ORIGINAL ARTICLE

Eastern Journal of Medicine

East J Med 26(1): 109-116, 2021
DOI: 10.5505/ejm.2021.06025

The Efficacies of Medicinal Leech Therapy and Platelet Rich Plasma Injection added to Muscle Stretching Exercises in the Treatment of Myofascial Pain Syndrome

Levent Ediz[1], Aydın Çağaç[2*], Veysel Delen[3]

[1]Van Yuzuncu Yil University Faculty of Medicine, Department of Physical Therapy and Rehabilitation, Van, Turkey
[2]Van Yuzuncu Yil University Faculty of Medicine, Department of Neurology, Van, Turkey
[3]Department of Physical Therapy and Rehabilitation, Van, Turkey

ABSTRACT

Myofascial pain syndrome is among the most common cause of physical disability and severe chronic muscle pain and affect millions of people worldwide. So far muscle stretching exercises and some therapeutic interventions have been recommended with various effects.

Sixty-six patients with myofascial pain syndrome due to trigger points in trapezius muscle were included in this study. Patients were divided randomly into 2 groups of 33 patients: group 1; medicinal leech therapy group, group 2; platelet rich plasma injection group. To the first group, 4 medicinal leech were applied to the trigger points 2 times in a 4 week interval. To the second group, a total of 2 ml platelet rich plasma was administered to each trigger point 2 times in a 4 week interval. All patients had also taught and given trapezius muscle stretching exercises for ten minutes as a daily diary schedule for 12 weeks.

At the end of the study there was a significant decrease in visual analogue scale scores in both groups, while a significant increase in pain threshold values in medicinal leech therapy group ($p<0.05$). Significant differences were found between groups in short form-36 pain, general health and vitality scores in favor of leech therapy group ($p <0.05$).

Although both methods were found effective in the treatment of myofascial pain syndrome, the clinical efficacy of medicinal leech therapy was greater than platelet rich plasma. Leech therapy seems to be an effective and reliable treatment option when added to muscle stretching exercises in myofascial pain syndrome.

Key Words: Myofascial pain syndrome, muscle stretching exercises, leech therapy, platelet rich plasma, treatment

Introduction

Myofascial pain syndrome (MPS) is characterized by pain and muscle spasms caused by trigger points in the muscles and/or facial tension bands, accompanied by tenderness, a limited range of motion, stiffness, fatigue, and sometimes autonomic dysfunction (abnormal sweating, lacrimation, dermal flushing, vasomotor symptoms, and body temperature changes) (1,2).

Previous studies reported that 30–50% of patients presenting with musculoskeletal complaints had symptoms associated with MPS. (3,4) This rate was reported to be as high as 85% in studies performed in chronic pain centers.3,4 The trigger point in a muscle with MPS is a constant nociceptive peripheral input source, leading to central and peripheral sensitization. Trigger points comprise focal points of about 2–5 mm in diameter located in the taut band of any skeletal muscle (3,5). A trigger point produces pain and a local twitch response during palpation and compression (3,5). Trigger points can be detected in a single skeleton muscle, as well as in more than one muscle at the same time (5).

According to the energy crisis theory proposed by Simons et al., (6,7) Calcium in the sarcoplasmic reticulum is released when muscle tissue is traumatized, which initiates uncontrolled physiological contractions. When these contractions continue for a long time, they cause the release of bradykinin, prostaglandin,

***Corresponding Author:** Aydın Çağaç, Van Yuzuncu Yil University Faculty of Medicine, Department of Neurology, Van, Turkey
E-mail: aydincagac@hotmail.com
ORCID ID: Levent Ediz: 0000-0002-2264-0151, **Aydın Çağaç:** 0000-0002-4476-0947, **Veysel Delen:** 0000-0002-8152-4628
Received: 10.08.2020, **Accepted:** 04.12.2020

potassium, serotonin, substance P, and leukotriene in muscle, resulting in local tenderness and pain. Subsequently, vasoconstriction occurs by reflex stimulation, and the blood flow in the muscle decreases significantly to prevent the resulting metabolic activity spreading to other regions. Thus, the amount of ATP in the muscle decreases, with the result that the energy requirements of the muscle cannot be met (6-9). For this reason, local physiological contractions turn into contractions resulting from the inability to meet energy needs of muscle. This leads to spontaneous metabolic activity and a vicious cycle, with increasing numbers of muscle spasms giving rise to local muscle sensitivity (6-9).

