Research Article

Investigating the Effects of Shockwave and Percussion Massage Gun on Subacute Myofascial Pain in Gasterocenemious Muscle

Seyedeh Zohreh Hosseini, Siamak Bashaardost Tajali*, Khadijeh Otadi, Kazem Malmir, Alireza Hosseinzadeh Chaijan

Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Introduction: Myofascial pain syndrome is a common musculoskeletal injury, especially among athletes, typically treated with symptomatic invasive and non-invasive methods. This study compares the effects of massage guns and radial extracorporeal shock wave therapies on myofascial pain syndrome symptoms in amateur athletes.

Materials and Methods: In this clinical trial, 45 amateur athletes (18-30 years old) were recruited, who were randomly assigned to 15-member groups of shock wave, massage gun, and control (routine treatment included electrotherapy and stretching, which was applied on three groups). After initial evaluations of the pain intensity, pain pressure threshold (PPT), isometric muscle strength, and range of motion (ROM), the patients received single-session treatment and were immediately reassessed.

Results: The results showed pain relief and improved PPT following shock wave plus routine treatment (P=0.03). The control group had less pain, while pain intensity and PPT did not change. The variables were not significantly different between the groups (P=0.12). Shock wave along with routine treatment increased plantar flexion ROM (P=0.00), unlike the massage gun. Additionally, dorsiflexion ROM (P=0.63) and maximal isometric gastrocnemius muscle strength (P=0.95) remained unchanged in all groups.

Conclusion: One session of massage gun therapy immediately reduced gastrocnemius muscle pain, while it failed to change PPT, maximal isometric gastrocnemius muscle strength, or dorsiflexion and plantar flexion ROM. However, shock wave therapy immediately increased plantar flexion ROM and PPT, and reduced pain intensity. These modalities led to limited changes, suggesting the need for repeated sessions and supplementary treatments.

*** Corresponding Author:**
Siamak Bashaardost Tajali, Associate Professor.
Address: *Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.*
Tel: *+98 (21) 77685105*
E-mail: *s_bashardoust@sina.tums.ac.ir*

Introduction

Musculoskeletal injuries are common in sports activities, Both at the amateur and professional levels. A large amount of money is spent every year on preventing and treating injuries in athletes [1]. Further, myofascial pain syndrome is a conventional clinical disorder in skeletal muscles, which includes muscle spasms associated with trigger points, hard and tight bands within the muscle, referred pain, and local muscle tenderness [2]. Chronic injuries caused by overuse, incorrect exercise, and repetitive activities are major contributors to myofascial pain syndrome (MPS). Regardless of age, gender, exercise level, and sports discipline, injuries related to muscle and soft tissue are frequent in all athletes [3].

Symptomatic treatments for MPS include non-invasive methods like stretching exercises, ultrasound, taping, massage, and transcutaneous electrical stimulation (TENS), as well as invasive techniques such as dry needling, shock wave therapy, injections, and surgery [4].

Recently, massage gun therapy has gained attention in sports and therapy. This method, by combining traditional and vibration massages, improves flexibility, sports performance, and recovery. Despite its novelty and limited evidence on mechanisms [5], it enhances local blood flow, reduces tissue stiffness, and accelerates healing [6]. While massage positively impacts delayed-onset muscle soreness, tissue flexibility, and range of motion (ROM), it does not significantly improve muscle endurance, and strength, or reduce muscle fatigue and jumping capacity [7]. Strength and related parameters benefit more from mechanical and manual vibrations compared to traditional massages [7, 8].

To the best of our knowledge, the effects of massage guns on soft tissue properties were not compared to those of other therapies. However, its use in modifying tissue stiffness, and muscle tone, reducing fatigue, improving performance, and aiding recovery is growing, especially among athletes [9].

Musculoskeletal disorders are often treated with extracorporeal shock wave therapy (ESWT). Some studies have reported the effectiveness of ESWT in improving MPS symptoms and reducing pain by producing mechanical energy through air pressure, which spreads in tissue and causes secondary biological effects, promoting tissue repair and regeneration [9]. ESWT significantly benefits conditions like non-union fractures, calcification, plantar fasciitis, tenosynovitis, and trigger points [10]. Shock waves are either focused or radial. Focused waves positively impact musculoskeletal disorders, while recent research suggests radial waves are effective for lateral epicondylitis, plantar fasciitis, and tendonitis calcifications, though their use in MPS needs further evaluation [11, 12]. The incidence of muscle damage in amateur athletes in various sports fields is higher than that of professional athletes due to technical weakness and limited sports experience. For this reason, in this study, the effect of these two interventions on amateur athletes was investigated [1]. Due to the similarity of ESWT and massage gun in the application and way of applying impact, as well as being more inexpensive, this study investigates the use of these two modalities in MPS. This study hypothesizes that massage gun therapy is as effective as ESWT in treating MPS in amateur athletes. Thus, it compares the effects of these therapies on ROM, pain intensity, pain pressure threshold (PPT), and isometric muscle strength.

Materials and Methods

Study design and subjects

This single-blind randomized clinical trial (IR.TUMS.FNM.REC.1401.188) involved amateur athletes with myofascial pain in the gastrocnemius muscle, referred to the physiotherapy clinic at the school of rehabilitation of Tehran University of Medical Sciences from April to July 2023. Volunteers provided informed consent before participation.

