International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

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Effect Low Level Laser Therapy versus Extracorporeal Shockwave Therapy in the management of pain and function of Cervical Myofascial Pain Syndrome patients: a Randomized-Comparative Study

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Abstract

Myofascial pain syndrome (MPS) is one of the most common causes of chronic neck pain. Both, Low level laser therapy (LLLT) and extracorporeal shockwave therapy (ESWT), are physical therapy modalities that can be used to reduce pain and improve function of patients with MPS. The aim of this randomized comparative trial was to compare the immediate effects of LLLT versus ESWT on pain intensity, pressure pain threshold (PPT) and cervical range of motion (ROM) in cervical MPS patients. Twenty-four adults diagnosed with cervical MPS according to Travell and Simons' criteria were randomized into 2 equal groups; Group A: received LLLT on upper trapezius trigger points with conventional physical therapy, while Group B: received ESWT on upper trapezius trigger points with conventional physical therapy. Measured outcomes were pain, PPT and cervical flexion and extension ROM, using Numerical Rating Scale (NRS), Algometer and Goniometer, respectively. Outcomes were measured pre-treatment and immediately post-treatment. A p-value less than or equal to 0.05 were considered statistically significant. A significant improvement in the pain, PPT and cervical flexion and extension were observed in all groups after treatment, compared to the pre-treatment values ($p<0.05$). However, there was no significant difference between the study groups post treatment for all measured outcomes. Low-level laser therapy and extracorporeal shockwave therapy have similar effect on pain, PPT and ROM in patients with cervical MPS with no significant difference between them.

Keywords: Myofascial pain syndrome, Trigger point, Laser therapy, LLLT, Shockwave therapy, ESWT.

Full length article **Corresponding Author*, e-mail: *ahmed_zahreldin@stud.cu.edu.eg*

1. Introduction

Myofascial pain syndrome (MPS) is considered a one of the most common chronic, nonarticular, musculoskeletal causes of neck pain, associated with specific trigger points (TrPs), most commonly in the upper trapezius and infraspinatus muscles [1]. Trigger point is a tender point within a tight muscular band, stimulated by excessive pressure, tension, or contraction and causes referred pain [2]. Myofascial trigger points are caused by the excessive discharge of acetylcholine into the neuromuscular junction that causes abnormal shortening of muscle leading to localized ischemia and increase the metabolism of the shortened area that eventually lead to energy crisis with the secretion of pain inducing substances such as prostaglandin, substance P, bradykinin, K+, serotonin and histamine [3]. Different approaches such as massage, acupuncture, electro-thermotherapy, local injections, and exercise programs are commonly used in the treatment of MPS [4].

Low level laser therapy (LLLT) is a light source treatment that used to reduce inflammation and edema; treat pain and neurological disorders; and to promote healing of wounds and deeper tissues [5]. In LLLT, the photons are absorbed by the mitochondria that stimulate more ATP production and low levels of reactive oxygen species, which then activates transcription factors [6]. Extracorporeal shockwave therapy (ESWT) has been introduced efficiently as a treatment modality in musculoskeletal disorders. Shock waves are not only sound waves; they also have impacts on tissue regeneration and pain management through cavitation bubbles, acoustic microstreaming, and hypervascularity that can directly affect tissue calcifications, thereby modulating cell activity [7]. Both LLLT and ESWT are considered relatively new physical therapy modalities that can improve pain and consequently improve the function of many musculoskeletal conditions. Limited studies have compared the effect of both interventions on patient of cervical MPS with no strong evidence to support the use of any of the two modalities, LLLT or ESWT, and recommended performing studies with higher quality to confirm these findings [8-9]. Therefore, the aim of this randomized comparative trial was to compare the immediate effects of LLLT versus ESWT on cervical MPS patients on pain, pressure pain threshold (PPT) and cervical range of motion (ROM).