Many studies have reported positive results of a wide variety of treatment options for MPS. Such options include Tender Point (TP) injections with botulinum toxin or local anesthetics, dry needling, acupuncture, Transcutaneous Electrical Nerve Stimulation (TENS), biofeedback, spray (vapocoolant spray) and stretch exercises, antidepressants, NSAIDs, muscle relaxants, and other medications (4,10). Medicinal leech therapy was also proven to be an effective treatment option for some painful musculoskeletal conditions (11,12). Previous studies reported effective and long-lasting pain relief in many pain conditions after leech therapy (11,12). The pain relief properties in medicinal leech therapy are based on leech saliva, which increases vascularity and contains therapeutic ingredients with thrombolytic, anti-inflammatory, and anticoagulant effects (12,13). Leech saliva also has lymphatic and blood-circulation enhancing properties due to its vaso-relaxant components (12,13).

Platelet-rich plasma (PRP), a plasma component obtained by centrifuging whole blood, contains a higher concentration of platelets than that found in whole blood.14 The presence of numerous growth factors in PRP has led to the use of PRP injections as a treatment for various musculoskeletal diseases (14-16). The hyperphysiological concentration of platelets in PRP means it accelerates the healing process of tendons, ligaments, cartilage, and muscle injuries, as demonstrated in animal experiments and human studies (14-16). A number of studies attributed the therapeutic effect of PRP in musculoskeletal tissues to it inducing cell proliferation, collagen synthesis, and increased vascularity (14-16). Furthermore, studies showed that PRP in vitro and in animal studies had positive effects on gene expression, matrix synthesis, and vascularization in tendons and tendon cells (14-16).

Based on the energy crisis theory, theory of Simons et al., (6) As both medicinal leech therapy and PRP enhance vascularization and the microcirculation, we investigated the potential effectiveness of medicinal leech therapy and PRP injections as treatment methods for MPS.

Material and methods

Study Design: This study included 66 patients (females, n = 38; males, n =28) with MPS who applied to physical medicine and rehabilitation and rheumatology clinics in our university hospital, between September 2014 and March 2017. The university's ethics committee approved the study. The participants were informed about MPS, the study, the treatment to be applied, and methods of MPS prevention. The trial was performed in accordance with the Declaration of Helsinki, and written informed consent was obtained from all subjects prior to the study.

The patient's appointment form was taken from every included patient. A detailed anamnesis was obtained, and systemic examinations were performed. MPS was diagnosed according to the criteria defined by Travel and Simons and expanded by Rosen (6,7).

Inclusion and Exclusion Criteria: This lists the inclusion criteria; trapezoidal MPS, aged between 18 and 50 y, levels of acute phase reactions in the normal range, normal complete blood count, and normal liver and kidney function laboratory tests. The exclusion criteria were refusal to participate in the study; inflammatory rheumatic disease; fibromyalgia syndrome according to the American College of Rheumatology 1990 criteria injection site infection; invasive treatment or surgery in the last 6 mo; aged older than 50 y or younger than 18 y; any systemic chronic disease, bleeding diathesis, malignancy, or psychiatric illness; and use of antithrombotic drugs, heparin, low-molecule heparin, coumadin, and their derivatives in the last week.

Study Course: The current study was a 12-wk, prospective, single-blinded, randomized controlled study. The patients were randomly divided into two groups (n =33 in each group). Group 1 received medicinal leech therapy group, and group 2 received PRP injections. The patients were not given any analgesics other than paracetamol when necessary as an analgesic.

The PRP injection or medicinal leech therapy was repeated 4 wk after the first treatment session. An expert blinded to the treatment conducted the pre- assessment and post-treatment assessments.

The patients underwent clinical evaluations for four times. The evaluation times were as follows: 1) at baseline, 2) before the second treatment session (4 wk post-treatment), 3) 4 wk after the second treatment session (8 wk post-treatment), and 4) 8 wk after the second treatment session (12 wk post-treatment).

