

Efficacy of Low Level Laser Therapy in Myofascial Pain Syndrome: An Algometric and Thermographic Evaluation

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Background and objectives: The efficacy of low level laser therapy (LLLT) in myofascial pain syndrome (MPS) seems controversial. Our aim was to clarify the effect of LLLT in MPS by using algometry and thermography.

Study Design/Materials and Methods: Sixty-two patients with MPS having an active trigger point in the neck or upper back region were randomly divided into two equal groups according to therapy applied (group 1: LLLT + stretching exercises, group 2: stretching exercises alone). The outcome measures were pain measured with visual analogue scale (VAS), algometry on the trigger point, algometric difference, thermographic difference, and thermal asymmetry. Comparison was made within and between the groups pre- and post-therapeutically and 3 weeks after therapy.

Results: Mean pain values decreased more significantly in group 1 from baseline to 3 weeks follow up (7.54–3.06) while these values were 7.03–5.19 in group 2 ($P < 0.05$). Group comparisons revealed significant favorable differences in group 1 patients in terms of all other parameters at the first and the second evaluation post therapeutically ($P < 0.05$).

Conclusions: LLLT seemed to be beneficial for pain in MPS by using algometry and thermography. *Lasers Surg. Med.* 33:339–343, 2003. © 2003 Wiley-Liss, Inc.

Key words: algometry; low level laser therapy; myofascial pain syndrome; stretching exercise; thermal asymmetry; thermography; trigger point

INTRODUCTION

Myofascial pain syndrome (MPS) is characterized by pain originating from trigger points at muscles and fascias associated with muscle spasm, tenderness, motion restriction, fatigue, and sometimes autonomic dysfunction of the related region [1,2]. As the exact pathogenesis and healing mechanisms are not known, many empirical modalities have been used in the treatment of this syndrome [3].

Low level laser therapy (LLLT) has been safely used in the treatment of MPS with its analgesic, myorelaxant, tissue healing, and biostimulation effects [4–7]. The clinical results of LLLT in musculoskeletal pain and MPS seemed controversial, however, this can probably be explained by inappropriate application of various types of

laser energy in some trials that revealed no beneficial effect of LLLT [8].

In outcome studies about the efficacy of treatment modalities on MPS, pain related parameters, such as visual analogue scale (VAS) and pressure algometer (PA), have often been used [7,9]. Although infrared thermography was reported as a non-invasive and useful tool for diagnosis and treatment follow up of MPS, this method has not been widely used as an outcome measure. Some authors suggest that thermographic imaging typically demonstrate a focal hot spot on the area of active trigger point [10]. However, the specificity of hot spots to detect trigger points for diagnosis has still been debated. Although Fischer [11] suggested infrared thermography can be used for diagnosis and monitoring the treatment efficacy in the follow up period, Swerdlow and Dieter [12] observed that it is not highly specific for diagnosis.

The main aim of this study was to investigate whether LLLT has clinical therapeutic effect on MPS by using not only the usual pain parameters, but also thermographic evaluation as outcome measures.

MATERIALS AND METHODS

Patient Selection

Sixty-two patients, between 18 and 60-years-old, applied to our outpatient clinics with complaints of neck and upper back pain and had the diagnosis of MPS with only one active trigger point in either trapezius or levator scapulae muscles according to Travell–Simons criteria [1,13], were included in the study. Diagnosis was based on the presence of all five major criteria and at least one of the three minor criteria. The five major criteria taken into account were regional pain, reference pain pattern, palpable taut band, presence of trigger point and motion restriction, whereas the minor

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criteria were induction of pain with pression on trigger point, local twitch response and diminishing pain by the injection of the point with stretching of the muscle. Patients who had: (1) systemic, infectious, inflammatory, tumoral, cardiopulmoner, and psychiatric diseases that may conflict the clinical picture, (2) Kellgren stage 3 or 4 osteoarthritis of cervical spine or cervical disk hernia causing radiculopathy symptoms, (3) multiple active or latent trigger points were excluded from the study. The study attendants were informed about the study procedure and signed the informed consent prepared for this study.

The Group Design

The patients were randomly allocated into two equal groups consisting 31 patients in a simple systematic manner ($x + 1$). Group 1 was treated with LLLT and stretching exercise program specified for the muscles involved. On the other hand group 2 was treated with only the same muscle specific exercise program. The exercise regime was a daily home program consisted of gradual and slow stretching of the trapezius or levator scapulae muscles, that achieves the full range of motion under the pain onset limits, 10 times a day. This exercise period lasted 10 days. The instruction of the patients were performed by a blinded physiotherapist to the therapy applied.