Study participants

The study included 18-30-year-old (Mean±SD=22.43±1.85 years) participants in both genders. The inclusion criteria were the absence of tendinitis, Achilles tendon rupture, systemic disease, central nervous system neurological disease, and recent fractures or dislocations in the fibula, tibia, or ankle. The participants had posterior leg muscle pain (visual analog scale [VAS]: 3-7) for at least two weeks, reduced ROM with pain and tension in dorsiflexion, and at least one referred pain symptom of the trigger point or muscle bundle of the gastrocnemius muscle. Meanwhile, the exclusion criteria included unwillingness to continue, use of drugs or physical intervention, and new neurological or musculoskeletal symptoms during the treatment [9, 13-17].

Study procedures

The participants were initially recruited through a convenient non-probability sampling method. To achieve randomization, a simple random sampling technique was employed. Each participant was assigned to a group using sealed envelopes that contained group allocations. These envelopes were shuffled thoroughly to warrant randomness. The participants were then randomly distributed into three groups, each with 15 members as follows: Shock wave (ESWT), massage gun, and control. No patient was informed about their group or the interventions and outcomes of other groups. Two different therapists assessed and treated the participants, and the data collector was blinded to the treatment groups. Based on previous research [18], the sample size was calculated to be 14 per group.

The subjects were evaluated at baseline and immediately post-treatment in one session. At baseline, patients were treated according to their groups. In the prone position with ankles off the bed, the ESWT group received 2500-3000 shocks at 20 Hz and 5 bars on the most painful point or trigger point of the gastrocnemius muscle and 300 shocks at the same frequency around the area [19-24] by using ballistic shock wave (Novin Med 360G, Iran). Then, they received the stimulation and exercise provided to the control group (Figure 1 and Figure 2). The massage gun group received a 3-min massage (2400-2700 pulses) by spherical head on the most painful spot or trigger point of the gastrocnemius muscle, followed by a 5-min full muscle massage (same features) (the protocol was performed by using massage gun Booster E model, USA; Figure 1 [9, 18]). Then, similar to the physiotherapy program implemented in the control group, stimulation, and exercise were performed. The control group received only TENS (100Hz, 0.2 ms pulse width for 15 min, by using stimulator Novin Med 620P, Iran) and performed standing calf stretching with dorsiflexion for eight repetitions with a 15-s hold [14, 25].

Clinical outcome measurements

An experienced, allocation-blinded examiner assessed ankle dorsiflexion and plantar flexion ROM, PPT, maximal isometric muscle force, and pain intensity, both pre- and immediately post-treatment (Figure 3).

Pain intensity was measured using a 10-cm VAS [26]. For PPT, an algometer (LUTRON FG-5020, Taiwan) was applied to the most painful point or trigger point of the gastrocnemius muscle in the prone position. The pressure was gradually increased until pain was felt, and the maximum levels from three trials were recorded as PPT (Figure 4).

Figure 1. Treatment devices

a) Massage gun, b) Extracorporeal radial shockwave

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Figure 2. The patient under intervention (shock wave application) JMR

Ankle dorsiflexion and plantar flexion ROM were measured with a hand-held goniometer. Patients sat long with ankles off the bed, starting from a rest position. The goniometer center was placed over the lateral malleolus, the moving arm parallel to the fifth metatarsus, and the fixed arm along the fibular shaft. ROM values were averaged from three repetitions [27].

Maximal isometric gastrocnemius muscle force was measured using a calibrated digital hand-held dynamometer (North Coast, USA). The patients sat long with ankles off the bed and pressed the plantar surface of the injured leg's metatarsus on the dynamometer with maximal force for 10 s, reporting pain. The highest value from three trials was recorded as the maximal isometric muscle force [28].

Statistical analysis

The data were analyzed in SPSS software, version 25, and the normality of data distribution was determined by using the Kolmogorov-Smirnov test. In addition, one-

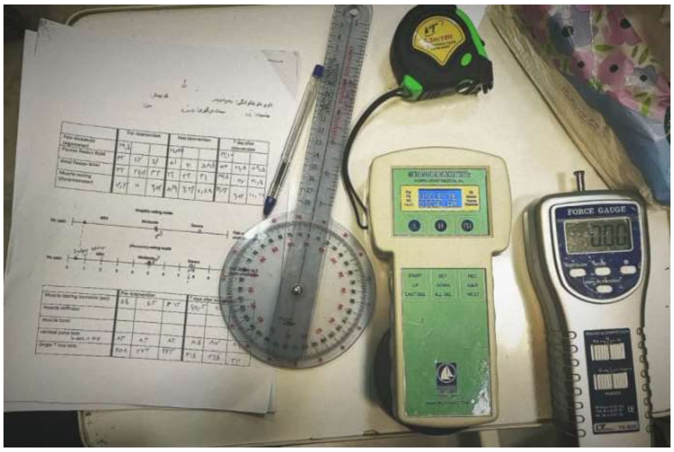

Figure 3. Assessment tools in order left to right: JMR

A) Goniometer, B) Dynamometer, and C) Algometer

Figure 4. Patient position during assessment with algometer

way analysis of variance (ANOVA) and non-parametric Kruskal-Wallis test were applied to assess the difference between the groups regarding the data with normal and non-normal distribution, respectively. Regarding the normally distributed data, the difference within groups pre- and post-intervention was assessed through utilizing the paired t-test, while the non-parametric Wilcoxon test was conducted for the data with non-normal distribution. The significant level was set at 0.05. Figure 5 illustrates the consort diagram of this study.