Medicinal Leech Therapy: Medicinal leeches (*Hirudo verbana*, 3–5 cm long) were purchased from Hirusan™, Samsun, Turkey. The trigger point in the trapezius muscle was identified and marked with a pen, and the skin was cleaned with a suitable antiseptic agent. As leeches are sensitive to odor, the skin was washed with pure water to eliminate any odor. Four sterile leeches were applied to the trigger point. The leeches were allowed to suck blood through the skin for 20 min. They were then removed from the skin by smelling alcohol to leech using a cotton swab soaked in alcohol. This procedure was repeated again 4 wk after the first application.

Platelet-rich Plasma (PRP) Injection: Platelet-rich plasma (PRP) was prepared from approximately 12 ml of cubital venous blood obtained from each patient and then centrifuged using an 9001:2008 ISO certified centrifuge in the the department's laboratory (Nuve™ NF800R, Ankara). Microscopic manual counting was performed to ensure that the absolute platelet count was at least 1 million platelets/cc. Under aseptic conditions, approximately 2 cc of the obtained autologous PRP fraction was injected using a 21-gauge injector, with 0.5 ml injected per trigger point. The 3 points surrounding the trigger point were also injected. This procedure was repeated 4 wk after the first application.

All patients were also taught trapezius muscle stretching exercises, which they were instructed to perform for 10 min each day and record this activity in a daily diary.

Evaluation of the Treatment Effectiveness: The primary outcome measures were pain, as assessed using a 10 cm visual analogue scale (VAS) and the pressure pain threshold on the trigger points, which as determined using algometric measurements. The secondary outcome measures were quality of life, which was evaluated using Short Form-36 and psychological status. The latter was assessed using the Beck depression scale.

In the VAS assessment, the patients were advised about the operation of the scale, with 0 denoting no pain, 5 signifying moderate pain, and 10 denoting the most severe pain. The patients were asked to mark their pain at rest and function on the 10-cm VAS line. This evaluation was conducted 4 times, as follows: VAS1, at baseline; VAS2, before the second treatment session (4 wk post-treatment); VAS3, 4 wk after the second treatment session (8 wk post-treatment); and VAS4, 8 wk after the second treatment session (12 wk post-treatment).

The pressure pain threshold of the trigger points was measured using a Digital Force Gauge™ sensor (model: SH-200), which consists of a 1-cm diameter metal pad at the tip, connected to a digital dial plate that can measure the pressure in kilograms (kg). Continuous pressure was applied by pressing the metal disk on the skin. The amount of applied pressure can be seen on the electronic screen through the metal piston. The applied pressure was increased in increments of approximately 1 kg/sec. The initial pressure at which the patient felt pain was recorded in kilograms (kg). The procedure was repeated 3 times at intervals of 60 sec to evaluate the mean pressure pain threshold (expressed in kilograms [kg]). The pressure pain threshold was evaluated 4 times: PT1, at baseline; PT2, before the second treatment session (4 wk post-treatment); PT3, 4 wk after the second treatment session (8 wk post-treatment); and PT4, 8 wk after the second treatment session (12 wk post-treatment).

SF-36, a 36-item short-form health survey, was used as a general quality of life scale. This form examines physical function, social function, role limitations due to physical problems, role limitations due to emotional problems, mental health, fitness, pain, and general health. In the SF-36 survey, items address positive, as well as negative, health status. For each dimension, the scores of the items are coded and converted into a scaled scale from 0 (worst health status) to 100 (best health status). The Short-form 36 survey was administered before the treatment (at baseline) and 8 wk after the second treatment session (12 wk post-treatment).

The Beck depression scale consists of 21 questions in total. This scale, which is organized as a questionnaire, requires patients to select the most appropriate statement. Each item consists of four statements, which are ranked using a 3-point scale based on the severity of depression, with 0 = I do not feel depressed, and 3 = I feel depressed most of the time. The highest score is 63. On this

