Lasers in Medical Science (2025) 40:404
https://doi.org/10.1007/s10103-025-04676-5

RESEARCH

Comparison of the efficacy of radial and focused extracorporeal shock-wave therapy (ESWT) in myofascial pain syndrome: a randomized, sham-controlled study

Hüma Bölük Şenlikci[1] · Özlem Yücealp[1] · Pınar Borman[2] · Zeynep Ince Keskin[1] · Sevgi Gümüş Atalay[1] · Evren Yaşar[3]

Received: 7 July 2025 / Accepted: 23 September 2025

Abstract

Myofascial pain syndrome (MPS) is one of the most common pain syndromes characterized by painful trigger points. Active trigger points may cause spontaneous pain, reduce quality of life, and result in workforce loss. Extracorporeal shock-wave therapy (ESWT), using radial or focused acoustic waves created outside the body, is a treatment method used for musculoskeletal problems. In Focused ESWT (F-ESWT), the depth of the body part to be targeted can be adjusted. Penetration into the tissue is better than radial waves. Radial ESWT (R-ESWT) has a more superficial effect, and its spread in liquids with a density similar to tissues is half that of focused ESWT. Previous studies have shown that radial and focused ESWT waves applied to trigger points in the upper trapezius fibres reduce reflected and local pain in myofascial pain syndrome. The aim of this study was to compare the effectiveness of radial and focused ESWT types on trigger points in upper trapezius fibres in patients with myofascial pain syndrome. This prospective, randomized, sham-controlled study included 57 patients, randomly assigned to one of 3 groups. The patients underwent R-ESWT, F-ESWT and sham protocols for 4 sessions. Evaluations were made with a Visual Analog Scale (VAS) to assess pain, the Health Assessment Questionnaire (HAQ), and the Beck Depression Inventory (BDI) before treatment, post-treatment, then at 1, 3 and 6 months after completion of the treatment. Symptom duration was the only parameter that was significantly different between the groups before the treatment ($p=0.025$). VAS scores improved after treatment compared to baseline for all groups ($p<0.05$), with improvements continuing in the ESWT groups. The BDI and HAQ scores did not differ between the groups, and the F-ESWT group showed a significant improvement in BDI and HAQ ($p<0.01$, $p=0.018$, respectively). The VAS scores of the ESWT groups were similar and significantly higher than those of the sham group, but mid-long term changes did not differ across the groups ($p=0.065$). In patients diagnosed with myofascial pain syndrome who underwent R-ESWT, F-ESWT and sham therapy on active trigger points in the upper trapezius fibres, an improvement in pain was observed in the R and F-ESWT groups even in the long term. While the improvement in pain scores was the same for the radial and focused types at all time points, the improvement in both was significantly higher compared to the sham application.

Keywords Pain · Pain management · Trigger points · Trapezius muscle

✉ Hüma Bölük Şenlikci
humaboluk@gmail.com

Özlem Yücealp
ozlem.yucealp@gmail.com

Pınar Borman
pinarborman@gmail.com

Zeynep Ince Keskin
dr.zeynepince@gmail.com

Sevgi Gümüş Atalay
sevgigumusatalay@hotmail.com

Evren Yaşar
evrenyasar@yahoo.com

[1] Department of Physical Medicine and Rehabilitation, University of Health Sciences, Ankara Bilkent City Hospital, Ankara, Turkey

[2] Department of Physical Medicine and Rehabilitation, Ankara Medipol University, Ankara, Turkey

[3] Rectorate, Bozok University, Yozgat, Turkey

Published online: 03 October 2025

Introduction

Myofascial pain syndrome (MPS) is a syndrome characterized by painful trigger points on palpation of certain points of common muscles. Pain on palpation tends to radiate and is sometimes even accompanied by sensory symptoms (such as paresthesia) or autonomic findings (piloerection, sweating, etc.) [1]. Trigger points can be either latent or active. Active trigger points may cause spontaneous pain, while latent trigger points more commonly cause pain radiating with palpation. Latent trigger points tend to become active trigger points as a result of acute stress, microtrauma or postural disorders, and the trapezius muscle is the muscle in which myofascial trigger points are most often seen [2]. Myofascial pain syndrome can cause many consequences such as disturbances in daily living activities, diminished quality of life, loss of workforce, anxiety and depression [1, 2]. Pharmacological therapy can be used for management, with stretching exercises, dry needling, acupuncture or physical therapy modalities as other effective treatment options for patients who are not willing to use drugs or have comorbidities [3, 4].

Extracorporeal shock-wave therapy (ESWT) is a physical therapy method using acoustic waves created outside the body. It is frequently used in musculoskeletal conditions, and has been demonstrated to be effective in disorders such as calcaneal spur, lateral epicondylitis, calcific tendinitis, myofascial pain syndrome, and fibromyalgia [5–8].

Radial or focused waves are differents types of ESWT targeting different depths of tissues. In Focused ESWT (F-ESWT), the depth of the body part to be targeted can be adjusted. Penetration into the tissue is better than radial waves, as Radial ESWT (R-ESWT) has a more superficial effect [6]. Although there may be some side-effects, both wave types are thought to be safe and are widely used [9].