Results

Out of 59 patients, 45 completed the study (17.8% men, 82.2% women; mean age = 24.24±3.11 years). A total of 14 participants dropped out due to exclusion criteria, unwillingness, new injury symptoms, or other reasons. MPS incidence was 55% in the right lower extremity and 45% in the left. Baseline demographic and clinical characteristics were similar across the three groups, with no statistical differences (Table 1).

The results of the paired t-test showed a significant increase in plantar flexion ROM immediately after one session in the shock wave group (P=0.02). The massage gun group showed no change (P=0.34), while the control group experienced a reduction in ROM post-treatment (P=0.00) (Table 2). The between-group results of the ANOVA test indicated significant increases in plantar flexion ROM for both shock wave and massage gun groups compared to the control (P=0.00) (Table 3); however, no significant difference between the two treatment methods (P=0.67) (Table 4). Nevertheless, the t-test paired results showed no significant change was observed in dorsiflexion ROM after one session of treatment in any of the three groups (shock wave group (P=0.33), massage gun group (P=0.81), control group (P=0.42) (Table 2). Between-group analysis by ANOVA test indicated no significant differences in the ability to change this parameter (P=0.63) (Table 3).

The t-test paired results indicated a significantly improved PPT and decreased muscle tissue sensitivity after

Table 1. Baseline characteristics of shockwave (n=15), massage gun (n=15), control groups (n=15)

Characteristics	Mean±SD			P
	Shock Wave Group	Massage Gun Group	Control Group	
Age (y)	22.43±1.85	24.20±3.40	26.10±2.80	0.01
Gender (Female), No.	9	14	14	NA
Height (m)	165.15±5.29	163.80±4.64	164.40±6.43	0.74
Weight (kg)	63.15±5.27	65.25±5.00	66.75±5.77	0.11
BMI (kg/m^2)	23.21±2.37	23.21±2.37	24.82±3.08	0.14

SD: Standard deviation; BMI: Body mass index; NA: Not available.