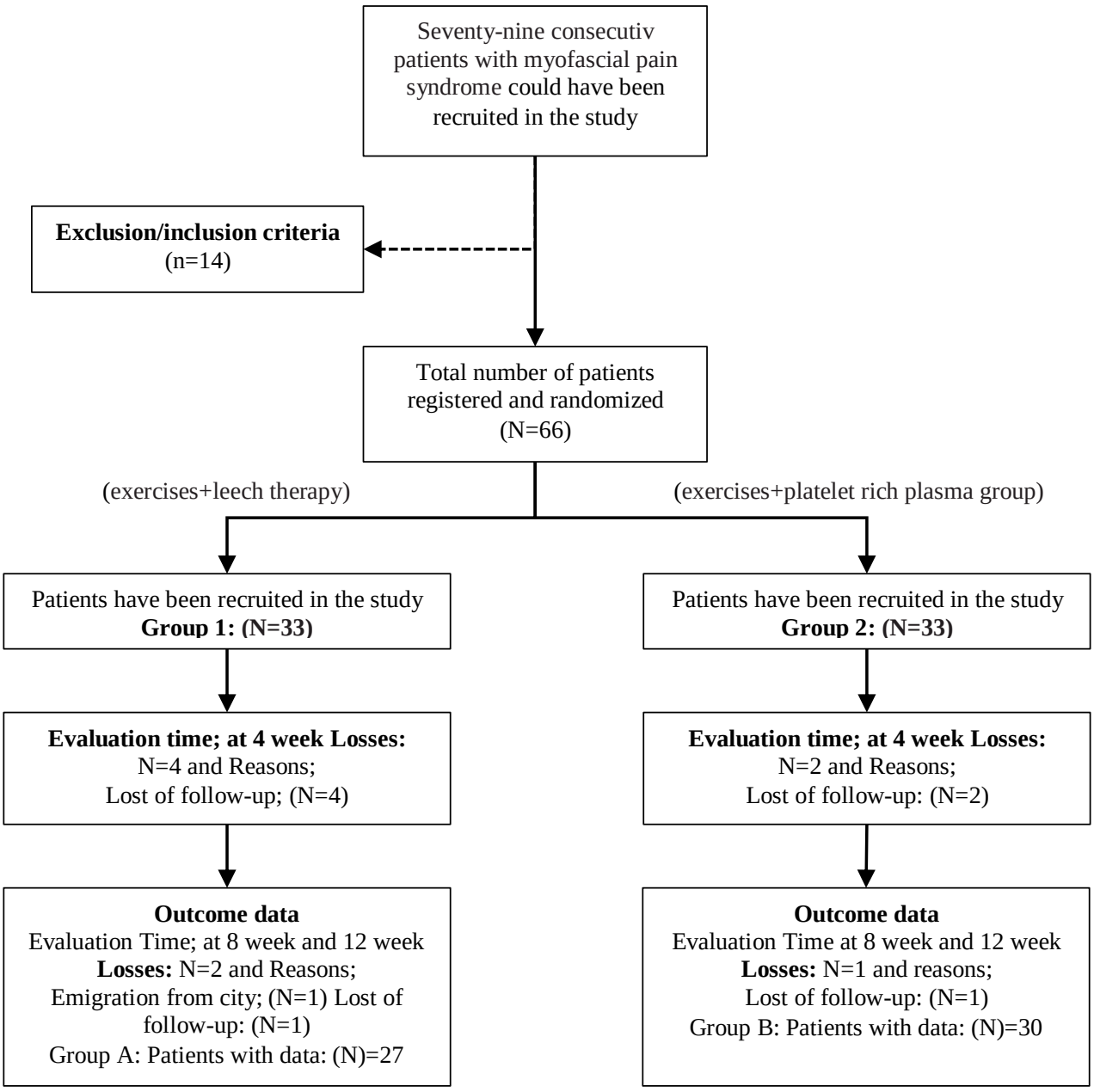

Fig. 1. Flow Chart of the Study

scale, 0-3 points denote no depression, 14-24 denote moderate depression, and more than 25 signify severe depression. This scale was administered before the treatment (at baseline) and 8 wk after the second treatment session (12 wk post-treatment).

Statistical Analysis: Statistical analyses were performed using SPSS, version 16.0 software (SPSS Inc., Chicago, IL, USA), and the significance level was $p < 0.05$. The Kolmogorov–Smirnov test was performed to test the normal distribution of the data. the Kolmogorov–Smirnov test showed that all the data had a normal distribution. A paired *t*-test or the Wilcoxon test was used to compare pre- and post-intervention values for each treatment within the same group. For data with a normal distribution, the student's *t*-test or the Mann–Whitney *U* test was performed to compare between-group differences in the measured parameters before and after the intervention. Analysis of variance was used to comparison of visual analogue scale (VAS) and pain threshold (PT) values within group. The Duncan multiple test was used to determine the significant differences in the analysis of variance.

