions such as MPS. Some

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of the above-mentioned invasive methods reduce pain quickly, despite their side effects such as addiction and abuse(2) .However, alternative methods with fewer side effects should be utilized to improve the pain resulting from this disorder (11). SMR and massage have attracted a lot of attention during the recent decades.

SMR, which is widely applied by active people and specialists in dealing with patients, is considered as useful for athletes in all of the sports fields at all of the levels in competition (12). SMR includes a set of self-massage methods in which certain areas are subjected to pressure and tension employing the weight of the person's own body by instruments such as foam rolling, lacrosse and tennis balls, as well as special release sticks(13). A person can adjust the amount of pressure based on his/her tolerance and comfort, which makes this approach bearable. Several benefits have been proposed for SMR, the most significant of which include the ROM improvement (14), sense of proprioception, increase in recovery speed (15), and performance enhancement, relieving the pain created by TPs (16).

Massage therapy and SMR are among the most critical interventions among the aforementioned methods. Massage is described as a method to manipulate soft tissue which helps create relaxation (17). This method can relieve pain and improve ROM through mechanisms such as increasing blood flow in the area following pressure application which occurs after temporary ischemia, resulting in enhancing the oxygen supply to the area, breaking the vicious cycle of energy (18), and discharging accumulated lactic acid after repeated motions (19). In addition, the release of parasympathetic hormones during the massage can help reduce muscle tone.

No study has been conducted to compare the above-mentioned methods in reducing complications created by TPs in the trapezius muscle including decreased pain and ROM following their presence, despite the increasing attention of researchers and athletes in this field. A more effective method should be found to improve the aforementioned areas and their complications in order to return the person to a normal life faster and improve the quality of his/her performance, considering the significance of the trapezius muscle in shoulder stability and high prevalence of creating TPs in these areas. This study seeks to investigate the above-mentioned methods in terms of efficiency in reducing the aforementioned complications.

Method

In order to conduct the study, a notice was distributed among academic women (students) in Shahid Beheshti University to attract the population. To this aim, eligible subjects were invited to cooperate after explaining about MPS and its symptoms. Then, OSIPOW psychological strain questionnaire (PSQ) and VAS were distributed among those interested in participating

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in the study. The sample size was determined based on previous interventional studies with similar methodology, including the study by Jafari et al. (20) Furthermore, an a priori power analysis was conducted using G*Power software (version 3.1) for a one way ANCOVA . Assuming a medium effect size (f = 0.25), a significance level of 0.05, and a statistical power of 0.80, the minimum required sample size was calculated to be 42 participants. To account for possible dropouts, 45 participants (15 per group) were included in the study.

All 45 participants were recruited from a single center (Shahid Beheshti University, Tehran); therefore, between-city comparisons were not applicable.

In the next step, 45 subjects were randomly divided into two experimental groups including massage (N=15) and SMR (N=15), as well as one control group based on the information obtained from the distributed questionnaires and expert's confirmation regarding the presence of MPS among the patients' trapezius muscle. In the next step, the primary diagnosis indices proposed by Simon were used to confirm the presence of TPs(2) .The indices included palpable stiff band in the muscle, identification of sensitive nodules in the stiff band, and reappearance of the patient's symptoms by applying constant pressure in the sensitive areas in the stiff muscle band. A lottery method was used to randomly dividing people into different groups which was as follows: The people's names were written on a sheet of paper of the same size and color, placed in a container, and randomly drawn. In this method, the first 15 people were placed in the massage group, the second 15 people in the self-release group, and the last 15 people in the control.. It must be mentioned that the control group did not receive any specific intervention during the intervention process and only participated in the pre-test and post-test. Then, briefing sessions were held, and the consent form for participating in the study was distributed among the subjects after explaining about MPS and type of treatment protocols. During the pre-test, the subjects were studied in terms of height and body mass index (BMI), by using a universal goniometer ROM were measured (neck: flexion, extension, bilateral rotation, bilateral lateral flexion; shoulder: flexion, extension, abduction, internal/external rotation) (21). Pain intensity was assessed with a visual analog scale (VAS) (22). Functional disability was assessed using the Persian-validated Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (23).

In addition, the subjects in the massage group were analyzed for skin sensitivity or lack of sensitivity to massage oil. Further, two experimental groups were intervened in a specified period of time (five days). Finally, all of the subjects were again assessed in terms of pain, shoulder ROM, and upper limb function, and the results were compared with the control group and initial results.

