

The immediate effects of 830-nm low-level laser therapy on the myofascial trigger point of the upper trapezius muscle in visual display terminal workers: A randomized, double-blind, clinical trial

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ABSTRACT

The aim of our study was to evaluate the immediate effects of an 830-nm Aluminium gallium arsenide (GaAlAs) laser, by examining the changes, in pressure-pain threshold (PPT) and tenderness at 3 kg of the myofascial trigger point (MTrP) of the upper trapezius muscle in visual display terminal (VDT) workers in comparison with placebo treatment. Thirty VDT workers (13 males, 17 females) with complaints of upper trapezius muscle were recruited. All participants were given either active GaAlAs laser (830 nm wavelength, 450 mW, 9 J at point) or placebo GaAlAs laser, according to the double-blinded and placebo-controlled trial. Both active and placebo low-level laser therapy (LLLT) treatments showed no significant effect on PPT and tenderness at 3 kg. These results suggest that a higher dosage may be necessary to produce immediate effects when applying LLLT to the MTrP of relatively large muscles such as the upper trapezius muscle.

Keywords: Low-level laser therapy, Myofascial trigger points, Pressure pain threshold, Upper trapezius muscle

1. INTRODUCTION

Many office workers spend long hours sitting at a desk while doing their jobs [1]. While working at a visual display terminal (VDT), the effects of a static sitting posture were found to be the greatest in the neck and shoulder regions and, as a result, forward neck flexion, and neck and shoulder muscle tension have been shown to increase [2], [3]. If the VDT work continues in the same sitting position for a long time, these static contractions will cause ischemia in the trapezius muscle, increase intramuscular tissue pressure, and result not only in pathologic changes such as stiffness, dullness and pain, but also an increase in muscle hardness [4]. However, traditional treatments for musculoskeletal disorders in VDT workers, such as physical therapy, drugs, exercises and education, have not always been found to be helpful [5].

In clinical settings, low-level laser therapy (LLLT) has been safely used in the treatment of musculoskeletal disorders, with its anti-inflammatory, analgesic [6], [7], myorelaxant, tissue-healing, and biostimulation effects [8], [9]. The LLLT is the application of light (1–500 mW output and 600–1000 nm

wavelength) with a power density or irradiance for the treatment of pathologic conditions [10]. Previous clinical studies have found positive effects of LLLT in musculoskeletal disorders such as neck muscle pain [11], fibromyalgia [12], and a resultant reduction in the use of drugs [13], [14], [15]. However, some studies have suggested no therapeutic benefits of LLLT in the treatment of musculoskeletal disorders [16], [17]. Despite its widespread use, especially in Europe and Brazil, the clinical applicability of LLLT in musculoskeletal disorders is still controversial [5]. In addition, studies of the immediate effects on pressure pain threshold (PPT) and pain relief achieved using LLLT on myofascial trigger points (MTrPs) are also insufficient.

The aim of our study was to evaluate the immediate effects of an 830-nm Aluminium gallium arsenide (GaAlAs) laser by examining changes in PPT and tenderness at 3 kg of the MTrP of the upper trapezius muscle in VDT workers in comparison with placebo treatment.

2. METHODS

2.1 Participants

This study was a randomized, double-blind and placebo-

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controlled trial. Thirty VDT workers (thirteen males, seventeen females) with complaints of upper trapezius muscle pain were recruited from our university hospital (Table 1). Participants were selected following a screening process to demonstrate the

Table 1. General characteristics of the subjects

Variable	LLLT group (N=15)		Placebo group (N=15)	
	Male (n=6)	Female (n=9)	Male (n=7)	Female (n=8)
Age (years)	26.00 ± 1.58*	25.38 ± 3.82	26.50 ± 1.29	24.20 ± 3.83
Height (cm)	175.60 ± 4.51	165.50 ± 8.96	177.00 ± 3.74	160.40 ± 6.88
Weight (kg)	64.60 ± 4.56	53.00 ± 6.85	65.25 ± 4.99	48.80 ± 4.15

*mean ± SD, LLLT: Low level laser therapy

presence of an MTrP in the upper trapezius muscle, which was based on their histories and physical palpation by a therapist with ten years of experience in MTrP palpation. Prior to the start of the experiment, the participants read and signed an informed consent document.