Radial and focused ESWT waves applied to trigger points in the upper trapezius fibres reduce reflected and local pain in myofascial pain syndrome. The effectiveness of these waves has been evaluated in various studies, but the effectiveness of the two wave types has not been compared in patients with MPS trigger points in the upper trapezius fibres [6, 7]. Therefore, the aim of this study was to compare the efficacy of R-ESWT and F-ESWT on trigger points in upper trapezius fibres in patients with myofascial pain syndrome.

Materials and methods

Patients and study design

This prospective, randomized, sham-controlled study was conducted in the Physical Medicine and Rehabilitation Department of Ankara Bilkent City Hospital. The study protocol was in accordance with the Declaration of Helsinki and was approved by the 2nd Ethics Committee of Ankara Bilkent City Hospital (Approval number: E2-22–3033). Human Ethics and Consent to Participate Declarations were obtained from all the patients. Clinical trials registration was done restrospectively (ClinicalTrials.gov/NCT06987721//25.05.2025). The study was funded by Ankara Bilkent City Hospital.

A total of 59 patients were enrolled in the study, and randomly assigned to one of three groups using randomization software; Group R-ESWT: $n=20$, Group F-ESWT: $n=19$, and Group Sham: $n=20$. All the patients were informed by an applicator physician about possible adverse effects of ESWT such as local swelling, reddening, tenderness, bruising or pain during application and hematoma developing in underlying tissues. One patient did not attend follow-up appointments and one patient left the study before the completion of sessions, so the study was completed with 57 patients (Fig. 1). Sociodemographic and clinical characteristics of the patients were collected at baseline. Evaluations of pain, functionality and depression were made at baseline (pre-treatment), immediately after the completion of ESWT sessions, then at 1, 3, and 6 months after the completion of 4 sessions. During the follow-up period, the study participants were prohibited from taking any analgesics other than paracetamol, from having any injections or any interventional procedures to the trigger points or from receiving physical therapy modalities.

Inclusion and exclusion criteria

The diagnosis of MPS was based on the Travell and Simons 5 major and 3 minor criteria. Major criteria were (1) localized spontaneous pain, (2) presence of spontaneous pain and/or changed sensation in referred pain area, (3) palpable bands in muscle, (4) sharp tenderness along the taut bands, and (5) measurable limitation in range of motion. Minor criteria were (1) pain or change in sensation caused by touching the taut bands, (2) presence of a local twitch response in the muscle upon needle insertion, and (3) reduced pain after stretching or injection of taut bands. All five major and at least 1 minor criteria are needed for a confirmed MPS diagnosis [10].

The study inclusion criteria were defined as age 18–70 years, confirmed MPS diagnosis with active trigger points in the upper trapezius fibres, and pain related to trapezius muscle trigger points > 4 on a VAS of 1–10.

Exclusion criteria were (1) any cervical disc herniation (protrusion or extrusion) causing cervical root compression seen on magnetic resonance imaging and/or radicular pain with motor or sensory deficit, (2) presence of neurological