Results

Demographic Data: Of the 66 included patients, 57 patients completed the study. Six patients in

Table 1. Demographic Properties of the Subjects Completed the Study

Demographic properties	Group 1 (Leech Therapy) Mean±SD	Grup 2 (PRP) Mean± SD
Age	32.53±6.93	33.11±7.18
Gender	N	N
Female	17	18
Male	10	12

Table 2. Comparison of Visual Analogue Scale (Vas) And Pain Treshold (Pt) Values Within Group

VAS (10 cm scale)	VAS 1 Mean±SD	VAS 2 Mean ±SD	VAS 3 Mean ±SD	VAS 4 Mean ±SD	P value
Group 1 (Leech therapy)	6.17±1.63	4.32±2.32	3.12±2.41	2.94±2.16	0.000*
Group 2 (PRP treatment)	6.01±1.56	4.48±2.01	4.46±1.93	4.23±2.22	0.026**
Pain Treshold (PT) (kg)	PT 1 Mean±SD	PT 2 Mean±SD	PT 3 Mean±SD	PT 4 Mean ±SD	P value
Group 1 (Leech Therapy)	3.35±0.86	3.42±0.94	3.98±1.02	4.12±1.62	0.007***
Group 2 (PRP group)	3.55±0.54	3.57±0.68	3.47±0.85	3.43±0.92	0.126 ϕ

p<0.05 significance* Statistically significant difference between VAS1 and VAS4 in group 1** Statistically significant difference between VAS1 and VAS4 in group 2 (PT: Pain Treshold)*** Statistically significant difference between PT1 and PT4 in group 1. ϕ Not statistically difference between PT1 and PT4 in group 2, **Evaluation times;** VAS1, PT1. At baseline VAS2, PT2. Before the second treatment session (at 4 week) VAS3, PT3. After 4 weeks from the second treatment session (at 8 week). VAS4, PT4. After 8 weeks from the second treatment session (at 12 week)

Table 3. Comparison of the differences between pre- and post-treatment values of Visual Analogue Scale (VAS) and pain threshold (PT) between groups

Groups	Group 1 Mean±SD	Group 2 Mean±SD	P value
VAS 1-VAS 2	1.83±1.78	1.06±1.95	0.326
VAS 1-VAS 3	2.92±1.89	1.78±2.06	0.024*
VAS 1-VAS 4	3.03±1.74	1.81±2.17	0.018*
PT 2-PT 1	0.13±0.75	0.09±0.47	0.217
PT 3-PT 1	0.56±0.88	-0.10±0.41	0.001*
PT 4-PT 1	0.63±1.13	-0.14±0.39	0.001*

**p<0.05 significance* Evaluation times; VAS1, PT1. At baseline VAS2, PT2. Before the second treatment session (at 4 week) VAS3, PT3. After 4 weeks from the second treatment session (at 8 week). VAS4, PT4. After 8 weeks from the second treatment session (at 12 week).

the medicinal leech therapy and 3 patients in the PRP group were lost to follow-up (Fig. 1, Table 1). There was no a significant between-group difference in the age or gender of the patients ($p > 0.05$).

Side Effects: Only minor transient local dermal allergic reactions lasting up to 10 d were observed in 8 patients in group 1 (medicinal leech therapy group). Minor bleeding after leech therapy continued for up to 12 h in 13 patients. No dermal infections due to the PRP injections or medicinal leech therapy were observed. No patient was excluded from the study because of side effects.

Evaluation of Treatment Efficacy: The VAS values (VAS4 and VAS1) were significantly improved at the end of the study as compared with the baseline values in both groups according to Duncan multiple comparison test ($p < 0.05$) (Table 2). There was no statistically significant between-group difference in the VAS values at the 4 wk evaluation as compared with the baseline values ($p > 0.05$) (Table 3). However, there was a statistically significant between-group difference in the VAS values 8 and 12 wk post-treatment, in favor of group 1 (medicinal leech therapy group) each time ($p < 0.01$) (Table 3).