2. Materials and Methods

2.1. Study design

This was a randomized clinical trial, applying the Consolidated Standards of Reporting Trials guidelines (CONSORT) [10]. Randomization sequence was generated using a block randomization website, with bock size= 6 to assign the participants in two equal parallel groups with allocation ratio 1:1 [11]. Randomization and allocation were done by an independent person, not involved in the study. After each participant fulfilled the eligibility criteria and consented to participate; they were assigned to one of these two groups, as shown in (Figure 1).

2.1.1. Group A

Laser therapy group, which received LLLT in addition to the conventional physical therapy program.

2.1.2. Group B

Shockwave therapy group, which received ESWT in addition to the conventional physical therapy program.

The participants, investigator and assessor were not blinded, because of the nature of the interventions. The principal investigator performed the interventions and assessment.

2.2. Study population

Twenty-four cervical myofascial pain syndrome male patients participated in this study. They were selected from a private physical therapy clinic. Participants were selected according to the following inclusion criteria:

1. Adults; over 18 years old.
2. Diagnosed with MPS according to Travell and Simons' criteria. Five major criteria and at least one minor criterion is required for diagnosis. Major criteria are:
   i. regional pain
   ii. referred pain
   iii. a taut band
   iv. tender point in the taut band
   v. restricted range of motion.

Minor criteria are:

   i. pain complaints reproduced by pressure on the tender spot
   ii. a local twitch response
   iii. relief of pain with injection, or by stretching [12].

3. Have active and palpable TrPs that cause pain and/or referred pain by pressure, on a single side or both sides of the upper trapezius muscle, with pain duration less than one week.

Exclusion criteria were; fractures or open wound, other neuro-musculo-skeletal disorders causes neck pain such as fibromyalgia, cervical disc lesion, radiculopathy or myelopathy, other systemic diseases, previous surgical procedures, or recent trigger point injection.

2.3. Study interventions

2.3.1. Low Level Laser Therapy

Laser therapy group received LLLT on the affected side of neck and shoulder. It was performed using LLLT device (INTELECT® NEO THERAPY SYSTEM, 6001-INT, Chattanooga) with the parameters shown in (Table 1). After eye protection, skin cleaning and stretching; laser therapy was done by placing the probe to the affected trapezius muscle with little pressure over the trigger points.

2.3.2. Extracorporeal Shockwave Therapy

Shockwave therapy group received ESWT for the affected side of neck and shoulder. It was applied using ESWT device (MASTERPULS® Shockwave Therapy, Shockwave Canada Inc.) with the parameters shown in (Table 2). A gel was applied to the patients affected neck and shoulder, then the shockwave therapy was done by orienting the probe to the trigger points and along the upper trapezius muscle from origin to insertion.

2.3.3. Conventional Physical Therapy

All participants in Group A and B received conventional physical therapy program for neck and shoulder pain lasted for 30 minutes, which included; hot packs, stretching and isometric exercises, ultrasound therapy and transcutaneous electrical nerve stimulation (TENS).

2.4. Measured outcomes

All participants had pre-treatment and post-treatment evaluation, to determine the immediate effects of the laser and shockwave therapies. Measured outcomes were pain intensity, pressure pain threshold and range of motion.

2.4.1. Pain

Pain was assessed using Numerical Rating Scale (NRS) which is 11-point numeric scale ranges from 0 (representing no pain) to 10 (representing worst pain imaginable) and the patients were asked to report the average pain intensity.

2.4.2. Pressure pain threshold (PPT)

Pressure pain threshold on the trigger point, which is the minimum pressure (kg/cm^2) that induces pain or discomfort, and tenderness in the upper trapezius muscle was measured with WANGER force dial. The participants sat upright in a chair, with the back fully supported, their feet flat on the floor, and their hands resting on their legs. A force gauge fitted with a rubber disk with a surface area of 1 cm^2 was placed perpendicular to the fibers of the upper trapezius muscle, exactly on the myofascial trigger points, and gradual compression at a rate of about 0.5 kg/cm^2/s was applied. Pressure was increased continuously up to the intensity at which the participant reported pain, and this amount of pressure was recorded in kg/cm^2. The measurement was taken three times at an interval of 60 seconds and the mean average value was recorded.