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The inclusion criteria included having active TPs in the trapezius muscle based on Simon's indices (2), being female, not being an athlete, not experiencing surgery and disorders in the cervical and thoracic spine(24), as well as not suffering from skin diseases and open wounds, abnormal neck lordosis (normal range: 31-40 degrees)(25) and back kyphosis (normal range: 20-50 degrees)(26), allergy to massage oils, and high mental tension.

This study was designed as a randomized controlled trial with blinded outcome assessment and blinded data analysis. To reduce measurement bias, the outcome assessor had no access to baseline measurements during post-intervention assessments. Additionally, prior to statistical analysis, group assignments were concealed and datasets were coded (A, B, and C), ensuring that the statistician remained blinded until the completion of the analysis.

Also this must be mentioned that The intervention protocols were researcher-developed and have been approved by two content experts: (1) a corrective exercise specialist, and (2) an associate professor from Shahid Beheshti University, Tehran. And also a Pilot testing was also conducted (n=5 participants with similar characteristics), with qualitative feedback confirming protocol feasibility and acceptability. No modifications were required.

In order to measure ROM using goniometer following methods was used:

For shoulder abduction measurement, the participant lay supine and the examiner abducted the arm until the end-range sensation or until upward rotation/elevation of the scapula was perceived. The goniometer axis was positioned over the acromion process, the stationary arm was aligned parallel to the sternum, and the moving arm was aligned with the midline of the humerus. To measure shoulder internal rotation, the participant lay supine with the shoulder abducted to 90°. The examiner internally rotated the arm until an end-range sensation occurred or until compensatory scapular protraction or anterior tilt was observed. The goniometer axis was placed over the olecranon process, the stationary arm was held perpendicular to the floor, and the moving arm was aligned with the ulna. For shoulder external rotation, the participant and goniometer were positioned as for internal rotation; the movement was stopped when the participant perceived the end of range or when compensatory scapular posterior tilt or retraction occurred(27).

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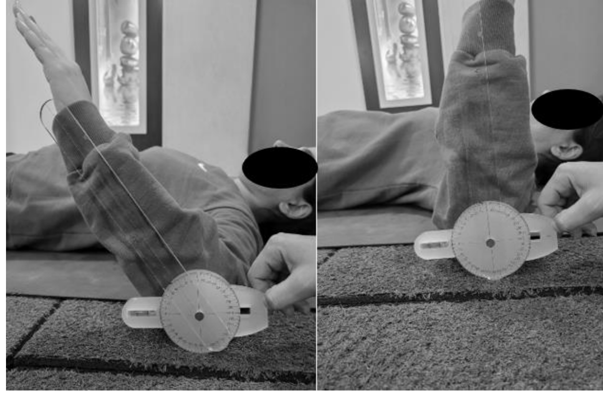

Figure 1 motion (ROM) in the supine position using a universal goniometer. The shoulder was positioned at 90° of abduction and the elbow at 90° of flexion. Internal rotation was measured actively.

Figure 2 motion (ROM) in the supine position using a universal goniometer. The shoulder was positioned at 90° of abduction and the elbow at 90° of flexion. externall rotation was measured actively.

Statistical method

Descriptive and inferential statistics were utilized to sort and analyze the data, respectively. In addition, the Shapiro-Wilk test was applied to check whether the data are considered as parametric or non-parametric. The result represented that the data were regarded as parametric. Further, a one-way analysis of covariance (ANCOVA) was conducted by using SPSS to compare post-intervention outcomes among the three groups (massage, self-myofascial release, and control), using baseline values as covariates. Assumptions of normality, homogeneity of variances, and homogeneity of regression slopes were examined prior to analysis. The homogeneity of regression slopes assumption was tested and met.