2.2 Inclusion criteria

- (1) Suffering from a disorder of the upper trapezius muscle for at least 6 months.
- (2) Using a computer for more than 7 hours per day.
- (3) A PPT of the upper trapezius muscle below 3 kg/cm².

2.3 Exclusion criteria

- (1) A history of fracture or neoplasm of the cervical spine shoulder joint.
- (2) A history of heart disease or the presence of a pacemaker, epilepsy, a psychological disorder or pregnancy.

2.4 Protocol for LLLT

All participants were administered either active LLLT (SC-laser CTLS-8; EINS MEDICAL, Busan, Korea) or placebo LLLT, according to the randomization procedure. The laser parameters are shown in Table 2. The laser probe was held stationary throughout the treatment and was set to a skin contact mode of 90° [6].

2.5 Randomization and blinding procedures

Randomization was performed using allocation cards A (active LLLT) and B (placebo LLLT), on which the treatment to be given to each participant was written. The randomization procedure was controlled by an assistant who was not participating in the experiment. The allocation cards were handed over to the technician who was operating the laser beam in the active or placebo LLLT mode, and both the participant and investigator were blinded to the type of treatment. The laser beam was switched on after the laser probe had been placed on the MTrP in the dominant upper trapezius muscle, and the laser probe was removed after irradiation was completed. Both the participant and therapist wore protective goggles during the treatment to ensure blinding and protect the eyes.

2.6 Test procedures

Evaluations were performed before and after the LLLT application in a relaxed sitting posture. The parameters evaluated were PPT [18] and tenderness at 3 kg, as assessed using an algometer and a numeric rating scale [19]. Both measurements were performed by the same investigator. The

Table 2. Laser parameters

Laser parameters
Wavelength: 830 nm (infrared)
Frequency: continuous output
Optical output: 450 mW
Spot diameter: 0.3 cm
Spot size: 0.07 cm ²
Power density: 6429 mW/cm ²
Energy: 9 J at point
Energy density: 128.6 J/cm ² at point
Treatment time: 20 s at point
Number of points: 1

algometer (Pain Test-Model FPK; Wagner Instruments, Greenwich, CT) has a standardized (1.52 cm²) flat circular probe and a scale marked from 0 to 10 kg, in increments of 0.1 kg. The pressure algometer is a semi-subjective instrument with a high reliability and is used clinically for follow-up assessment of tenderness after therapy [20], [21]. The algometer was pressed against the MTrP of each patient's dominant upper trapezius muscle until the PPT was reached, by increasing the pressure by 0.1 kg per second. The PPT was recorded as the value, in kg, at which the participant expressed that the pressure changed into pain [18]. The tenderness at a pressure of 3 kg was assessed on a numeric rating scale ranging from 0 to 10 [19]. The patients described the pain level using this numeric rating scale, with 0 representing no pain and 10 representing the worst unbearable pain.

2.7 Statistical analysis

SPSS software (version 14.0; SPSS, Chicago, IL, USA) was used to examine the changes in the PPT and the tenderness at 3 kg at the MTrP of the upper trapezius muscle before and after the LLLT application. A two-sample t-test was used to examine differences between the active LLLT and placebo LLLT groups, with a significance level of p<0.05.

3. RESULTS

The PPT of the active LLLT group did not significantly increase after the active LLLT application (p>0.05). The PPT was 1.24 ± 0.39 before the application and 1.15 ± 0.41 thereafter (Table 3). The PPT of the placebo LLLT group also did not significantly increase after the placebo LLLT application (p>0.05). The PPT was 1.25 ± 0.43 before the application and 1.26 ± 0.46 thereafter (Table 4).

Values recorded using the numeric rating scale for tenderness at 3 kg in the active LLLT group did not significantly decrease after the active LLLT application (p>0.05). The numeric value for the tenderness was 7.08 ± 2.15

before the active LLLT application and 7.00 ± 2.22 thereafter (Table 3). The numeric value for tenderness at 3 kg in the placebo group also did not significantly decrease after the placebo LLLT application ($p > 0.05$). The numeric value for the tenderness was 7.33 ± 1.78 before the placebo LLLT application and 7.17 ± 1.99 thereafter (Table 4).