At the end of the study, there was a significant increase in the pain threshold values in group 1

Table 4. Comparison of the Beck depression scale and SF-36 values within group

Scale		No of Group	Before treatment	After treatment*	P value
Beck depression scale		Group 1 (Mean±SD)	10.94±6.78	9.46±6.73	0.136
		Group 2 (Mean±SD)	11.13±7.04	10.08±6.64	0.364
SF-36 Parameters	Physical function	Group 1 (Mean±SD)	71.32±24.14	72.66±22.32	0,342
		Group 2 (Mean±SD)	69.88±21.04	70.24±23.34	0.464
	Physical role restriction	Group 1 (Mean±SD)	49.75±36.87	52.65±32.43	0.256
		Group 2 (Mean±SD)	50.66±28.79	51.08±30.62	0.682
	Pain	Group 1 (Mean±SD)	38.94±23.73	59.65±24.64	0.000**
		Group 2 (Mean±SD)	39.02±22.13	50.72±19.24	0.032**
	General health	Group 1 (Mean±SD)	52.56±18.67	60.84±17.29	0.028**
		Group 2 (Mean±SD)	51.95±17.45	54.43±18.64	0.642
	Vitality	Group 1 (Mean±SD)	48.37±19.18	54.47±18.31	0.044**
		Group 2 (Mean±SD)	47.64±20.06	50.57±18.72	0.536
	Social function	Group 1 (Mean±SD)	60.42±22.47	69.89±21.85	0.027**
		Group 2 (Mean±SD)	61.91±22.76	65.69±22.77	0.367
	Emotional role restriction	Group 1 (Mean±SD)	42.54±33.72	46.53±32.84	0.258
		Group 2 (Mean±SD)	41.43±31.34	45.35±33.11	0.435
	Mental health	Group 1 (Mean±SD)	55.73±17.12	62.76±15.83	0.028**
		Group 2 (Mean±SD)	56.42±15.48	58.86±16.52	0.693

*After 8 weeks from 2nd treatment session (at 12 week), ** p<0.05 significance

Table 5. Comparison of pre- and post-treatment values (at 12 week) data change of SF 36 parameters between groups

SF 36 parameters	Group 1 (Medicinal Leech Therapy) (Mean±SD)	Group 2 (PRP treatment group) (Mean±SD)	P value
Physical function	1.07±17.04	0.63±14.58	0.264
Physical role restriction	3.76±19.13	2.46±17.54	0.626
Pain	20.84±19.63	12.71±15.88	0.024*
General health	8.18±12.64	3.42±13.28	0.038*
Vitality	5.56±15.64	3.06±17.15	0.048*
Social function	8.17±21.24	5.02±26.17	0.442
Emotional role restriction	4.82±31.56	4.29±29.25	0.873
Mental health	6.06±14.21	3.22±17.65	0.216

*p<0.05 significance

(medicinal leech therapy group). There was no statistically significant difference between the groups in the increase in pain threshold values at the 4 wk evaluation as compared with the baseline values according to Duncan multiple comparison test ($p > 0.05$) (Table 2). However, there was a statistically significant difference between-group difference in the increase in the pain threshold values at the 8 and 12 wk post-treatment, in favor of group 1 (medicinal leech therapy group) ($p < 0.05$) (Table 3). Although the Beck depression scale scores decreased at the 12 k evaluation in both groups, the finding was not statistically significant ($p > 0.05$) (Table 4).

At the 12 wk evaluation, there were statistically significant improvements in SF-36 pain, general health, vitality, social function, and mental health items in group 1 (medicinal leech therapy group) as compared with the baseline ($p < 0.05$) (Table 4), whereas only the pain item on SF-36 improved significantly in group 2 (PRP injection group) ($p < 0.05$) (Table 4). As compared with the baseline, at the 12 wk evaluation, there were statistically significant between-group differences in SF-36 pain, general health, and vitality scores, in favor of group 1 (leech therapy group) ($p < 0.05$) (Table 5).

Discussion

No other published studies appear to have assessed the efficacy of medicinal leech therapy and PRP injections as treatments for MPS. The findings of the current study confirm that both medicinal leech therapy and PRP injection are effective treatments for MPS. In the present study, the clinical efficacy of medicinal leech therapy was better than that of PRP. This finding suggest that medicinal leech therapy may be a new, effective, fast and reliable treatment option for MPS because its therapeutic action comprises almost all clinical aspects of MPS. The reduction in pain after the PRP injections into the trigger points also suggests that PRP therapy is effective for pain relief in MPS.