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SMR

The SMR intervention (figure 6) lasted five days, during which the motion performance increased by five minutes every day. The performance lasted ten minutes during the first session, which increased to 25 minutes during the last session. Time intervals most frequently examined in foam rolling research are 30, 60, and 120 seconds, and these durations have commonly been adopted by researchers. This is likely because manual fascial techniques applied in clinical settings are typically performed within similar time frames (28). Patel et al. (29) reported that most participants experienced therapeutic effects when the intervention lasted between 60 and 120 seconds. In this context, the study by Sullivan et al. (28) is particularly noteworthy, as the number of repetitions and their duration were manipulated while pressure and rolling frequency were kept constant. In the sit-and-reach test, a 4.3% increase in range of motion was observed in participants who rolled for 10 seconds compared with those who rolled for 5 seconds. However, the authors acknowledged that these findings were insufficient for drawing definitive conclusions and emphasized the need for further investigation into the relationship between treatment duration, intensity, and the resulting outcomes. Based on these findings, the duration of foam rolling in the present study ranged from 30 to 120 seconds. The intervention time was progressively increased across different sessions to enhance the potential effectiveness of the protocol. Applying pressure and performing the SMR process increased relatively during each session. Accordingly, most of the intervention was performed through the foam rolling process during the first session, while more penetrating and concentrated pressure was used by applying point pressure with a tennis ball in different areas with TPs during the last session.

it must be mentioned that that a researcher-made protocol was utilized here after implementing the pilot process.

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Figure 3 Self-myofascial release (SMR) technique applied to the upper trapezius muscle using a foam roller. The participant was positioned in supine with knees flexed, and slow controlled rolling was performed over the trigger point region using a tennis ball with sustained pressure over the identified trigger point in supine position.

Table 1 massage protocol which consist of time and technique used in each session

dureation	rest		session
10 minute	30 seconds	5 minute warm-up. In the first session, the individual is introduced to the movement and tools. The individual performs 3 sets of 20x20 foam rolling behind the shoulder while lying on the foam roller.	1
15 second	30 seconds	5 minutes warm-up 30 x 3 seconds of foam rolling is performed on the back of the shoulder 20 x 3 seconds of tennis ball is contracted on the back of the head on each side of a painful point 3 minutes cool-down	2
20 minutes	30 seconds	10 minutes warm-up 40 x 3 seconds foam rolling of the back of the shoulder area 30 x 3 seconds tennis ball is placed in the back of the head in the painful areas 5 minutes cool-down	3
25 minutes	30 seconds	10 minutes of warm-up are performed. 50 x 3 seconds of foam rolling of the area behind the shoulder blades are performed. 30 seconds of tennis ball are placed in the occipital region in the painful areas (from the midline of the occipital bone prominence, the area is divided into two parts, left and right, and 3 points are considered on each side). Two painful points are identified on each side of the spine in the area around the shoulder blades, and each point is placed with a tennis ball for 2 x 1 minutes. 5 minutes of cooling down.	4
25 minutes	30 seconds	10 minutes warm-up. 1 x 90 foam roll in the area between the shoulder blades. 3 painful points on each side of the spine around the shoulder blades and each point. 1 x 2 minutes tennis ball is placed. 3 x 30 seconds tennis ball is placed in the occipital region in the painful areas (from the midline of the occipital bone prominence, the area is divided into two parts, left and right, and 3 points are considered on each side). 5 minutes cool down.	5

Massage

Like the SMR, a researcher-made massage protocol (figure 7) was applied after the pilot process. The duration of the intervention increased during each session. Accordingly, the intervention lasted 10 minutes during the first session, which increased to 25 minutes until the last session. The techniques employed during the initial sessions included Swedish massage with adjusted pressures. A friction technique was applied for one minute using the palms at a high speed in order to increase the temperature of the targeted areas. The kneading technique was then performed, particularly to identify tender points, in combination with massage movements for variable intervals of 2 to 4 minutes. This technique was also used to apply stretching to the identified trigger points. Pressure technique constituted the primary method for trigger point release in this protocol. The trigger points identified during kneading were subjected to ischemic compression. In the initial sessions, mild pressure was applied using the palms. Gradually, deeper pressure was introduced using the thumbs and subsequently the elbows, with intensity progressively increasing from moderate to strong. The duration of pressure application increased from 90 seconds in the first session to 10 minutes in the final session, with pressure delivered in repeated sets of 90 seconds. In order to increase the

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efficiency, pressure techniques were used in the TP areas during each session. More penetrating pressure was applied from the palm to the tip of the thumb and elbow during the final sessions with duration of 60-90 seconds in three sets.