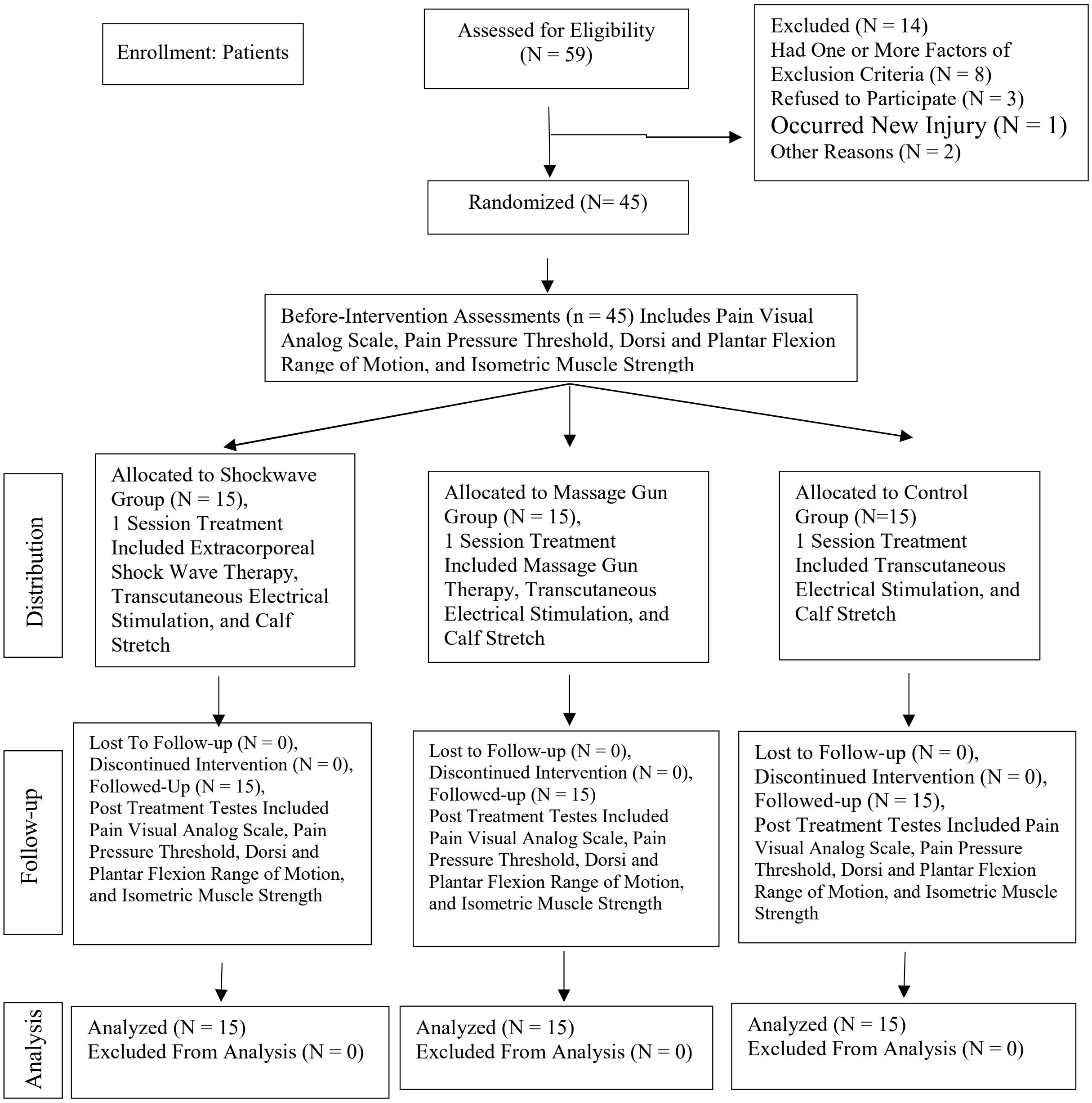

Figure 5. CONSORT diagram of the study

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applying shock waves compared to before the start of treatment (P=0.01). The massage gun and control group had a limited, statistically insignificant increase in PPT (P=0.46 for the massage gun group and P=0.66 for the control) (Table 2). Meanwhile, the Kruskal-Wallis test results showed similar PPT variations across all groups, indicating no superiority of shock wave therapy over the other treatments (P=0.12) (Table 3).

The results of the paired t-test showed no significant change in maximal isometric gastrocnemius muscle force after one treatment session in any group (shock wave [P=0.38], massage gun [P=0.63], control groups [P=0.83]) (Table 2). Between-group analysis by the Kruskal-Wallis test revealed no significant differences in the ability to alter this muscle force (P=0.95) (Table 3).

The paired t-test results showed a significant decline in VAS score for the shock wave (P=0.00) and control groups (P=0.00) after one session, while the massage gun group had a limited variation (P=0.52) (Table 2). Although the shock wave group had a higher effect on pain relief compared to the control group, the difference was not statistically significant. The results of the one-way ANOVA showed both treatments were more effective than the massage gun (P=0.03) (Table 3 and Table 4).

Table 2. Within-group changes before and after intervention

Outcome Measure	Groups	Mean±SD		P	Effect Size
		Before Intervention	After Intervention		
VAS	Shock wave	6.01±1.39	4.26±1.72	0.00*	0.12
	Massage gun	5.49±1.53	5.15±2.29	0.52	0.17
	Control	5.63±1.51	3.72±1.52	0.00*	0.26
PPT (N/cm^2)	Shock wave	19.87±7.84	23.82±9.74	0.01*	0.45
	Massage gun	23.14±10.97	22.82±13.57	0.46	0.03
	Control	21.32±9.78	19.65±9.56	0.66	0.17
Plantar flexion (degree)	Shock wave	42.12±4.65	45.42±5.47	0.02*	0.69
	Massage gun	51.13±7.56	52.42±7.23	0.34	0.17
	Control	47.21±8.92	43.05±8.09	0.00*	0.59
Dorsi flexion (degree)	Shock wave	26.89±4.99	26.33±4.45	0.33	0.12
	Massage gun	28.47±6.23	28.12±9.81	0.81	0.04
	Control	27.57±5.93	28.36±6.57	0.42	0.13
Isometric muscle force (N)	Shock wave	15.15±3.93	14.63±4.20	0.38	0.13
	Massage gun	14.69±3.76	14.45±3.39	0.63	0.07
	Control	15.48±2.95	15.33±3.40	0.83	0.05

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Notes: Paired t-test and the Wilcoxon test were respectively used for the data with normal distribution (almost all the data, except for the data of PPT of massage gun) and those with non-normal distribution (massage gun data for PPT). * indicates significant difference ($P<0.05$).

VAS: Visual analog scale; PPT: Pain pressure threshold.

Discussion

Myofascial pain syndrome is a prevalent soft-tissue injury among athletes, necessitating fast, effective, and economical treatment methods. This study is among the first to compare the effects of massage gun and ESWT on injured tissue. ESWT combined with routine treatment positively affected plantar flexion ROM, PPT, and pain intensity. However, massage gun therapy along with routine treatment or routine treatment alone did not significantly alter these variables. Dorsiflexion ROM and maximal isometric gastrocnemius muscle force remained unchanged across all groups. The treatment parameters for ESWT and massage gun therapy were based on previous research [9, 18-24]. A single-session intervention was conducted with pre-and post-treatment evaluations.

The results of this study are consistent with those of some previous research. For example, Manafnezhad et al. (2019) investigated the effects of ESWT and dry needling in the upper trapezius muscle of 70 patients with non-specific cervical pain and found the effectiveness of both ESWT and dry needling on target points and pain relief [20]. Ji et al. (2012) applied ESWT on 20 patients with upper trapezius Myofascial pain syndrome and observed a significant decrease in their myofascial pain intensity and improved PPT [29]. According to Zimmermann et al. (2009), ESWT enhanced capillary blood flow and relieved pain in 60 patients with chronic pelvic pain syndrome [30]. Hausdorf et al. (2008) assessed the effects of ESWT on the number of neurons immunoreactive for substance P in dorsal root ganglia L5. The results suggested the ability of ESWT to selectively destroy unmyelinated nerve fibers, reduce substance P production, and decrease pain transmission [29, 31, 32].