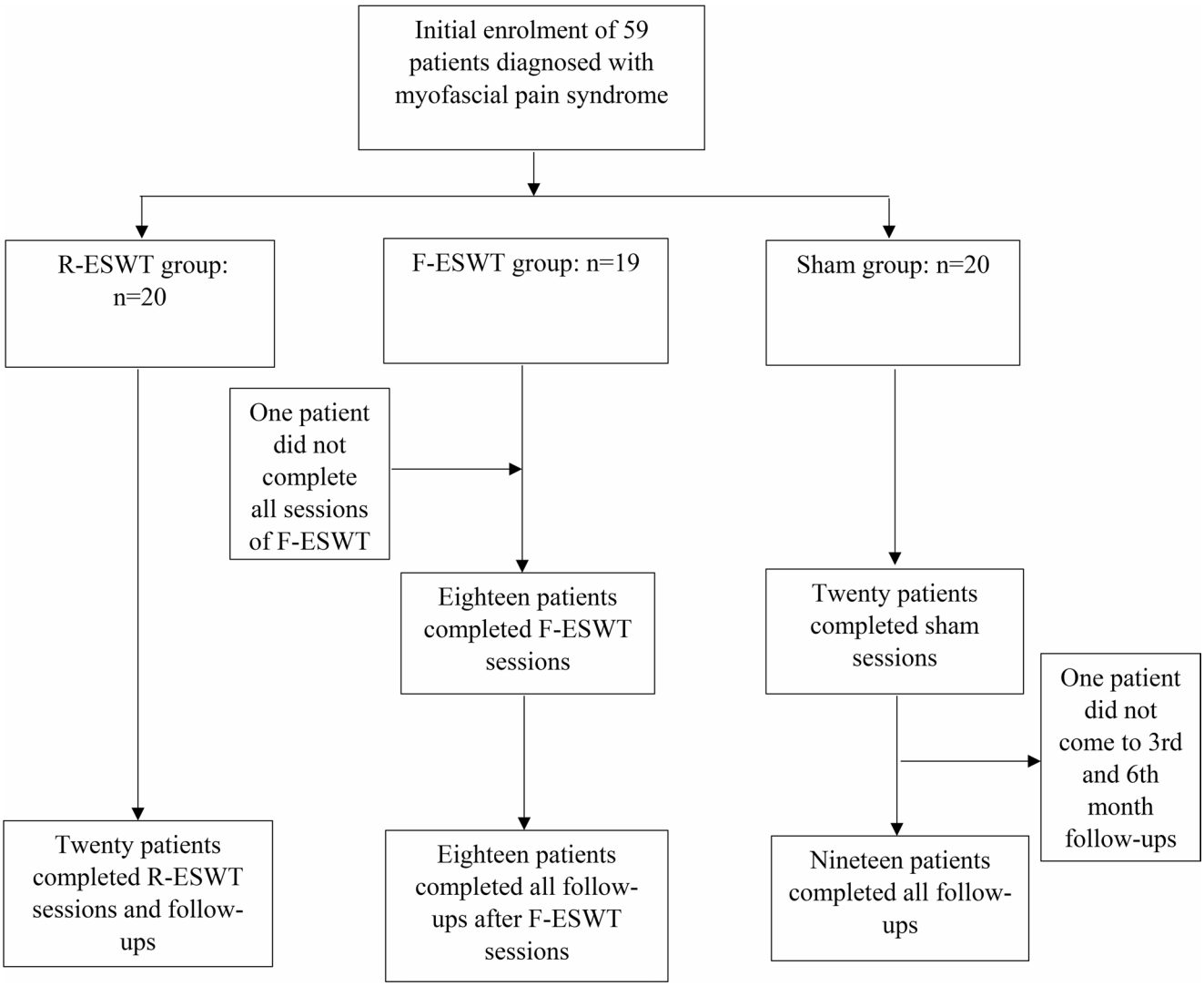

Fig. 1 Flowchart of the study participants

or rheumatological disorders and/or malignancy, (3) cognitive impairment (Mini Mental State Examination < 23), (4) acute systemic infection or any other diseases that affect general condition, and (5) any open wound or sensory deficit in the application area.

Randomization and blinding

A clinical trials randomization tool was used in the randomization process. First, the physician assessed patients in terms of eligibility criteria and then the patients were randomly assigned to one of the groups using the clinical trials randomization tool. A second physician, blinded to the application method conducted the baseline evaluation and another resident applied the ESWT method under the guidance of the first physician.

All the patients were informed about the application method in detail and signed informed consent forms were obtained. After all the sessions were completed, the second physician who was blinded to the application type, performed the follow-up assessments.

Outcome measures

Visual Analog Scale (VAS)

A Visual Analog Scale (VAS) was used for the self-assessment of pain intensity associated with MPS. Higher scores indicate more pain related to the trigger points of upper trapezius muscle fibres [11].

Beck Depression Inventory (BDI)

The Beck Depression Inventory (BDI) was used to evaluate depression symptoms. The BDI consists of 21 items with

higher scores indicating increased depression symptom severity [12].

Health Assesment Questionnaire (HAQ)

This questionnaire has 8 sections: dressing, arising, eating, walking, hygiene, reach, grip, and activities. There are 2 or 3 items in each section, with each item scored on a Likert scale from 0 to 3 (0 = without any difficulty, 3 = unable to do). Higher scores indicate worse health based on the self-report [13].

Procedure

An exercise program of stretching exercises for the trapezius muscle was given to all the participants for 4 weeks. Weekly reminders were given via telephone calls and in-person follow-up visits. ESWT was applied with the same directions and to the same points of the trapezius muscle for a total of 4 sessions at one-week intervals (Figs. 2 and 3).

In accordance with the literature, the ESWT settings were 1500 pulses, 0.1 mj/mm, 10–16 Hz for radial applications, and 1500 pulses, 0.056 mj/mm, 6 Hz for focused applications. Focused application was adjusted to 3 cm depth [14–16]. The sham application mode is available on the device and produces only sound at a frequency similar to that of the radial or focused application. The Modus Radial & Focused Combined Shockwave Therapy Device (Inceler Med. Comp, Türkiye) was used for all applications (Fig. 4).

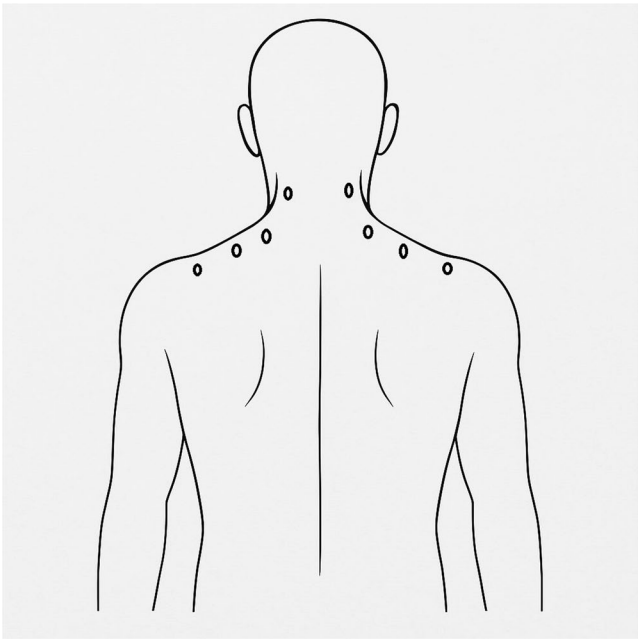

Fig. 2 Application regions of upper trapezius muscle

Sample size analysis

Using the randomized controlled study conducted by Özen et al., which aimed to determine the effects of physical therapy modalities in lumbar disc herniation patients, the effect size (Effect size d = 0.47) was calculated based on the post-treatment VAS (patient group = 5.33 ± 0.81, control group = 4.93 ± 1.16) [17]. With alpha error (p value) of 0.05 and 1-beta error (power) value of 0.80 at this effect size value, it was determined that a minimum of 48 participants (16 per group) would be sufficient for the study. G*Power Statistical Program version 3.1.9.4 (Universität Düsseldorf, Germany) was used for the sample size calculation.