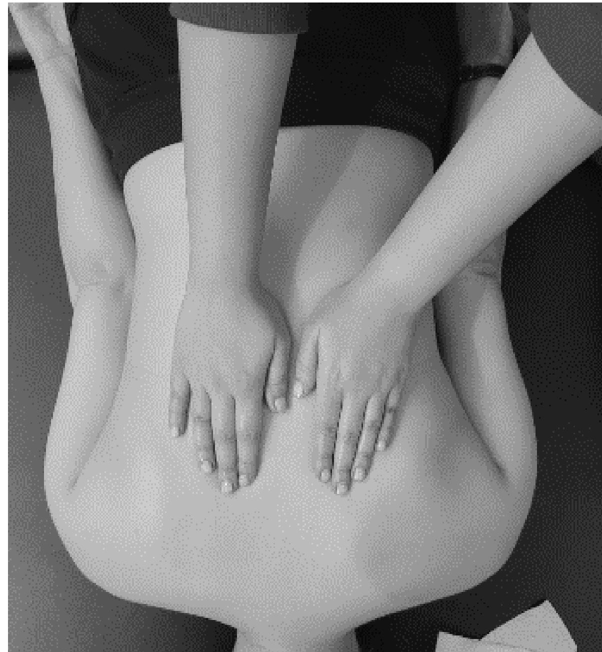

Figure 4 Manual massage technique applied to the upper trapezius muscle with the participant in prone position. Bilateral thumb and palm pressure was applied over the identified myofascial trigger point region.

Results

Table 1 indicates the mean (M) and standard error (SE) of the participants' height, weight, and BMI by groups.

Table 2 the mean (M) and standard error (SE) of the participants' height, weight, and BMI by groups.

	Mean	Max	Min	SE
age	**21.66**	**25**	**19**	**1.83**
height	**165.46**	**171**	**160**	**3.15**
weight	**61.53**	**71**	**52**	**6.44**
BMI	**20.24**	**24.31**	**18**	**3.43**

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Table 2,3 shows the results related to the Describing pre-test, post-test, and adjusted post-test

Table 3 Descriptive statistics (Mean ± SE) for pre-test, post-test, and adjusted post-test measurementsVAS

Variable	**Groups**	**Pre-test M±SE**	**Post-test M±SE**	**Adjusted post-test** M±SE	**CI 95%**
VAS	Control	0.38 ±5.86	0.52 ±6.20	0.33 ±6.21	5.50 – 6.92
	Massage	0.4 ±6.46	0.25 ±2.46	0.34 ±2.23	1.50 – 2.96
	SMR	0.56 ±5.40	0.30 ±2.60	0.33 ±2.81	2.10 – 3.52

Table 4 Descriptive statistics (Mean ± SE) for pre-test, post-test, and adjusted post-test measurements

Variable	**Groups**	**Pre-test M±SE**		**Post-test M±SE**		**Adjusted post-test M±SE**		**CI 95%**
Right flexion	Control	4.07	±148.46	3.98	±147.60	2.93	±145.23	138.95 - 151.51
	Massage	6.12	±149.13	4.61	±159.20	2.94	±156.44	150.14-162.74
	SMR	1.88	±135.93	2.85	±160.4	3.03	±165.52	159.02 - 172.02
Left flexion	Control	6.23	±149.00	6.53	±148.86	4.02	±145.76	137.13- 154.39
	Massage	5.25	±151.40	4.27	±161.53	4.07	±156.91	165.64 – 148.18
	SMR	3.61	±131.86	4.12	±157.46	4.23	±165.18	156.10 - 174.26
Right extension	Control	4.17	±38.93	3.8	±39.00	3.03	±36.99	30.49- 43.49
	Massage	2.35	±33.26	4.11	±45.06	3.02	±46.79	53.26 – 40.32
	SMR	2.60	±35.46	2.8	±44.53	3.00	±44.81	51.24 – 38.38
Left extension	Control	4.35	±39.33	4.25	±38.80	3.57	±39.32	46.98 – 31.66
	Massage	7.47	±44.26	4.11	±45.06	3.58	±44.14	36.47- 51.81
	SMR	3.93	±39.73	3.18	±45.40	3.57	±45.80	38.14 - 53.46
Right abduction	Control	9.01	±138.00	8.84	±137.33	4.38	±132.22	122.83 - 141.61
	Massage	4.88	±142.46	8.49	±154.53	4.42	±149.21	139.73 - 158.69
	SMR	4.07	±130.00	3.03	±151.8	4.44	±158.22	148.70 - 167.74
Left abduction	Control	4.98	±150.93	5.03	±150.33	2.89	±145.94	139.74- 152.14