Table 3. Between-group differences for each outcome measure in shockwave (n=15), massage gun (n=15), and control groups (n=15)

Outcome Measure	Mean±SD/ Mean Rank			F or χ²	P	95% Confidence Interval for Mean	Effect Size
	Shock Wave	Massage Gun	Control				
VAS	19.63	30.17	19.20	χ^2=6.78	0.03*	_	0.71
PPT (N/cm²)	27.87	18.60	20.93	χ^2=4.21	0.12	_	0.44
Plantar flexion (degree)	3.50±5.53	1.28±5.10	-4.15±3.87	F=9.25	0.00*	-1.44 - 2.06	0.54
Dorsi flexion (degree)	-0.55±2.16	-0.35±5.73	0.79±3.63	F=0.45	0.63	-1.29 - 1.18	0.13
Isometric muscle force (N)	22.10	22.13	23.32	χ^2=0.08	0.95	_	0.47

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Notes: F and H distribution are the test statistics for analysis of variance and Kruskal-Wallis tests, respectively. These tests were respectively applied for the data with normal distribution (dorsi and plantar flexion) and non-normal distribution (VAS, PPT, and isometric muscle force). * indicates significant difference (P<0.05).

VAS: Visual analog scale; PPT: Pain pressure threshold.

The results of the present study indicated that massage gun therapy may be ineffective in pain intensity and PPT, which is not in line with those of the previous research. Moraleda et al. (2019) focused on the effects of vibrating and non-vibrating foam rolling on recovery after exercise among 38 subjects with induced muscle damage. They reported that vibration therapy, such as a vibrating foam roller can relieve pain sensation after exercise by increasing skin temperature and blood flow [33, 34]. Clarke et al. (2024) evaluated the effect of massage gun therapy on physical and perceptual recovery in 65 active adults. Based on the results, percussion massage guns combine massage and vibration therapy, allowing for more intense muscle tissue movement and stimulation of mechanoreceptors [35, 36]. The protocol of the present study was prepared according to the results of previous research previous research although contradictory results were obtained for the massage gun group. This modality can lead to better results if the number of therapeutic sessions elevates or the features of massage gun treatment change.

Additionally, Notarnicola et al. (2018) assessed the effects of ESWT on the biceps femoris and quadriceps femoris muscles of 32 healthy athletes over three sessions. They found increased tissue flexibility and muscle stiffness immediately after treatment and 15 days later, improving athletes' performance during competition [19]. The results of another study suggested that shock wave therapy may reduce abnormal stiffness and shortening, as well as target point formation in muscles, by affecting acetylcholine discharge at the neuromuscular junction. Ischemia, increased metabolism, energy crisis, and pain associated with the release of substances like prostaglandins, bradykinin, and substance P may occur in a part of the sarcomere, not the entire muscle fiber [37].

Table 4. Pairwise comparison using Bonferroni correction plantar flexion range of motion and visual analog scale

Outcome Measure	Between Groups	Mean Difference	Standard Error	P
Plantar flexion range of motion (degree)	Shockwave–massage gun	2.21	4.77	0.08
	Shockwave-control	7.65	4.77	1.00
	Massage gun-control	5.44	4.77	0.06
Visual analog scale	Shockwave–massage	0.43	1.79	0.67
	Shockwave-control	10.96	1.82	0.00*
	Massage gun-control	10.53	1.82	0.01*

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Shock wave therapy was found to reduce muscle tension and improve local ischemia in abnormally-shortened muscle tissue [38]. The results of the present study indicated that ESWT enhanced the active range of motion by improving muscle tone and tissue flexibility although the overall improvement was not statistically significant compared to massage gun and control groups [37].

Numerous studies have explored the effect of vibration therapy on flexibility and ROM. Compared to stretching exercises (traditional passive stretching, control group), the massage gun group showed no significant improvement in flexibility, which may reflect its ineffectiveness [9, 38]. However, these results are not in agreement with those of other studies that demonstrated its effectiveness in enhancing lower-limb flexibility. For instance, Konrad et al. (2020) found that the use of massage guns increased ROM and flexibility in the plantar flexor muscles, similar to traditional massages, without affecting muscle strength [9]. These results are in line with those of a meta-analysis on the immediate and long-term effects of vibration [9]. Moraleda et al. (2019) suggested that improved tissue flexibility may related to increased tissue and skin temperature [33, 34]. Clarke et al. (2024) attributed increased ankle ROM to 5 min of massage gun application following heavy exercise in cuff muscles [35], contrary to the results of the present study. Applying a massage gun according to the protocol outlined in the present study did not enhance plantar flexion ROM. The within-group results of the massage gun group may be distorted by environmental and confounding factors, such as different sports fields, previous contextual conflicts, people's jobs, weather conditions, and individuals' daily fatigue of each person.

Further, applying ESWT and massage guns to the muscles affected by MPS did not alter dorsiflexion ROM (antagonist ROM), which could be ascribed to the non-treatment of dorsiflexion agonist muscle in this study.