Table 3. Comparison of clinical outcomes upper trapezius muscle in active LLLT (450mW×20s) group (N=15)

Variable	LLLT group (mean ± SD)		
	Before	After	p
PPT (kg)	1.24 ± 0.39	1.15 ± 0.41	0.12
Tenderness at 3 kg (VAS)	7.08 ± 2.15	7.00 ± 2.22	0.34

LLLT: Low level laser therapy, PPT: Pressure-Pain Threshold, VAS: Visual analog scale

Table 4. Comparison of clinical outcomes upper trapezius muscle in placebo group (N=15)

Variable	Placebo group (mean ± SD)		
	Before	After	p
PPT (kg)	1.25 ± 0.43	1.26 ± 0.46	0.88
Tenderness at 3 kg (VAS)	7.33 ± 1.78	7.17 ± 1.99	0.34

PPT: Pressure-Pain Threshold, VAS: Visual analog scale

4. DISCUSSION

This study was conducted to investigate the immediate effects of the LLLT (830-nm GaAlAs laser) on the MTrP of the upper trapezius muscle of VDT workers by assessing the PPT changes, as well as changes in tenderness at 3 kg, in comparison with placebo treatment. Although the physiologic mechanism by which the LLLT application decreases pain in musculoskeletal disorders is not fully defined [22], the LLLT has been shown to exert photochemical and photobiologic, rather than thermal, effects on cells and tissues, thereby providing energy to the cells and tissues to increase the natural healing process [23]. The LLLT has been shown to be a noninvasive physical therapy modality with analgesic, tissue-healing, myorelaxant, fibroblast-proliferating, ligament-repairing and anti-inflammatory effects that are induced nonthermally and nondestructively [16], [24]-[27]. The clinical results from many previous studies suggest that the LLLT application may be a successful method of pain control in musculoskeletal disorders [28]-[34].

However, some studies have proposed that the LLLT may be associated with negative effects in the treatment of musculoskeletal conditions, and its use therefore remains controversial. In patients with acute and chronic lower back pain (LBP), the LLLT was shown to have only minor positive effects on pain and disability [35]. In the chronic LBP patients, LLLT application was shown to have no significant effect on pain relief [16]. In our study, both the active and placebo LLLT treatments showed no significant immediate effect on PPT and tenderness at 3 kg in VDT workers with pain in the upper trapezius muscle.

Various factors such as laser wavelength, intensity, dosage, frequency, and energy density affect the effectiveness of the

LLLT [36]. Additionally, so far, there is no accepted standard consensus about optimum wavelength, dosage and application technique for the treatment of musculoskeletal disorders [36]. The power density chosen for this study was based on that described by Leal Junior et al [37], although the power densities were not completely the same between the 2 studies, because of differences in optical output. The fact that beneficial effects were not shown in this study may be explained by the use of inappropriate LLLT parameters to achieve the PPT changes and a reduction in tenderness at 3 kg [38]. Tunér and Hode [23] suggested that a high power density was necessary for pain treatment in deep regions using the GaAlAs laser. In addition, if the region to which a probe is applied is 1 cm deep or more, the laser dosage that reaches the targeted region is decreased by one tenth in proportion to the distance [23]. The sum of the thicknesses of the subcutaneous layers of the upper trapezius and the upper trapezius muscle itself has been shown to be at least 1 cm on average [39], [40]. Therefore, the laser dosage that actually reached the painful region may have been reduced by one tenth, thus having no effect on the PPT or the muscle tenderness. These results suggest that a higher dosage than that applied in this study are necessary to produce the immediate effects when applying the LLLT to the MTrP of relatively large muscles such as the upper trapezius muscle.

This study has some limitations. Firstly, it was difficult to detect differences between groups because the sample sizes were small. Secondly, the follow-up duration was too short. Thirdly, we did not compare various kinds of laser treatment. Furthermore, the LLLT was not applied to multiple MTrPs of the upper trapezius muscle. Randomized clinical trials with larger patient populations are necessary to standardize appropriate dosages of the LLLT for producing immediate therapeutic efficacy in relatively large or thick muscles such as the upper trapezius muscle.

5. CONCLUSION

The fact that the application of approximately 128.6 J/cm^2 and 6429 mW/cm^2 to the MTrP of the upper trapezius muscle, using a GaAlAs laser at 830 nm and 450 mW, did not produce immediate changes in PPT and tenderness at 3 kg does not necessarily mean that the LLLT is not effective at reducing pain. These results suggest that a higher dosage than that applied in this study are necessary to produce immediate effects when applying the LLLT to the MTrP of relatively large muscles such as the upper trapezius muscle.

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