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	Massage	4.77	±140.20	3.39	±160.13	2.82	±161.85	155.80-167.90
	SMR	4.65	±138.53	2.94	±163.2	2.84	±155.86	149.77-161.95
Internal rotation right	Control	2.48	±43.40	2.35	±43.00	3.10	±40.56	33.91-47.21
	Massage	5.05	±39.86	4.63	±50.80	3.05	±50.31	43.77-56.85
	SMR	4.02	±33.66	3.85	±31.66	3.12	±34.59	27.90-41.28
Internal rotation left	Control	4.48	±42.60	4.30	±39.93	2.61	±38.90	33.30-44.50
	Massage	4.98	±43.20	4.40	±52.60	2.61	±53.16	15.56-26.76
	SMR	4.20	±37.35	3.43	±35.66	2.62	±38.13	32.50-43.76
External rotation right	Control	1.87	±49.80	1.91	±49.26	3.38	±51.86	44.61- 59.11
	Massage	5.02	±53.73	4.48	±76.93	3.32	±77.44	70.32- 84.56
	SMR	3.86	±60.53	4.56	±71.86	3.40	±68.76	61.47-76.05
External rotation left	Control	3.90	±58.06	3.89	±57.26	3.15	±55.87	49.11- 62.63
	Massage	4.75	±53.93	3.63	±76.80	3.13	±77.08	70.37- 83.79
	SMR	3.86	±51.93	4.56	±72.13	3.15	±73.23	66.47-79.99
DASH	Control	3.23	±42.21	3.07	±40.98	1.52	±40.56	37.30- 43.82
	Massage	3.34	±35.43	0.291	±26.72	1.56	±28.38	25.03-31.73
	SMR	3.04	±4.86	0.291	±26.72	1.54	±25.48	22.18- 28.78

Table 3 shows the results related to one-way ANCOVA test utilized to compare the adjusted mean between the groups.

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Table 5 one-way ANCOVA test

		Sum of Squares	Degrees of Freedom	Mean of Squares	F	p	Effect size
vas	Pre test	23.176	1	23.176	13.860	0.001	0.253
	group	138.647	2	69.324	41.458	<0.001	0.669
	Error	68.557	41	1.672			
Right flexion	Pre test	4318.033	1	4318.033	34.075	<0.001	0.454
	group	2853.078	2	1426.539	11.257	<0.001	0.354
	Error	5195.567	41	126.721			
Left flexion	Pre test	6659.896	1	6659.896	28.060	<0.001	0.406
	group	2578.109	2	1289.054	5.431	0.005	0.209
	Error	9731.304	41	237.349			
Right extension	Pre test	2712.189	1	2712.189	20.063	<0.001	0.329
	group	775.751	2	378.875	2.869	0.068	0.123
	Error	5542.478	41	135.182			
Left extension	Pre test	1625.810	1	1625.810	8.484	0.006	0.171
	group	339.769	2	169.885	0.886	0.420	0.041
	Error	7857.123	41	191.637			
Right abduction	Pre test	21716.341	1	21716.341	75.410	<0.001	0.648
	group	3618.023	2	1809.011	6.282	0.004	0.235
	Error	11807.126	41	287.979			
Left abduction	Pre test	4704.457	1	4740.457	39.647	<0.001	0.492
	group	1809.480	2	904.740	7.625	0.002	0.271
	Error	4865.010	41	118.659			
Internal rotation right	Pre test	3057.799	1	3057.799	21.804	<0.001	0.347
	group	1853.966	2	926.983	6.610	0.003	0.244
	Error	5749.935	41	140.242			
Internal rotation left	Pre test	6251.717	1	6251.717	61.172	<0.001	0.599
	group	1589.097	2	794.549	7.775	0.001	0.275

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	Error	4190.150	41	102.199			
External rotation right	Pre test	2591.941	1	2591.941	15.703	<0.001	0.277
	group	4951.217	2	2475.609	14.998	<0.001	0.422
	Error	6767.659	41	165.065			
External rotation left	Pre test	2311.871	1	2311.871	15.654	<0.001	0.276
	group	3770.262	2	1885.131	12.764	<0.001	0.384
	Error	6055.195	41	147.688			
DASH	Pre test	612.624	1	612.624	17.761	<0.001	0.302
	group	1919.674	2	959.837	27.827	<0.001	0.576
	Error	1414.218	41	34.493			

Effect sizes were interpreted as small (0.01), medium (0.06), and large (0.14).
Table 5 shows the results related to Bonferroni Post Hoc Test.