Cho et al. (2021) investigated the effects of radial ESWT on muscle mass and function in 15 patients undergoing maintenance hemodialysis. In this regard, they divided subjects into intervention and placebo groups, the first one of which received 12 shock wave sessions (weekly). The results revealed improved quadriceps volume and performance in both lower limbs along with enhanced quality of life [23]. Furthermore, d'Agostino et al. (2015) discovered that ESWT can influence mechano-transduction, aiding the body's signaling pathways by converting mechanical stimuli into biochemical signals and consequently affecting the intracellular matrix, nucleus, and cell mitochondria. However, myogenic factor 5 expression was observed in the stellate cells isolated from spine muscles post-ESWT compared to controls [39]. Mattyasovszky et al. (2018) assessed ESWT as a biological therapeutic tool and reported myogenic stimulation and muscle building in the myoblast cells of the mice receiving low-intensity ESWT. The results suggested the possible potential of ESWT to positively affect non-fat volume and muscle building by modulating myogenic factor-related gene expression and stimulating myogenesis [40]. Therefore, a single-session treatment based on the proposed protocol could not improve isometric strength, indicating the need for multiple shock wave therapy sessions to significantly influence muscle strength.

Konrad et al. (2020) studied the acute effects of a percussion massage gun on performance and ROM of plantar flexors among 16 individuals and found the ineffectiveness of this tool in enhancing maximal voluntary isometric contraction of plantar flexor muscles in the leg [9]. Various studies have represented that both general and local exposure to vibration therapy increases metabolic activities within muscle tissue, including blood flow, oxygen saturation, and tissue temperature [41, 42]. Some researchers have suggested that these physiological responses may positively affect muscle strength and explosive power [43, 44]. However, the collective results represented that massage guns, as local vibration devices, do not appear to alter isometric muscle strength although additional treatment sessions may effectively improve muscle strength.

Based on the results, a massage gun could be used as a suitable tool to relieve muscle pain and increase joint flexibility in the playfield, but it failed to improve muscle strength immediately and in the playfield. Shock wave therapy may be associated with better clinical outcomes compared to massage gun therapy. In terms of tissue effectiveness, a shock wave is more effective in reducing pain and intended symptoms immediately.

Conclusion

A single-session ESWT combined with routine physiotherapy immediately reduced pain, increased PPT, and enhanced plantar flexion ROM among amateur athletes with gastrocnemius MPS compared to massage gun therapy plus routine electrotherapy or electrotherapy alone. However, none of these treatment protocols were effective in altering maximal isometric gastrocnemius muscle force after a single session. Further studies are needed to assess the effectiveness and long-term effects of massage guns and ESWTs, particularly through multi-session use.

Study limitations

Several limitations affect this study. First, the participants were non-professional athletes, for whom the level of the daily and occupational activities influencing readiness was not assessed or standardized. Another limitation is the lack of evaluation of soft tissue components in terms of stiffness, tissue thickness, and elasticity, which could provide more detailed information on the effects of each treatment protocol. Furthermore, gender differences may affect the results, as the study included participants of both sexes. Finally, the study only evaluated the immediate effects of a single treatment session, which may not reflect the outcomes of multiple sessions or long-term effects.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Tehran University of Medical Sciences (IR.TUMS.FNM.REC1401.188). All patients were aware of the study procedures and signed an informed consent form before participating in the study.

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This study was extracted from the master's thesis of Seyedeh Zohreh Hosseini, at Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences.

Authors' contributions

Conceptualization and Supervision: Siamak Bashaardost Tajali and Kazem Malmir; Methodology, Investigation, and Writing original draft: Seyedeh Zohreh Hosseini; Data collection: Seyedeh Zohreh Hosseini and Alireza Hosseinzadeh Chaijan; Data analysis: Siamak Bashaardost Tajali, Kazem Malmir, and Seyedeh Zohreh Hosseini; Funding acquisition and Resources: Siamak Bashaardost Tajali; Writing – review & editing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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References

[1] Fredericson M, Misra AK. Epidemiology and aetiology of marathon running injuries. Sports Medicine. 2007; 37:437-9. [DOI:10.2165/00007256-200737040-00043]

[2] Sciotti VM, Mittak VL, DiMarco L, Ford LM, Plezbert J, Santipadri E, et al. Clinical precision of myofascial trigger point location in the trapezius muscle. Pain. 2001; 93(3):259-66 [DOI:10.1016/S0304-3959(01)00325-6]

[3] Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. British Journal of Sports Medicine. 2009; 43(13):966-72. [DOI:10.1136/bjsm.2009.066936]

[4] Rickards LD. The effectiveness of non-invasive treatments for active myofascial trigger point pain: A systematic review of the literature. International Journal of Osteopathy Medicine. 2006; 9(4):120-36. [DOI:10.1016/j.ijosm.2006.07.007]

[5] Kujala RP, Davis CD, Young L. The effect of handheld percussion treatment on vertical jump height. International Journal of Exercise Science. 2019; 8(7):75. [Link]

[6] Writers Group. How to use a massage gun. Massagegunfight [Internet]. 2022 [Updated 25 July 25 2022].