2.4.3. Cervical range of motion

The active ROM of cervical joint flexion and extension were measured using Goniometer. The participants were sitting with thoracic and lumbar spine well supported by the back of the chair, and shoulder girdle was stabilized. Goniometer was over the external auditory meatus, the stationary arm aligned perpendicular to the floor and the moving arm to the base of the nose. The participants were instructed to perform cervical flexion or extension with the maximum active range of motion and the readings of the goniometer were recorded at each extreme of the motion. The measurement was taken three times and the mean average value was recorded.

2.5. Ethical considerations

This study was conducted under the guidelines and the approval of Ethics Committee of the National Institute of Laser Enhanced Sciences (NILES), Cairo University. The study protocol was explained to all participants before their participation and they signed a consent form authorizing their participation.

2.6. Statistical analysis

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Descriptive analysis (mean ± standard deviation) using histograms with the normal distribution curve and Normality test of data using Shapiro-Wilk test showed that the data pain, PPT and ROM values in all groups were normally distributed and not violates the parametric assumption. Paired-Samples T Test was used to compare the variables at different measuring periods (within group). While, between subjects' factor which had two levels (Laser therapy and Shockwave therapy groups) was assessed using Independent-Samples T Test. Alpha level was 0.05. Analysis was done as if each subject received the treatment or control condition as planned.

3. Results and discussion

The mean and standard deviation of subjects' age in both groups were 37.42±13.58 and 36.92±9.86 for Laser therapy and shockwave therapy groups, respectively with no statistically difference between groups at baseline (p> 0.05), as shown in (Table 3). In the Laser therapy group; MPS were 3 on the right and 9 on left side while in Shockwave therapy group; MPS were 6 on the right and 6 on left side. Within group comparison of pain intensity, PPT and cervical flexion and extension ROM showed statistically significant within each group post treatment (P < 0. 001) (Table 3). Between groups comparison showed no statistically significant difference between mean values of pain intensity, PPT and cervical flexion and extension ROM measurement between the study groups before treatment and after treatment (P = 0.916, 0.287, 0.097, 0.607) for each measured outcome, respectively (Table 3). This study aimed to compare the immediate effects of LLLT and ESWT on active MPS of the upper trapezius muscle, and found that both laser and shockwave therapy are significantly effective in improving pain, PPT and cervical ROM, with no significant differences between both therapies. According to our search, this was the first study comparing the immediate effect of LLLT and ESWT on upper trapezius muscle MPS.

Laser therapy has immediate analgesic effects as it decreases mitochondrial membrane potential (MMP) in the dorsal root ganglion neurons that causes reduction in the level of ATP production leading to neural blockage [13]. While, extracorporeal shock wave has immediate direct analgesic effect resulted from hyperstimulation and transient dysfunction of synapse transmission, with selective destruction of nonmyelinated fibers and reducing level of substance P in the target tissue and dorsal root ganglia [14]. This could explain the immediate significant effect of both interventions on MPS, without significant difference between them, according to our findings. In line with our results, a previous study concluded that laser therapy and shock wave therapy have similar effects on long-term improvement of neck disability index (NDI), shoulder pain and disability index (SPADI) and pain score assessed with visual analogue scale (VAS), in addition to the short term effect on SPADI in patients with MPS [15]. However, they found that laser therapy provided faster effect in the short term on VAS and NDI after applying 100 mW, 6 J/cm^2 LLLT, for 3 min once daily for 2 weeks (10 session) in addition to stretching exercises and medication [15]. Effects of LLLT could be rely on the anti-inflammatory and tissue-repair promoting effects [13].