Myofascial pain syndrome (MPS) is among the most common causes of physical disability and severe chronic muscle pain and affects millions of people worldwide.3 It is characterized by extremely tender myofascial trigger points (MTPs) and causes motor, sensory, and autonomic symptoms (3,9). Direct trauma or muscle overuse and/or overload during recreational, sports, or occupational activities that involve maximal or submaximal concentric or eccentric contraction or sustained or repetitive low-level contractions can lead to the development of MTP. A muscle energy crisis occurs when muscle use exceeds muscle energy availability (6). Muscle healing in MPS is a difficult and complex process, as the cycle of pain, local physiological contractions, spontaneous metabolic activity, and energy crisis must be broken for restoration of muscle function (4).

Medicinal leech therapy has been used since ancient times as a treatment for a variety of diseases, most of which had pain symptoms (12). In the current study, the VAS scores of the patients with MPS decreased significantly, and the pain threshold values increased significantly in the medicinal leech therapy group. Compared to the baseline, at the end of the study, there were statistically significant between-group differences in SF-36 pain, general health, and vitality scores, in favor of the medicinal leech therapy group. Thus far, medicinal leech therapy has been used successfully in the treatment of flap surgery (skin grafting), extremity vein diseases, and various musculoskeletal diseases, such as epicondylitis, osteoarthritis, and musculoskeletal pain. (18-21). Previous research showed that pain relief after leech therapy was effective, rapid, and long-lasting in many disorders (18-21). Its mode of action is linked to the amount of blood withdrawal and the injection of leech saliva into tissues (12). Leech saliva contains more than 100 analgesic and anti-inflammatory substances, as well as bioactive molecules with anti-coagulant, thrombolytic, vasodilatory, anti-edematous, and lymphatic and blood-circulation enhancing properties (11). These bioactive molecules may eliminate the muscle energy crisis and hypoxia in MTPs and resolve MPS by restoring the damaged microcirculatory function, vascular permeability, and bioenergetic status of the muscle.

Platelet-rich plasma (PRP) prepared from autologous blood contains various bioactive proteins and growth factors. Although extensive in vitro and in vivo trials have verified the efficacy and safety of PRP and growth factors in the muscle healing process, (16,17) no studies have focused on its effects on MPS. The muscle recovery process in MPS may be modulated by the bioactive proteins and growth factors in PRP activating or ameliorating the process of muscle repair. To date, approximately 300 different bioactive molecules have been found in platelet (PLT) granules (22), Many bioactive molecules in PLT granules may play a role in muscle regeneration.23 These include angiogenic factors, such as angiogenin and vascular endothelial growth factor, and hemostatic factors, such as fibrinogen, Von Willebrand factor, and factor V. Other bioactive molecules that may contribute to muscle regeneration include proteases, such as matrix metalloproteinases 2 and 9, as well as growth factors, such as IGF-1, IGF-2, PDGF, TGF-A, EGF, and FGF.23 Additional factors that may be involved in muscle regeneration include necrotic factors and many cytokines, such as TNFα and β, as well as serotonin, polyphosphates, calcium ions, and adenosine diphosphate, all of which are involved in PLT activation.23 All these bioactive molecules in PRP may break the energy crisis, pain, and contraction cycle seen in MPS and may play a role in the muscle regeneration process. Recent research showed that PRP decreased inflammation and promoted regeneration of injured skeletal muscle (16,17,23). In this study, as compared with the baseline values, both the VAS values and SF-36 pain scores were significantly improved in the PRP group at the end of the study. There is a need for in vivo and in vitro trials focusing on this topic.

Limitations of the Study: Our study has some limitations. First, it did not include a randomized placebo group. Second, MTP resolution in muscles was not confirmed by radiological US, MRI elastography, and neuromuscular

electromyography, or histopathological investigations.

This study is unique in that it assesses the efficacy of medicinal leech therapy and PRP injections in the treatment of MPS. The findings confirmed that both medicinal leech therapy and PRP injections were effective in MPS treatment, although the clinical efficacy of medicinal leech therapy was greater than that of PRP. As the therapeutic actions of medicinal leech therapy cover almost all clinical aspects of MPS, it may be a promising, effective, fast, and reliable treatment option. Still there is a need for randomized clinical trials that include radiological and histopathological investigations to draw firm conclusions about the effectiveness of medicinal leech therapy and PRP injections for MPS.