Statistical analysis

Data were analyzed using SPSS, version 25.0 software (IBM Corp., Armonk, N.Y., USA). The normality of numerical data distribution was examined using the Kolmogorov–Smirnov test. Normally distributed continuous variables were reported as mean and standard deviation values, non-normal variables as median and interquartile range (IQR; 25th −75th percentiles) values, and qualitative data as frequencies and percentages. The categorical variables were compared using Fischer's Exact test, Pearson chi-square, and Continuity correction according to expected counts. Numerical variables were compared with the Mann-Whitney U or Independent Samples t-test between the two groups. The Paired Samples t-test or Wilcoxon test was applied in comparisons of repeated variables with two measurements. Repeated numerical variables with three or more values were analyzed using the Repeated measures ANOVA or Friedman tests. In the analysis of numerical variables between more than two groups, ANOVA or the Kruskal-Wallis test with posthoc Bonferoni correction were used. The confidence interval was set at 95%, and the margin of error at 5%. A value of $p<0.05$ was considered statistically significant.

Results

The demographic data and clinical features of the patients are shown in Table 1. The symptom duration was higher in the F-ESWT group than in the sham group ($p<0.01$), with no significant differences determined between the other paired group comparisons ($p>0.05$).

The VAS, BDI and HAQ baseline scores were similar in all three groups ($p>0.05$) Post-treatment and 3rd month VAS scores were significantly higher in the sham group than in both ESWT groups ($p<0.01$). There was no significant

Fig. 3 Application of Focused and Radial ESWT, respectively

difference in the BDI and HAQ scores between the groups at different time points ($p>0.05$) (Table 2).

All three groups showed improvement in VAS over time ($p<0.001$,$p=0.029$, $p<0.001$; respectively). The baseline VAS score was significantly higher than the 1 st month, 3rd month, and 6th month scores in both the F-ESWT and R-ESWT groups ($p<0.05$). Post-treatment VAS scores were lower than baseline only in the sham group ($p=0.023$) (Table 2).

Compared to baseline, the BDI scores did not improve in the R-ESWT and sham groups ($p=0.114$,$p=0,255$; respectively). The F-ESWT group showed significant improvements in the BDI score compared to baseline ($p<0.01$), at the1st month, 3rd month and 6th month ($p=0.021$,$p=0.012$,$p=0.018$, respectively). The F-ESWT group showed improvement in HAQ compared to baseline ($p=0.018$); the baseline-3rd month and baseline-6th month follow-up comparisons showed a significant difference ($p=0.028$ and $p=0.011$) (Table 2).

The decrease in VAS scores after treatment was higher in the R-ESWT group than in the sham group ($p<0.01$), with no significant difference found between R-ESWT and F-ESWT, and between F-ESWT and sham group ($p>0.05$). The change in VAS at the 1 st month was higher in the F-ESWT group than in the sham group ($p=0.011$); no significant difference was found between the R-ESWT and F-ESWT groups ($p=0.297$) and between the R-ESWT and sham groups ($p=0.125$) ($p>0.05$). The decrease in VAS score at 3 months was seen to be higher in the R-ESWT ($p<0.01$) and F-ESWT ($p<0.01$) groups than in the sham group, with no statistical difference between the R-ESWT and F-ESWT groups ($p=0.832$). At 6 months no significant differences were determined in terms of change in VAS scores across the groups ($p=0.065$) (Table 3).

The multivariate logistic regression analysis including age, gender, BMI, marital status, symptom duration, and VAS-pretreatment variables in the model showed that only the VAS-pretreatment score was positively associated with the change in VAS scores at 1, 3, and 6 months ($p<0.001$ for all analyses).

Fig. 4 Modus Radial & Focused Combined Shockwave Therapy Device (Inceler Med. Comp, Türkiye)

Discussion

The results of this study demonstrated an improvement in pain over time in the ESWT groups. F-ESWT was seen to have a positive effect on depression and general health, but the sham and R-ESWT applications had no effect. The greatest improvement in pain over time was seen in the ESWT groups, but there was no difference in improvement between the two modalities in the mid-long term. Based on these findings, it can be concluded that ESWT is effective in myofascial pain, and F- ESWT may be the first option for better outcomes.