[7] Veqar Z, Imtiyaz S. Vibration therapy in management of delayed onset muscle soreness (DOMS). Journal of Clinical and Diagnostic Research. 2014; 8(6):LE01-4. [DOI:10.7860/JCDR/2014/7323.4434] [PMID]

[8] Lee CL, Chu IH, Lyu BJ, Chang WD, Chang NJ. Comparison of vibration rolling, nonvibration rolling, and static stretching as a warm-up exercise on flexibility, joint proprioception, muscle strength, and balance in young adults. Journal of Sports Sciences. 2018; 36(22):2575-82. [DOI:10.1080/02640414.2018.1469848]

[9] Konrad A, Glashüttner C, Reiner MM, Bernsteiner D, Tilp M. The acute effects of a percussive massage treatment with a hypervolt device on plantar flexor muscles' range of motion and performance. Journal of Sports Science & Medicine. 2020; 19(4):690-694. [PMID] [PMCID]

[10] Wang CJ. Extracorporeal shockwave therapy in musculoskeletal disorders. Journal of Orthopedic Surgery Research. 2012; 7(11):1-8. [DOI:10.1186/1749-799X-7-11]

[11] Akinoglu B, Kose N. A comparison of the acute effects of radial extracorporeal shockwave therapy, ultrasound therapy, and exercise therapy in plantar fasciitis. Journal of Exercise Rehabilitation, 2018; 14(2):306-12. [DOI:10.12965/jer.1836048.024]

[12] Malliaropoulos N, Thompson D, Meke M, Pyne D, Alaseirlis D, Atkinson H, et al. Individualised radial extracorporeal shock wave therapy (rESWT) for symptomatic calcific shoulder tendinopathy: A retrospective clinical study. BMC Musculoskeletal Disorder. 2017; 18:513. [DOI:10.1186/s12891-017-1873-x]

[13] Simons DG, Travell JG, Simons LS. Travell & simons' myofascial pain and dysfunction: Upper half of body. Philadelphia: Lippincott Williams & Wilkins; 1999. [Link]

[14] Fernández-Tenorio E, Serrano-Muñoz D, Avendaño-Coy J, Gómez-Soriano J. [Transcutaneous electrical nerve stimulation for spasticity: A systematic review (Spanish)]. Neurología. 2019; 34(7):451-60. [DOI:10.1016/j.nrl.2016.06.009]

[15] Physiopedia. Extracorporeal shockwave therapy [Internet]. 2019 [Updated 2019 October 31]. Available from: [Link]

[16] Palastanga N, Soames R. Anatomy and human movement: Structure and function. Edinurgh: Elsevier; 2012. [Link]

[17] Dixon JB. Gastrocnemius vs. soleus strain: How to differentiate and deal with calf muscle injuries. Current Reviews in Musculoskeletal Medicine. 2009; 2(2):74-7. [DOI:10.1007/s12178-009-9045-8]

[18] Hwang S, Kim T. [The effect of applying various tools to the stiffness and muscle tone of hamstring muscles (Korean)]. Journal of The Korean Society of Integrative Medicine. 2020; 8(4):223-30. [Link]

[19] Notarnicola A, Covelli I, Maccagnano G, Marvulli R, Mastromauro L, Ianieri G, et al. Extracorporeal shockwave therapy on muscle tissue: The effects on healthy athletes. Journal of Biological Regulators and Homeostatic Agents. 2018; 32(1):185-93. [PMID]

[20] Manafnezhad J, Salahzadeh Z, Salimi M, Ghaderi F, Ghojazadeh M. The effects of shock wave and dry needling on active trigger points of upper trapezius muscle in patients with non-specific neck pain: A randomized clinical trial. Journal of Back and Musculoskeletal Rehabilitation. 2019; 32(5):811-8. [DOI:10.3233/BMR-181289]

[21] Wu KT, Chou WY, Wang CJ, Chen CY, Ko JY, Chen PC, et al. Efficacy of extracorporeal shockwave therapy on calcified and noncalcified shoulder tendinosis: A propensity score matched analysis. BioMed Research International. 2019; 2019(1):2958251. [DOI:10.1155/2019/2958251]

[22] Crupnik J, Silveti S, Wajnstein N, Rolon A, Vollhardt A, Stiller P, et al. Is radial extracorporeal shock wave therapy combined with a specific rehabilitation program (rESWT+ RP) more effective than sham-rESWT+ RP for acute hamstring muscle complex injury type 3b in athletes? Study protocol for a prospective, randomized, double-blind, sham-controlled single centre trial. Journal of Orthopaedic Surgery and Research. 2019; 14(234):1-3. [DOI:10.20944/preprints201905.0054.v2]

[23] Cho YS, Joo SY, Lee EK, Kee YK, Seo CH, Kim DH. Effect of extracorporeal shock wave therapy on muscle mass and function in patients undergoing maintenance hemodialysis: A randomized controlled pilot study. Ultrasound in Medicine & Biology. 2021; 47(11):3202-10. [DOI:10.1016/j.ultrasmedbio.2021.07.021]

[24] Morgan JP, Hamm M, Schmitz C, Brem MH. Return to play after treating acute muscle injuries in elite football players with radial extracorporeal shock wave therapy. Journal of Orthopaedic Surgery and Research. 2021; 16(708):1-1. [DOI:10.1186/s13018-021-02853-0]

[25] Quinn E. Stretching exercises for soleus and calf muscle. 2019 [Updated 2019 October 31]. Available from: [Link]

[26] Boonstra AM, Preuper HR, Reneman MF, Posthumus JB, Stewart RE. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. International Journal of Rehabilitation Research. 2008; 31(2):165-9. [DOI:10.1097/MRR.0b013e3282fc0f93]