Low level laser therapy activates photons transmission that in turn activates cellular activities. They can initiate the production of enzymes, activate mitochondria, improve vasodilatation and lymphatic drainage, synthesize ATP and enhance collagen formation substances to minimize scar formation [16]. It also causes reversible varicosities or beading along the axons, which in turn cause mitochondria to pile up where the cytoskeleton is disrupted. It also decreases the release of pro inflammatory neuropeptides (i.e. substance P and CGRP) [17]. Laser therapy can improve tissue oxygenation by reducing spasm in muscle arterioles leading to the reduction of oxidative stress and muscle fatigue [18]. Therefore improvement of cervical ROM in patient with MPS could be attributed to the local effects of LLLT, improvement of local circulation and reduction of muscle fatigue, thus, enhance muscle flexibility and contraction [19]. On the other hand, Shockwave therapy demonstrated significantly better changes in pain tolerance, neck functionality, and quality of life, after applying one session/week for 3 weeks of ESWT; 1000 impulses in the region of the trigger point, 1.5 bar, 10 Hz, 0.25 mJ/mm^2, followed by 1000 impulses with 2 bar [20].

Moreover, four sessions of ESWT; 2000 impulses, 1.6 bar, 10 Hz, 0.38 mJ/mm^2 in addition to ischemic pressure to the rotator cuff muscle, demonstrated significantly better changes in pain intensity level, pressure pain threshold, shoulder ROM [21]. This could be attributed to mechanical pressure effect of the ESWT that produces different tensile and compressive stresses on cells that relaxes tissues, accelerates capillary microcirculation and increases oxygen uptake. This can promote local blood circulation, increase lymphatic reflux, release local tissue adhesion, reduce muscle tension, thus, effectively relieve pain on long term [22]. The other effects of ESWT occur secondary to the ESWT pain relief effect, in addition to the improved perfusion, tissue recovery, ATP supplies to the blood stream around the trigger points, and altered pain signaling in ischemic tissues caused by calcium influx [23]. No evident explanation for these conflicting results in comparing the LLLT and ESWT. Different patients' characteristics, stage of MPS, used devices and regimens of the applied therapies, could be considered.