Laser Application

The treatment period was 10 daily sessions. Endolaser™ 476 (Enraf-Nonius), a Ga-As-Al laser device which has the probe with 0.5 cm beam diameter and emitting laser beam with 780 nm wavelength was used. The maximum power output of the device was 10 mW. The energy intensity given to the trigger points was adjusted to be 5 J/cm² by applying a continuous 5 mW power output (50% of the maximum) for 3 minutes 16 seconds duration per trigger point in each session.

Outcome Evaluation

The evaluation of the patients was performed three times; before the treatment, at the end of the treatment, and 3 weeks after the treatment by a blinded physician to the therapy applied. The parameters evaluated were quantified by VAS, algometry, and thermography.

VAS measurement. The patients were instructed to choose the grade of their spontaneous pain intensity on a 10 points scale. Pain levels were labeled on a line in 10 categories. Ten points indicated unbearable pain and 0 point, no pain at all.

Algometric evaluation. Pressure algometer device which displays the pressure in units of kg and which has 1 cm diameter rubber probe on the tip of a piston was used. It was applied to the patient perpendicularly on the myofascial trigger point with increasing the pressure 1 kg per second. The pressure was stopped when the patient expressed that pain had started. The value of pressure was recorded as kg/cm². The two algometric parameters evaluated were the local algometric pressure value on the trigger point that elicited pain (algometry value) and the difference of local algometric value from the symmetrical

point which is on the opposite side of the body (algometric difference). The increase in the former parameter and the decrease in the latter were regarded as positive response to the treatment.

Thermographic evaluation. Infrared thermography device (Meditherm med 2000) consisting of a thermal camera, a computer and a monitor was used to detect thermal differences and their response to treatment on myofascial trigger points. Thermographic screening of the patients was performed before algometric assessment. The patients were warned not to have sun exposure, apply face or body lotion, drink alcohol or caffeine drinks, do severe exercises and activities on thermographic evaluation day. The patients waited upper body naked for 15 minutes in 21°C constant temperature before the thermographic screening. The images were captured at 100 cm distance from the back of the standing patient. Thermal activity of 1 cm² area on the central part of the trigger and the symmetrical point on the opposite side of the body were recorded in °C. A difference of at least 0.5°C between myofascial trigger point and its symmetrical point was considered as thermal asymmetry. We evaluated thermal difference between the points (thermographic difference) and the presence of thermal asymmetry.

Statistical Analysis

The statistical analysis was performed by SPSS program for Windows. The clinical improvement within the groups between the evaluations were compared by paired samples *t*-test. For the comparative evaluation of the groups, Student's *t*-test was performed when the distribution was normal. Mann-Whitney *U* test was performed only for the between-groups comparisons of algometric values at the first and second evaluations after therapy, as the distribution was not normal for this parameter. For the presence of thermal asymmetry, Pearson Chi-Square analysis was performed to assess the differences between the groups while Cochran Q and Mc Nemar tests were used to examine the changes within the groups. Significance was determined at $P < 0.05$.

RESULTS

Sixty-two patients were divided into two equal groups consisting of 31 patients in each, according the therapy applied. There were 22 female and 9 male patients in group 1, 24 female and 7 male patients in group 2 ($P > 0.05$). The mean age \pm SD of the first group was 37.3 \pm 10.1 while it was 34.2 \pm 10.2 in the second group showing a non-significant difference ($P > 0.05$). The baseline pain related and thermographic values were comparable between the groups ($P > 0.05$), (Table 1).

All five pain related and thermographic parameters (Fig. 1a,b) were observed to improve in group 1 patients in the first evaluation after therapy and this significant improvement persisted in the second evaluation 3 weeks after the treatment. However, only spontaneous pain and algometric value were found to improve in group 2 patients at the first and the second evaluation after therapy. In this group thermographic difference was observed to decrease

TABLE 1. Pain and Thermography Related Parameters in the Groups

Parameter	Group 1 (n = 31)	Group 2 (n = 31)	P-value (between group values)
Spontaneous pain (VAS)			
Before therapy	7.54 ± 1.0	7.03 ± 1.1	<i>P</i> > 0.05
After therapy	3.41 ± 2.0 ^a	5.77 ± 2.0 ^a	<i>P</i> < 0.001
Three weeks later	3.06 ± 1.7 ^b	5.19 ± 1.7 ^b	<i>P</i> < 0.001
Algometry value (kg/cm ²)			
Before therapy	2.61 ± 0.4	2.69 ± 0.4	<i>P</i> > 0.05
After therapy	3.79 ± 0.8 ^a	2.85 ± 0.4 ^a	<i>P</i> < 0.001
Three weeks later	3.96 ± 0.8 ^b	2.86 ± 0.2 ^b	<i>P</i> < 0.001
Algometric difference (kg/cm ²)			
Before therapy	1.94 ± 0.7	1.77 ± 0.6	<i>P</i> > 0.05
After therapy	0.77 ± 0.5 ^a	1.60 ± 0.7	<i>P</i> < 0.001
Three weeks later	0.66 ± 0.5 ^b	1.69 ± 0.5	<i>P</i> < 0.001
Thermographic difference (°C)			
Before therapy	0.80 ± 0.5	0.71 ± 0.5	<i>P</i> > 0.05
After therapy	0.18 ± 0.4 ^a	0.53 ± 0.5	<i>P</i> < 0.01
Three weeks later	0.18 ± 0.2 ^b	0.42 ± 0.3 ^b	<i>P</i> < 0.01
Presence of thermal asymmetry (n)			
Before therapy	20	17	<i>P</i> > 0.05
After therapy	6 ^a	13	<i>P</i> < 0.001
Three weeks later	3 ^b	12	<i>P</i> < 0.001