Conflict of Interest Disclosure Statement: No conflict of interest

References

1. Hong CZ, Simons DG. Pathophysiologic and electrophysiologic mechanisms of myofascial trigger points. Arch Phys Med Rehabil 1998; 79: 863-872.
2. Alvarez DJ, Rockwell PG. Trigger points: diagnosis and management. Am Fam Physician 2002; 65: 653-660.
3. Gerwin RD. Diagnosis of myofascial pain syndrome. Phys Med Rehabil Clin N Am 2014; 25: 341-355.
4. Borg-Stein J, Iaccarino MA. Myofascial pain syndrome treatments. Phys Med Rehabil Clin N Am 2014; 25: 357-374.
5. 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: 259-266.
6. Simons DG. New views of myofascial trigger points: etiology and diagnosis. Arch Phys Med Rehabil 2008; 89: 157-159.
7. Travell JG, Simons DG. Myofascial Pain and Dysfunction. The Trigger Point Manual. Vol 1, upper half of body. Baltimore:Williams and Wilkins 1992; 5-201.
8. Borg-Stein J, Simons DG. Myofascial pain. Arch Phys Med Rehabil 2002; 83: 40-47.
9. Shah JP, Thaker N, Heimur J, Aredo JV, Sikdar S, Gerber L. Myofascial Trigger Points Then and Now: A Historical and Scientific Perspective. PM R 2015; 7: 746-761.
10. Desai MJ, Saini V, Saini S. Myofascial pain syndrome: a treatment review. Pain Ther 2013; 2: 21-36.
11. Sig AK, Guney M, Uskudar Guclu A, Ozmen E. Medicinal leech therapy-an overall perspective. Integr Med Res 2017; 6: 337-343.
12. Koeppen D, Aurich M, Rampp T. Medicinal leech therapy in pain syndromes: a narrative review. Wien Med Wochenschr 2014; 164: 95-102.
13. Gödekmerdan A, Arusan S, Bayar B, Sağlam N. Medicinal leeches and hirudotherapy. Turkiye Parazitol Derg 2011; 35: 234-239.
14. Scully D, Naseem KM, Matsakas A. Platelet biology in regenerative medicine of skeletal muscle. Acta Physiol (Oxf) 2018; 6: 13071.
15. Marques LF, Stessuk T, Camargo IC, Sabeh Junior N, dos Santos L, Ribeiro-Paes JT. Platelets. Platelet-rich plasma (PRP): methodological aspects and clinical applications 2015; 26: 101-113.
16. Hamid MS, Yusof A, Mohamed Ali MR. Platelet-rich plasma (PRP) for acute muscle injury: a systematic review. PLoS One 2014; 28; 9: e90538.
17. Tsai WC, Yu TY, Chang GJ, Lin LP, Lin MS, Pang JS. Platelet-Rich Plasma Releasate Promotes Regeneration and Decreases Inflammation and Apoptosis of Injured Skeletal Muscle. Am J Sports Med 2018; 1: 363546518771076.
18. Herlin C, Bertheuil N, Bekara F, Boissiere F, Sinna R, Chaput B. Leech therapy in flap salvage: systematic review and practical recommendations. Ann Chir Plast Esthet 2016; 62: 1-13.
19. Abdualkader AM, Ghawi AM, Alaama M, Awang M, Merzouk A. Leech therapeutic applications. Indian J Pharm Sci 2013; 75: 127-137.
20. Abdullah S, Dar LM, Rashid A, Tewari A. Hirudotherapy/leech therapy: applications and indications in surgery. Arch Clin Exp Surg 2012; 1: 172-180.
21. Das BK. An overview on hirudotherapy/leech therapy. Ind Res J Pharm Sci 2014; 1: 33-45.
22. Coppinger JA, Cagney G, Toomey S, Kislinger T, Belton O, McRedmond JP, et al. Characterization of the proteins released from activated platelets leads to localization of novel platelet proteins in human atherosclerotic lesions. Blood 2004; 103: 2096Y104.
23. Scully D, Naseem KM, Matsakas A. Platelet biology in regenerative medicine of skeletal muscle. Acta Physiol (Oxf) 2018; 6: e13071.