Table 6 Bonferroni Post Hoc Test Results

Group I	Group I	Group J	Difference of Means I-J	p
Vas	Control	Massage	3.98	<0.001
		SMR	3.40	<0.001
	Massage	SMR	-0.57	0.725
Right flexion	Control	Massage	-11.20	0.028
		SMR	-20.28	<0.001
	Massage	SMR	9.08	0.126
Left flexion	Control	Massage	-11.15	0.163
		SMR	-19.42	0.007
	Massage	SMR	-8.27	0.545
Right extension	Control	Massage	-	-
		SMR	-	-

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	Massage	SMR	-	-
Left extension	Control	Massage	-	-
		SMR	-	-
	Massage	SMR	-	-
Right abduction	Control	Massage	-12.99	0.128
		SMR	-21.99	0.003
	Massage	SMR	-9.00	0.490
Left abduction	Control	Massage	-15.90	0.001
		SMR	-9.92	0.063
	Massage	SMR	5.98	0.421
Internal rotation right	Control	Massage	-9.74	0.041
		SMR	5.96	0.056
	Massage	SMR	15.71	0.003
Internal rotation left	Control	Massage	-12.25	0.006
		SMR	0.77	1.000
	Massage	SMR	13.02	0.003
External rotation right	Control	Massage	-25.57	<0.001
		SMR	-16.89	0.004
	Massage	SMR	8.68	0.230
External rotation left	Control	Massage	-21.21	<0.001
		SMR	-17.36	0.001
	Massage	SMR	3.85	1.000
DASH	Control	Massage	12.18	<0.001
		SMR	15.07	<0.001
	Massage	SMR	2.89	0.616

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Based on the VAS, massage and SMR can significantly reduce the pain created by TPs ($p<0.001$). Regarding ROM, none of the interventions affected the right ($p>0/001$) and left ($p>0/001$) shoulder stretch significantly. However, massage affected the right internal ($p>0/001$), right external ($p>0/001$), left internal ($p>0/001$), and left external rotation ($p<0.001$) between and within the groups significantly. In addition, SMR affected the right ($p>0/001$) and left ($p<0.001$) abduction, as well as right ($p<0.001$) and left ($p>0/001$) flexion significantly. Finally, both interventions improved the score of the DASH test significantly ($p<0.001$).

After adjustment for baseline values, ANCOVA demonstrated significant group effects for VAS ($F(2,41)=41.458$, $p<0.001$, partial $\eta^2=0.669$), indicating a arge effect size.

Significant group differences with "large effect sizes" were also observed for right flexion ($F=11.257$, $p<0.001$, $\eta^2=0.354$), left flexion ($F=5.431$, $p=0.005$, $\eta^2=0.209$), right abduction ($F=6.282$, $p=0.004$, $\eta^2=0.235$), left abduction ($F=7.625$, $p=0.002$, $\eta^2=0.271$), internal rotation right ($F=6.610$, $p=0.003$, $\eta^2=0.244$), internal rotation left ($F=7.775$, $p=0.001$, $\eta^2=0.275$), external rotation right ($F=14.998$, $p<0.001$, $\eta^2=0.422$), external rotation left ($F=12.764$, $p<0.001$, $\eta^2=0.384$), and DASH ($F=27.827$, $p<0.001$, $\eta^2=0.576$).

No significant group effects were found for right extension ($p=0.068$) or left extension ($p=0.420$). Overall, the magnitude of the partial eta squared values indicates predominantly "large practical effects", supporting the clinical relevance of the interventions.

Results and discussion

The present study aims to evaluate the effect of SMR and massage on the symptoms created by TPs in the trapezius muscle among women suffering from MPS. The results represented those five sessions of massage and SMR protocols significantly reduced the pain among the patients with TPs measured by VAS.