Data presented are mean ± SD except for presence of thermal asymmetry which shows the number of cases.

VAS, visual analog scale; °C, celcius centigrade.

^aSignificant change between the baseline and after treatment values within the groups (*P* < 0.05).

^bSignificant change between the baseline and 3 weeks later values within the groups (*P* < 0.05).

only at the second evaluation 3 weeks after the therapy (Table 1).

The group comparisons revealed significant favorable differences in group 1 patients when compared with the patients in group 2 in terms of all five parameters at the first and the second evaluation days after therapy (Table 1).

DISCUSSION

Myofascial pain syndrome is a common source of discomfort and disability for many patients, however, it is generally ignored or misdiagnosed leading to chronic painful conditions. The aim of treatment in MPS is to decrease the

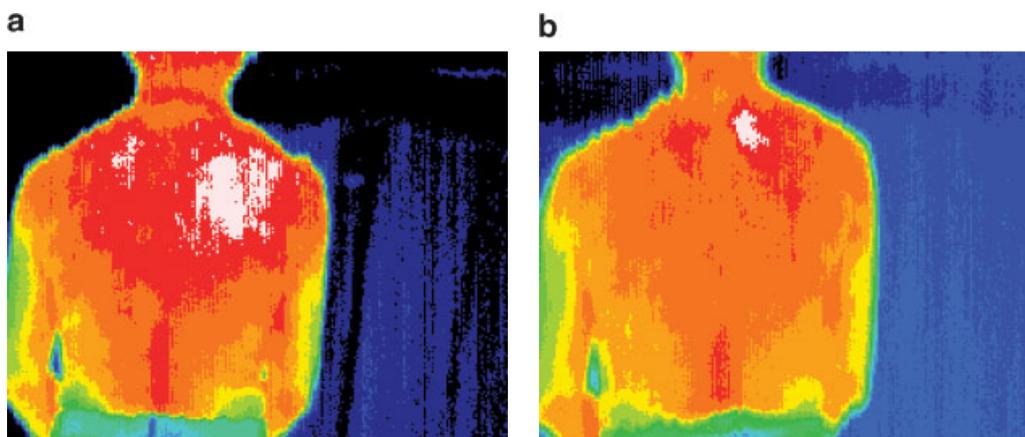


Fig. 1. **a:** Hot spot on the thermographic image before low level laser therapy (LLLT). **b:** The regression on the hot spot region 3 weeks after LLLT. [Figure can be viewed in color online via www.interscience.wiley.com.]

trigger point sensitivity [14,15]. Vapocoolant spray with stretching the involved muscle and local anaesthetic injection with muscle stretching were the main methods which were proposed by Travell and Simons [15] as specific treatments. Jaeger et al. [2] suggested that stretching is the major and effective part of the treatment which we already used in both groups. Besides these so called specific methods, various physical modalities such as ice, heat, ultrasound, transcutaneous electrical nerve stimulation (TENS), ischaemic compression and massage have been used to treat trigger points [14–16]. Despite the widely use of therapeutic modalities, Hanten et al. [14] claimed the quality of the studies on the efficacy of these modalities were low and the supporting results reported only temporary relief for many of the modalities.

Low level laser therapy has often been applied in various musculoskeletal and soft tissue pain syndromes [8]. Myofascial pain syndrome is one of the indications of LLLT [8]. Simunovic [4] reported functional recovery and decrease of spontaneous pain with LLLT on trigger points. According to the author, LLLT increases oxygen supply to hypoxic cells in trigger point areas by regulating microcirculation. In medical practice LLLT have often been used for its analgesic, biostimulation, and wound healing effects [17]. Laser irradiation is suggested to provide analgesia by decreasing the spasm in muscle arterioles which is essential for tissue oxygenation and by increasing ATP formation with a consequent normalization in metabolic rate of the tissues with diminished energy levels. The other mechanisms may be related with its effects on endorphin levels and gate control of pain. By all these mechanisms it can interrupt the vicious cycle of the trigger point [17].