Myofascial pain syndrome is a common disorder of the musculoskeletal system characterized by widespread taut bands and trigger points. Although its pathophysiology is not clear, it is thought to be due to triggering of low threshold mechanosensitive afferents by a local dysfunction. The increase of inflammatory mediators around active trigger points also causes pain [1]. These metabolites may contribute to nerve dysfunction, particularly autonomic and

Table 1 Demographic and clinical features of the study participants

	R-ESWT Group ($n=20$)	F-ESWT Group ($n=18$)	Sham Group ($n=19$)	p
Age (years) (mean ± SD)	40.6 ± 14.3	43.9 ± 10.5	40.1 ± 11.1	0.884[a]
Sex (n/%)	17 (85.0)	14 (78.8)	19 (90.5)	0.546[b]
Female	3 (15.0)1	4 (22.2)	2 (9.5)	
Male				
Body mass index	26.3 ± 4.3	26.1 ± 4.4	26.6 ± 6.9	0.957[a]
Marital status (n/%)	14 (70.0)	16 (88.9)	19 (90.5)	0.159[b]
Married	6 (30.0)	2 (11.1)	2 (9.5)	
Single				
Education level (n/%)	4 (20.0)	3 (16.7)	3 (14.3)	0.864[b]
Primary school	2 (10.0)	1 (5.6)	4 (19.0)	
Middle school	6 (30.0)	5 (27.8)	7 (33.3)	
Highschool	8 (40.0)	9 (50.0)	7 (33.3)	
University				
Occupation (n/%)	9 (45.0)	7 (38.9)	8 (38.1)	0.520[b]
Clerical	1 (5.0)	4 (22.2)	6 (28.6)	
Manual	1 (5.0)	2 (11.1)	1 (4.8)	
Retired	9 (45.0)	5 (27.8)	6 (28.6)	
Housewife				
Smoking (n/%)	3 (15.0)	9 (50.0)	6 (28.6)	0.060[b]
Alcohol (n/%)	1 (5.0)	3 (16.7)	3 (14.3)	0.493[b]
Symptom duration (months) (mean ± SD)	4.9 ± 2.1	5.7 ± 1.8	3.9 ± 2.0	**0.025[a]**
Previous treatments (n/%)	11 (55.0)	9 (50.0)	16 (76.2)	NA
	2 (10.0)	-	2 (9.5)	
None	5 (25.0)	6 (33.3)	2 (9.5)	
Pharmacological treatment	2 (10.0)	3 (11.1)	1 (4.8)	
Physical therapy agents				
Trigger point injection				
Comorbidities (n/%)	16 (80.0)	15 (83.3)	15 (71.4)	NA
	2 (10.0)	1 (5.6)	3 (14.3)	
None	1 (5.0)	2 (11.2)	1 (4.8)	
Hypertension	1 (5.0)	-	2 (9.6)	
Diabetes mellitus	1 (5.0)	1 (5.6)	-	
Hypothyroidism				
Asthma				

[a] ANOVA, [b] Pearson-Chi square, *NA* Not analyzed

sensory small fibre, leading to local vasoconstriction and decreased blood flow, which results in hypoperfusion, as well as referred pain, allodynia, and hyperalgesia [2, 18]. It is thought that the effectiveness of ESWT increases the release of anti-inflammatory mediators and mediators that provide tissue regeneration by increasing the cell membrane permeability. Due to endorphins, pain pathways are inhibited and blood flow is provided to hypoperfused trigger points with mediators [19, 20].

The beneficial effect of ESWT on pain in patients with MPS has been shown many times. In the current study, pain scores decreased in both the R-ESWT and F-ESWT patient groups. However, as expected, this improvement was limited in the sham group. Previous studies have reported that pain reduction in patients undergoing real ESWT was superior to radiofrequency ablation therapy and dry needling methods [18]. Similar efficacy was obtained in the current study. This superiority even over interventional methods offers a good treatment option in terms of safety. In line with previous studies, the current study participants did not experience any complications or side-effects. Trapezius stretching exercises were shown to all MPS patients and the patients were followed up with exercise compliance until the end of the treatment. It has been clearly stated that stretching exercises are another effective treatment method for MPS and that this effect is increased when combined with ESWT [21]. Therefore, improvement was also observed in the patients in the sham group who only applied stretching exercises. It is most likely that the pain scores of the patients in the sham group before and after treatment improved for this reason, but the effect did not increase through the mid-long term follow-ups.

Myofascial pain syndrome significantly impacts daily living activities. In previous studies, one of the reasons for preferring ESWT in daily clinical practice in MPS was the long-lasting effect. Those studies also indicated that pain relief and functional improvement generally start immediately after the first session and last for up to 2 years [19]. In the current study, the long-term effect on the pain scores was observed in both ESWT types. Depression and general health-functionality scores improved for up to 6 months after treatment, although this effect was not seen in the R-ESWT group [19].

The release of hyaluronan vesicles and the increase in collagen type 1 and 3 production induced by ESWT in MPS may contribute to extracellular matrix regulation [9, 19]. Previous studies have shown that ESWT is superior to dry needling, laser applications, and trigger point injections with local anesthetic in MPS and it has been emphasized that the aforementioned mechanisms may be responsible for this effect. In addition, the reason for preferring ESWT in these studies has been stated to be both the quality and duration of the effect [9, 19].

The effectiveness of mesotherapy, another method used in the treatment of MPS, has also been the subject of studies in terms of comparison with ESWT, and ESWT has been shown to be superior [22]. In another study investigating the effect on MPS of tissue mobilization techniques, which are safe methods used in many musculoskeletal problems, it was revealed that ESWT has similar effectiveness to tissue mobilization techniques and is just as safe [21].