Several theories are proposed to explain the effectiveness of SMR processes and massage in reducing the pain of TPs in MPS including changes in elasticity due to thixotropic properties of soft tissue (30), piezoelectric effects, release of fascia adhesions, cellular responses to pressure, stimulation of tissue fluid flow, nerve inhibition, and release of TPs (31).

Existing theories which describe the effect of SMR include gate control theory of pain, intrapersonal attention, parasympathetic response of the autonomic nervous system, and serotonin release (32). Based on the gate control theory of pain, sensory stimuli such as pressure are transmitted in the pathways of the nervous system faster than pain. The pressure stimulus, which acts faster, intervenes in the process of transferring painful stimuli to the brain, resulting in eliminating the gate of pain perception (32). Intrapersonal attention refers to the level of

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attention of a person while receiving a massage. Some claim that human attention to touch reduces the perception of pain by the brain. Stimulating the parasympathetic response reduces the release of stress hormones, resulting in decreasing anxiety, depression, and pain. The release of serotonin prevents the transmission of harmful stimuli to the brain. Other inhibitory neurotransmitters such as endorphins may be released following the application of pressure through the therapeutic method.

The results revealed that SMR increased the ROM in right and left shoulder flexion, as well as right and left abduction more than the massage. Generally, the trapezius muscle provides stability, as well as facilitating the motion of the scapula. The elevators, upper scapular rotators, and neck extensors form the upper fibers in the trapezius muscle. The medial fibers pull the scapula back, while the inferior ones lower the scapula and assist in its upward rotation. This superficial and extensive muscle, which is mostly posterior, actively participates in motions such as lateral neck flexion, head rotation, shoulder elevation and lowering, as well as arm internal rotation. Apparently, releasing the trapezius muscle without focusing on partner and opposing ones improves the shoulder ROM limitedly.

Based on the results, the massage protocol can significantly increase the range of internal and external rotation in the right and left arms after five sessions on the trapezius muscle among women suffering from MPS.

It should be noted that these findings align with studies by Bethers et al.(33) and Yang et al.(34), which examined the immediate effects of massage. In fact, TPs can occur in muscle fibers and fascia tissue. Damage to fascia tissue can lead to its disruption differently. Limitation of motion in the fascia tissue can reduce its shock absorption process and leads to the peripheral involvement of blood vessels and nerves, resulting in decreasing the ROM throughout the body. The functional role of fascia may be impaired after repeated injuries, physical trauma, and inflammation, which can alter the natural biomechanics in the body, increase tension in the system, develop myofascial pain, and decrease the ROM. In addition, Mechanical pressure application can reduce adhesions between tissue layers, enhance muscle compliance, and decrease muscle fiber stiffness. Prolonged pressure on muscle tissue can induce muscle relaxation. Pressure on myofascial trigger points (TrPs) increases sarcomere length, thereby reducing abnormal tension, overall pain, and improving range of motion(35). Additionally, localized pressure enhances hyperemia and blood perfusion, promoting oxygenation, reducing production of inflammatory and nociceptive mediators, and consequently minimizing muscle fiber damage while optimizing muscle strength and length (35).

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A decrease in the DASH questionnaire score was observed in both massage and SMR groups, indicating an effective result. The musculoskeletal system is considered as a network of interconnected tissues which should work together to produce effective motion. The restrictions created by the fascia can disrupt the normal function of the muscle when the muscle and fascia are subjected to microtrauma. Myofascial TPs can interfere with the normal function of the fascia and lead to muscle dysfunction, which is manifested in reduced ROM, neuromuscular components, and decreased strength. Improved ROM allows for better motion patterns which can improve the performance and reduce the risk of musculoskeletal injuries.

Reserch Ethical statement:

The present study was conducted under the supervision of the ethics committee of Shahid Beheshti University with code IR.SBU.REC.1402.067 and clinical trial code IRCT20230914059432N1.

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Personal financial resources were applied for conducting this study.

Author Contributions:

Sara Matinfard conceptualized the study, conducted the investigation, prepared the original draft, and curated the data. Dr. Fariborz Hovanloo supervised the work, contributed to the methodology, validated the findings, and reviewed and edited the manuscript.

AI Use Statement:

No artificial intelligence tools were used in the preparation of this manuscript**.**

Conflict of interest statement:

No conflict of interest was reported in the present study.

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