The results of the clinical trials about treatment of musculoskeletal pain syndromes with LLLT seems controversial. Beckerman [8] reported in a meta-analysis that the trials supporting the positive effect of LLLT had higher methodological quality. On the other hand in another meta-analysis, Gam [18] suggested that efficacy of LLLT was found to be lower in double blind trials when compared with the uncontrolled ones. This inconsistency is also valid for the effect of LLLT in the therapy of MPS. In a study, Olavi et al. [6] suggested that LLLT had an effect on the trigger points and that the treatment significantly increased the pain threshold while Thorsen et al. [19] reported no beneficial effect over placebo in a controlled cross-over study during 5 weeks follow up. Why the effect of LLLT is controversial on trigger points may be due to many reasons. Methodological differences in patient selection, trigger points treated (active or inactive) outcome measures selected, and the application parameters of LLLT (wavelength, intensity, duration) may effect the final improvement in pain or functional limitation. No scientific consensus seemed to exist on the application dosage of LLLT.

Defining the study protocols clearly, paying special attention to the population selected, trigger points treated and the application parameters of LLLT is of great importance to judge the effectiveness. In this study, we selected only two muscles which are frequently involved. Active trigger points cause spontaneous ongoing discomfort and

also referred pain, whereas inactive or latent trigger points cause tenderness only by palpation [3]. The reason why we selected symptomatic patients with one active trigger point in this study was to avoid probable other pain sources to conflict the clinical picture. In this study, we used VAS and PA as outcome measures to evaluate pain. Pressure algometer is a semi-subjective instrument with a reported high reliability used clinically for quantification of tenderness and the follow up assessment after therapy applications [9,20,21]. The other outcome measure we used was infrared thermography which measures cutaneous surface temperature that is reflective of the underlying sympathetic activity and local chemical mediators through an infrared camera which captures body surface heat emission. It is suggested that focal hyperthermia overlying the trigger point results from a vasodilatory somatocutaneous reflex response to nociceptive impulses that the trigger point causes [22]. Fischer and Chang [10] observed hot spots which were 0.5–1°C warmer than the opposite site of the body or the surrounding region, discoid in shape with a diameter of 5–10 cm compatible with the location of trigger points. Diakow [23] reported thermography may be a useful tool in distinguishing active trigger points from latent ones with a specificity of 70% and a sensitivity of 74%. We excluded patients with latent trigger points which did not reveal hot spots to be able to observe the thermal changes due to therapy in a standard group of patients. Uematsu [24] defined thermal asymmetry concept as to be a 0.5°C difference from the symmetrically opposite part of the active trigger point. We used this definition as thermal asymmetry in our patients. However, many investigators have questioned its accuracy because it has been difficult for thermographers to delineate standards of practice. Some of them like Swerdlow et al. [12] and Kruse et al. [25] reported no related activity between thermal asymmetry and trigger points however they did not claim that there was no thermal activity associated with MPS. Radhakrishna [26] could not find any relationship between the temperature over tender spots and pressure sensitivity and rejected the use of thermography. However, the authors of this study not only disregarded the active and latent trigger point presence, they included two pathological conditions of different etiopathogenesis like fibromyalgia or MPS patients together in the same group.

The wavelength, power output, energy intensity, and the application duration of LLLT are important parameters determining the success of therapy. The most important parameter is the energy intensity in J/cm² adjusted using the other parameters. There is a large discrepancy of the energy intensity values used in trials investigating the efficacy for musculoskeletal pathologies. And also many studies did not mention sufficient data for the energy intensity parameter making the dosage standardization and interpretation of the results on the efficacy of LLLT difficult [19]. In a placebo controlled study, LLLT was reported to have no effect on pain in MPS, however in this study energy intensity was not mentioned like many others [19]. We think the inadequate dosages used may be the main reason for the inconsistency among the LLLT efficacy

trials. We applied a 5 J/cm² energy intensity which Laakso et al. [5] had found more successful than 1 J/cm² in treating trigger points. There is also lack of studies investigating the effectiveness of various LLLT devices with various wavelengths. We used laser beams with 780 nm wavelength in the treatment of trigger points and observed successful results.

Stretching alone seemed to aid relieving pain significantly while LLLT with muscle stretching exercises had superior significant effect on pain of active myofascial trigger points within 3 weeks follow up. Furthermore this clinical response was parallel to the thermographic changes in patients who were treated with additional LLLT. Despite the confusion in the literature about LLLT efficacy on MPS and the use of thermography as an evaluation method, our findings encourage to consider both methods for treatment and follow up evaluation of MPS. However, the major limitation of our study was that we did not include placebo laser treatment group in this study to rule out placebo effect. We think the probable placebo effect might have been more active on pain related parameters but not on the thermographic values. Further placebo controlled trials with high methodological quality in which the features of the laser are well documented are still required.

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