To the best of our knowledge, although there are many musculoskeletal disorder studies comparing R-ESWT and F-ESWT modalities, their effectiveness in MPS has not

Table 2 The within and between group comparisons of the scales

	R-ESWT Group ($n=20$)	F-ESWT Group ($n=18$)	Sham Group ($n=19$)	p (Between group comparisons)
	Mean ± SD or Median (IQR)			
VAS				
VAS-pretreatment	7.1 ± 1.8	7.7 ± 1.8	7.0 (2.0)	0.146[c]
VAS- after treatment	3.4 ± 1.8	5.0 ± 2.0	6.0 (3.0)	**< 0.01**[c]
VAS-at 1 st month	4.9 ± 2.6	4.7 ± 2.4	6.0 (2.0)	0.245[c]
VAS-at 3rd month	4.5 ± 2.4	5.0 ± 2.8	7.0 (2.0)	**< 0.01**[c]
VAS-at 6th month	5.1 ± 2.6	5.4 ± 3.2	7.0 (2.0)	0.062[c]
p (Within group)	**< 0.001**[a]	**0.029**[a]	**< 0.001**[b]	
Pairwise comparisons				
P (pretreatment/post-treatment)	**< 0.001**[d]	**< 0.001**[d]	**0.023**[e]	
p (pretreatment/1st month)	**< 0.01**[d]	**< 0.001**[d]	0.053[e]	
p (pretreatment-3rd month)	**< 0.01**[d]	**< 0.01**[d]	0.971[e]	
p (pretreatment/6th month)	**< 0.01**[d]	**< 0.01**[d]	0.749[e]	
BDI				
BDI-pretreatment	15.72 ± 9.6	8.0 (14.0)	11.0 (11.0)	0.212[c]
BDI- post-treatment	13.0 ± 9.2	5.5 (10.0)	10.0 (11.0)	0.237[c]
BDI-at 1 st month	14.3 ± 10.8	4.0 (10.0)	9.0 (17.0)	0.126[c]
BDI-at 3rd month	12 ± 10.5	2.0 (9.0)	10.0 (16.0)	0.136[c]
BDI-at 6th month	11.5 ± 10.8	3.0 (9.0)	10.0 (14.0)	0.118[c]
p (Within group)	0.114	**< 0.01**	0.255	
Pairwise comparisons				
p pretreatment/post-treatment)	NA	0.068	NA	
p (pretreatment/1st month)	NA	**0.021**	NA	
p (pretreatment/3rd month)	NA	**0.012**	NA	
p (pretreatment/6th month)	NA	**0.018**	NA	
HAQ				
HAQ-pretreatment	5.0 (23.0)	1.5 (18.0)	3.0 (12.0)	0.836[c]
HAQ- post-treatment	5.0 (25.0)	0.0 (5.0)	1.0 (20.0)	0.231[c]
HAQ-at 1 st month	3.5 (12.0)	0.0 (5.0)	3.0 (15.0)	0.448[c]
HAQ-at 3rd month	2.0 (5.0)	0.0 (3.0)	1.0 (5.0)	0.082[c]
HAQ-at 6th month	1.0 (6.0)	0.0 (1.0)	1.0 (25.0)	0.091[c]
P(Within group)	0.104	**0.018**	0.390	
Pairwise comparisons				
p (pretreatment/post-treatment)	NA	0.293	NA	
p (pretreatment/1st month)	NA	0.683	NA	
p (pretreatment/3rd month)	NA	**0.028**	NA	
p (pretreatment/6th month)	NA	**0.011**	NA	

[a] One-way ANOVA analysis, [b] Friedman test, [c] Kruskal-Wallis test with posthoc Bonferroni test, [d] Paired Samples t-test, [e] Wilcoxon signed-ranks test NA: Not analyzed, *VAS* Visual Analog Scale, *BDI* Beck Depression Inventory, *HAQ* Health Assessment Questionnaire

Table 3 Comparisons of changes in visual analog scale scores over time

	R-ESWT Group ($n=20$)	F-ESWT Group ($n=18$)	Sham Group ($n=19$)	p^*
Change in VAS scores	Mean ± SD or Median (IQR)			
VAS pretreatment/ post-treatment	3.8 ± 2.7	2.7 ± 2.4	1.0 (2.5)	**< 0.01**
VAS pretreatment/1st month	2.2 ± 2.9	3.0 ± 2.6	0.8 ± 1.7	**0.036**
VAS pretreatment/3rd month	2.5 ± 2.8	2.7 ± 2.8	0.0 (1.5)	**< 0.01**
VAS pretreatment/6th month	2.0 ± 3.0	2.3 ± 3.5	−0.9 ± 1.5)	**0.065**