[27] Norkin C, White DJ. Measurement of joint motion: A guide to goniometry. Philadelphia: FA Davis; 2009. [Link]

[28] Mentiplay BF, Perraton LG, Bower KJ, Adair B, Pua YH, Williams GP, et al. Assessment of lower limb muscle strength and power using hand-held and fixed dynamometry: A reliability and validity study. Plos One. 2015; 10(10):e0140822. [DOI:10.1371/journal.pone.0140822]

[29] Ji HM, Kim HJ, Han SJ. Extracorporeal shock wave therapy in myofascial pain syndrome of upper trapezius. Annals of Rehabilitation Medicine. 2012; 36(5):675-80 [DOI:10.5535/arm.2012.36.5.675]

[30] Zimmermann R, Cumpanas A, Miclea F, Janetschek G. Extracorporeal shock wave therapy for the treatment of chronic pelvic pain syndrome in males: A randomised, double-blind, placebo-controlled study. European Urology. 2009; 56(3):418-24. [DOI:10.1016/j.eururo.2009.03.043]

[31] Hausdorf J, Lemmens MA, Heck KD, Grolms N, Korr H, Kertschanska S, et al. Selective loss of unmyelinated nerve fibers after extracorporeal shockwave application to the musculoskeletal system. Neuroscience. 2008; 155(1):138-44. [DOI:10.1016/j.neuroscience.2008.03.062]

[32] Hausdorf J, Lemmens MA, Kaplan S, Marangoz C, Milz S, Odaci E, et al. Extracorporeal shock wave application to the distal femur of rabbits diminishes the number of neurons immunoreactive for substance P in dorsal root ganglia L5. Brain Research. 2008; 1207:96-101. [DOI:10.1016/j.brainres.2008.02.013] [PMID]

[33] Kasahara K, Yoshida R, Yahata K, Sato S, Murakami Y, Aizawa K, et al. Comparison of the acute effects of foam rolling with high and low vibration frequencies on eccentrically damaged muscle. Journal of Sports Science Medicine. 2022; 21(1):112-9. [DOI:10.52082/jssm.2022.112]

[34] Romero-Moraleda B, González-García J, Cuéllar-Rayo Á, Balsalobre-Fernández C, Muñoz-García D, Morencos E. Effects of vibration and non-vibration foam rolling on recovery after exercise with induced muscle damage. Journal of Sports Science & Medicine. 2019; 18(1):172-80. [PMID] [PMCID]

[35] Clarke AC, Leabeater AJ, James LJ, Huynh M, Driller M. Under the gun: Percussive massage therapy and physical and perceptual recovery in active adults. Journal of Athletic Training 2024; 59(3):310-6. [DOI:10.4085/1062-6050-0041.23]

[36] Lewis PB, Ruby D, Bush-Joseph CA. Muscle soreness and delayed-onset muscle soreness. Clinics in Sports Medicine. 2012; 31(2):255-62. [DOI:10.1016/j.csm.2011.09.009]

[37] Jeon JH, Jung YJ, Lee JY, Choi JS, Mun JH, Park WY, et al. The Effect of Extracorporeal Shock Wave Therapy on Myofascial Pain Syndrome. Annals Rehabilitation Medicine. 2012; 36(5):665-74. [DOI:10.5535/arm.2012.36.5.665]

[38] Park S. Effect of local vibration on triceps surae flexibility compared to static stretching. Journal of Korean Physical Therapy. 2020; 32(4):245-9. [DOI:10.18857/jkpt.2020.32.4.245]

[39] d'Agostino MC, Craig K, Tibalt E, Respizzi S. Shock wave as biological therapeutic tool: From mechanical stimulation to recovery and healing, through mechanotransduction. International Journal of Surgery 2015; 24:147-53. [DOI:10.1016/j.ijsu.2015.11.030]

[40] Mattyasovszky SG, Langendorf EK, Ritz U, Schmitz C, Schmidtmann I, Nowak TE, et al. Exposure to radial extracorporeal shock waves modulates viability and gene expression of human skeletal muscle cells: A controlled in vitro study.

Journal of Orthopaedic Surgery and Research. 2018; 13(75):1-10 [DOI:10.1186/s13018-018-0779-0]

[41] Venslauskas M, Ostasevicius V, Vilkinis P. Influence of low-frequency vibrations on blood flow improvement in human's limbs. Biomedical Materials and Engineering. 2017; 28(2):117-30. [DOI:10.3233/BME-171661]

[42] Cochrane DJ. The potential neural mechanisms of acute indirect vibration. Journal of Sports Science & Medicine. 2011; 10(1):19-30. [PMID] [PMCID]

[43] Sams L, Langdown BL, Simons J, Vseteckova J. The effect of percussive therapy on musculoskeletal performance and experiences of pain: A systematic literature review. International Journal of Sports Physical Therapy. 2023; 18(2):309-27. [DOI:10.26603/001c.73795]

[44] Wang CJ, Wang FS, Yang KD, Weng LH, Hsu CC, Huang CS, et al. Shock wave therapy induces neovascularization at the tendon-bone junction. A study in rabbits. Journal of Orthopedic Research 2003; 21(6):984-9 [DOI:10.1016/S0736-0266(03)00104-9]