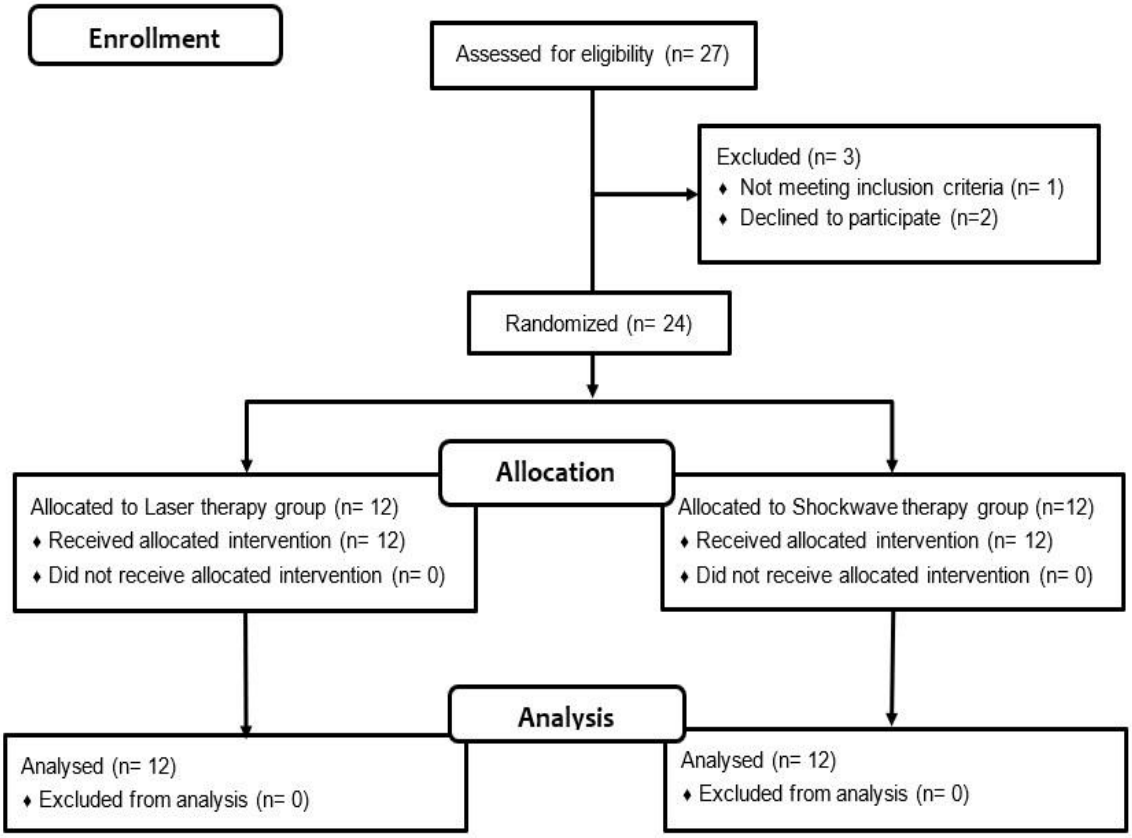

Figure 1: CONSORT flow chart.

Table 1: LLLT parameters.

Laser type	GaAlAs Diode, CW
Wavelength	850 nm
Treatment time per point	70 sec (total around 6 min)
Output power	100 mW
Energy density	8.9 J/cm^2
Spot size	0.5 cm^2
Points	on the trigger point (maximum 5 points)
Probe	Directly, stationary, perpendicular and slightly contacting the skin of participants during the treatment process

Table 2: ESWT parameters.

Impulses	2000
Treatment time	90 sec
Frequency	10 Hz
Intensity	2.5 bars
Points	Along the trapezius muscle and on the trigger point (maximum 10 points)
Probe	Perpendicular

Table 3: Comparison between (Mean±SD) values of outcome measured variables pre- and post-treatment within and between groups.

		Laser therapy Group (n= 12) Mean±SD	Shockwave therapy Group (n= 12) Mean±SD	P-value
Age	At Baseline	37.42±13.58	36.92±9.86	0.918
Pain	Before Treatment	5.92±2.15	6.50±1.38	0.437
	After Treatment	2.92±1.93	2.83±1.90	0.916
	P-value	< 0. 001	< 0. 001	
PPT	Before Treatment	57.50±17.77	47.50±27.01	0.112
	After Treatment	77.50±17.12	68.33±23.58	0.287
	P-value	< 0. 001	< 0. 001	
Flexion	Before Treatment	53.17±6.15	45.04±11.97	0.048
	After Treatment	57.67±6.39	51.46±10.64	0.097
	P-value	< 0. 001	< 0. 001	
Extension	Before Treatment	67.67 6.46	66.83 8.04	0.782
	After Treatment	72.17 6.96	73.58 6.36	0.607
	P-value	< 0. 001	< 0. 001	

Notes: * = significant at P<0.05.

4. Limitations and recommendations

The limitations of the present study included the small sample size and male only participants in the study. Besides, the needs to compare both interventions to placebo and control groups to determine the effectiveness of the interventions, overcome the placebo effects and serve as a baseline. In addition, no evidence of standardized LLLT and ESWT regimens for patients of cervical MPS was available. Therefore, larger randomized placebo-controlled trials that comparing laser and shockwave as a stand-alone therapy are recommended. In addition, comparing different treatment regimens with each other to reach the most effective and appropriate protocol. Furthermore, using more objective assessment of the outcomes is needed.

5. Conclusions

Low-level laser therapy and extracorporeal shockwave therapy have similar immediate effects on pain relief, pressure pain threshold reduction and cervical ROM improvement among the patients of cervical myofascial pain syndrome, with no significant difference between them. Both therapies are considered as alternative treatment therapies and their superiority should be confirmed by additional randomized controlled trials for longer duration.

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