*Kruskal-Wallis test with posthoc Bonferroni test, *VAS* Visual Analog Scale

been compared in any previous study. The wave activity of R- ESWT follows a sudden and bouncing path by drawing a ballistic curve, while the energy density is low and large-scale waves are created at a depth of 3–4 cm. In F- ESWT, since the energy density is high, both a cavitation effect is created and there are waves that can reach deep tissues. In a study by Yun et al. comparing the effectiveness of R-ESWT and combined ESWT on pelvic and hip tendinopathy, functional improvement was found to be superior in patients receiving R-ESWT [23]. In a recent study conducted with hip osteoarthritis patients, F-ESWT was found to be more effective in terms of pain and functionality [22]. As reported in previous studies, it is thought that not only the depth of the pathology but also the tissue structural differences may

play a role in the treatment success [24]. In another study comparing the effectiveness of F-ESWT and R-ESWT in patients with knee osteoarthritis, F-ESWT was found to be superior [25]. Plantar fasciitis and calcaneal spur are amongst the most common disorders for which ESWT can be used, and it has been previously reported that R-ESWT or F-ESWT did not show any difference in terms of pain and functionality in patients with calcaneal spur and plantar fasciitis [26]. In another study conducted on patients with only calcaneal spurs, radial applications were found to be superior and it was suggested that the reason for this was that tissue structural disorders prevented the spread of the wave and led to cut off from the source [27–29]. In the current study, no difference for pain may be related to the presence of no tissue resistance or structural difference during the spread of the waves along the trapezius muscle.

Depression can be more common in patients with myofascial pain compared to the normal population [22]. This increased depression prevalence may be due to pain alone, or a lack of mediators that inhibit descending inhibitory pain pathways. The endorphins produced by the effect of ESWT may also have a positive effect on depression symptoms with the help of this pathway [22, 23]. The current study results showed an improvement in BDI scores after F-ESWT application to trapezius muscle trigger points at the 6th month follow-up compared to baseline, and there were no changes in the R-ESWT group. Depressive symptoms after ESWT application for MPS have not been assessed in previous studies.

A limitation of this study could be said to be the relatively small sample size. Although the sample size was determined based on the effect size of a previous study, a greater number of treated MPS patients would provide more reliable findings. Another limitation of the study was that a functionality index related to neck pain or stiffness was not used.

Conclusion

In conclusion, ESWT is an effective method in treating MPS-related trigger points in the upper trapezius muscle. Focused ESWT seems to be more effective for general health perception and improvement of depression. Both ESWT approaches can be safely used in the clinic to treat patients with MPS.

Acknowledgements Special thanks to Seher Kalic, for technical support and images.

Author contributions Concept: HBŞ, ÖY, PB Design: PB, HBŞ, EY Supervision: HBŞ, PB, EY, SGA Resource: PB, EY Materials: ÖY, ZK Data Collection and Processing: ZK, ÖY, HBŞ Analysis: ZK, ÖY, HBŞ Literature Search: EY, PB, ZK, ÖY, HBŞ, SGA Writing Manuscript: HBŞ, SGA Critical Review: HBŞ, SGA.

Funding Ankara Bilkent City Hospital. The authors have no relevant financial or non-financial interests to disclose. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

ClinicalTrials.gov/NCT06987721/25.05.2025 (retrospectively registered).

Consent to participate Obtained from all the participants.

Competing interests The authors declare no competing interests.

References

1. Taşoğlu Ö, Şahin Onat Ş, Bölük H et al (2017) Comparision of two different dry-needling techniques in the treatment of myofascial pain syndrome. Agri 29:9–16. https://doi.org/10.5505/agri.2016.38991
2. Urits I, Charipova K, Gress K (2020) Treatment and management of myofascial pain syndrome. Best Pract Res Clin Anaesthesiol 34:427–448. https://doi.org/10.1016/j.bpa.2020.08.003
3. Barbero M, Schneebeli A, Koetsier E et al (2019) Myofascial pain syndrome and trigger points: evaluation and treatment in patients with musculoskeletal pain. Curr Opin Support Palliat Care 13:270–276. https://doi.org/10.1097/SPC.0000000000000445
4. Iaroshevskyi OA, Morozova OG, Logvinenko AV (2019) Non-pharmacological treatment of chronic neck-shoulder myofascial pain in patients with forward head posture. Wiad Lek 72:84–88
5. Yao G, Chen J, Duan Y et al (2020) Efficacy of extracorporeal shock wave therapy for lateral epicondylitis: A systematic review and Meta-Analysis. Biomed Res Int. https://doi.org/10.1155/2020/2064781. 18;2020:2064781
6. Sun K, Zhou H, Jiang W (2020) Extracorporeal shock wave therapy versus other therapeutic methods for chronic plantar fasciitis. Foot Ankle Surg 26:33–38. https://doi.org/10.1016/j.fas.2018.11.002
7. Paoletta M, Moretti A, Liguori S (2022) Efficacy and effectiveness of extracorporeal shockwave therapy in patients with myofascial pain or fibromyalgia: a scoping review. Medicina (B Aires) 58:1014. https://doi.org/10.3390/medicina58081014
8. Müller-Ehrenberg H, Licht G (2005) Diagnosis and therapy of myofascial pain syndrome with focused shock waves (ESWT). Med Orthop Tech 5:1–6
9. Schmitz C, Császár NB, Milz S et al (2015) Efficacy and safety of extracorporeal shock wave therapy for orthopedic conditions: a systematic review on studies listed in the PEDro database. Br Med Bull 116:115–138. https://doi.org/10.1093/bmb/ldv047
10. Simons DG, Travell JG, Simons LS (1999) Travell and simons' myofascial pain and dysfunction: the trigger point manual, vol 1, 2nd edn. Williams & Wilkins, Baltimore, MD
11. Wewers ME, Lowe NK (1990) A critical review of visual analogue scales in the measurement of clinical phenomena. Res Nurs Health 13:227–236. https://doi.org/10.1093/bmb/ldv047
12. Beck AT, Ward CH, Mendelson M et al (1961) An inventory for measuring depression. Arch Gen Psychiatry 4:561–571
13. Fries JF, Spitz P, Kraines RG et al (1980) Measurement of patient outcome in arthritis. Arthritis Rheum 23:137–145. https://doi.org/10.1002/art.1780230202

14. Jeon JH, Jung YJ, Lee JY et al (2012) The effect of extracorporeal shock wave therapy on myofascial pain syndrome. Ann Rehabil Med 36(5):665–674. https://doi.org/10.5535/arm.2012.36.5.665
15. Ji HM, Kim HJ, Han SJ (2012) Extracorporeal shock wave therapy in myofascial pain syndrome of upper trapezius. Ann Rehabil Med 36:675–680. https://doi.org/10.5535/arm.2012.36.5.675
16. Iuamoto LR, Hsing WT (2025) Penetration depth and tissue interaction of focused extracorporeal shock waves: an. In-vitro Invest Cureus 17(3):e80205. https://doi.org/10.7759/cureus.80205
17. Ozen S, Guzel S, Senlikci HB et al (2023) Efficacy of ultrasound versus short wave diathermy in the treatment of chronic low back pain in patients with lumbar disk herniation: a prospective randomized control study. BMC Sports Sci Med Rehabil 15:157. https://doi.org/10.1186/s13102-023-00769-2
18. Wu T, Li S, Ren J et al (2022) Efficacy of extracorporeal shock waves in the treatment of myofascial pain syndrome: a systematic review and meta-analysis of controlled clinical studies. Ann Transl Med 10:165. https://doi.org/10.21037/atm-22-295
19. De la Corte-Rodríguez H, Román-Belmonte JM, Rodríguez-Damiani BA et al (2023) Extracorporeal shock wave therapy for the treatment of musculoskeletal pain: a narrative review. Healthcare 11:2830. https://doi.org/10.3390/healthcare11212830
20. Ryskalin L, Morucci G, Natale G et al (2022) Molecular mechanisms underlying the pain-relieving effects of extracorporeal shock wave therapy: a focus on fascia nociceptors. Life 12(5):743. https://doi.org/10.3390/life12050743
21. Candeniz Ş, Çitaker S, Maraş G et al (2023) Comparison of the effectiveness of instrument-assisted soft tissue mobilization and extracorporeal shock wave therapy in myofascial pain syndrome. Turk J Med Sci 53(6):1825–1839. https://doi.org/10.55730/1300-0144.5753
22. Scaturro D, Migliorino D, Lauricella L (2024) Extracorporeal shockwave treatment vs. mesotherapy in the treatment of myofascial syndromes: a clinical trial. Front Med 11:1388922. https://doi.org/10.3389/fmed.2024.1388922
23. Yun PH, DeLuca S, Robinson D et al (2021) Radial versus combined shockwave therapy in the management of proximal hamstring tendinopathy: similar functional outcomes in run- Ning cohort. Muscle Ligaments Tendons J 11:742–748. https://doi.org/10.32098/mltj.04.2021.18
24. Şah V (2022) The short-term efficacy of large-focused and controlled-unfocused (radial) extracorporeal shock wave therapies in the treatment of hip osteoarthritis. J Pers Med 13:48. https://doi.org/10.3390/jpm13010048
25. Hsu SL, Cheng JH, Wang CJ et al (2017) Extracorporeal shockwave therapy enhances expression of Pdia-3 which is a key factor of the 1α,25-dihydroxyvitamin D 3 rapid membrane signaling pathway in treatment of early osteoarthritis of the knee. Int J Med Sci 14:1220–1230. https://doi.org/10.7150/ijms.20303
26. Tezen Ö, Bilir EE, Arslan HB et al (2025) Investigation of the effectiveness of extracorporeal shock wave therapy in patients diagnosed with plantar fasciitis: comparison of radial and focus applications. J Foot Ankle Surg 64:36–41. https://doi.org/10.1053/j.jfas.2024.08.012
27. Şah V, Kaplan Ş, Özkan S et al (2023) Comparison between radial and focused types of extracorporeal shock-wave therapy in plantar calcaneal spur: A randomized sham-controlled trial. Phys Sportsmed 51:82–87. https://doi.org/10.1080/00913847.2022.2091413
28. Lohrer H, Nauck T, Dorn-Lange NV et al (2010) Comparison of radial versus focused extracorporeal shock waves in plantar fasciitis using functional measures. Foot Ankle Int 31:1–9. https://doi.org/10.1002/art.1780230202
29. Castro Sánchez AM, García López H, Fernández Sánchez M et al (2019) Improvement in clinical outcomes after dry needling versus myofascial release on pain pressure thresholds, quality of life, fatigue, pain intensity, quality of sleep, anxiety, and depression in patients with fibromyalgia syndrome. Disabil Rehabil 41:2235–2246. https://doi.org/10.1080/09638288.2018.1461259