Clinical Effect of Low Level Laser Therapy on the Trigger Points of Orofacial Pain Patient*

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CONTENTS

Ⅰ. INTRODUCTION

A trigger point is a focus of hyperirritability in a tissue that, when compressed, is locally tender and, if sufficiently hypersensitive, gives rise to referred pain and tenderness and sometimes to referred autonomic phenomena and distortion of proprioception[1]. Since the referred pain is often felt as headache, this condition has also associated with tension-type headache[2,3]. A trigger point may present in either active or latent. An active trigger point causes the patient pain. Palpation of the active trigger point causes reproducible alternation of pain to a more extensive area that may or may not include the muscle containing the trigger points[4]. A latent trigger point is clinically silent with respect to pain, but may cause restriction of movement and weakness of the affected muscle. A latent trigger point may persist for years after apparent recovery from injury; it predisposes to acute attacks of pain, since minor overstretching, overuse, or chilling of the muscle may suffice to reactivate it. Both latent and active trigger points cause dysfunction; only active trigger points cause pain[1]. Inactivation of the trigger points with injection of local anesthetics, ice, or vapocoolant spray followed by stretch or transcutaneous electrical nerve stimulation (TENS) relieves the larger area of pain[3].

Tenderness upon muscle palpation, which indicates a decreased pressure pain threshold (PPT)[5,6], is a common clinical sign in myofascial pain[7]. Pressure algometers enable the quantification of local muscle tenderness in patients with musculoskeletal disorders, and in

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asymptomatic subjects[8-11]. This has led to the use of the instruments as and aid in evaluation of hypersensitive spots[12], fibrositis[13] and activity of arthritis[14], and documenting clinical effects of different treatment such as intramuscular injection[6], physical therapy[15], transcutaneous electrical nerve stimulation(TENS)[16], laser therapy[17] and acupuncture and occlusal splint[18].

Medical lasers can be divided into two main types; the high-intensity laser is now commonly used in the orofacial region for soft tissue excision(CO_2, Argon and Nd:YAG) and experimentally for hard tissue applications (Erbium: YAG, TEA CO_2 and Excimer) while photodynamic therapy is finding increasing application in such contexts as the management of oral neoplasms and destruction of periodontal pathogens(Tuneable Dye and Helium Neon)[19]. On the other hand, the low-intensity laser has been advocated for pain control and promotion of healing in this anatomical region(Gallium Aluminium Arsenide, Gallium Arsenide, Helium Neon)[20].

Low level Laser therapy(LLLT) has utilized large portions of the visible and infrared spectrums. Initial research emphasized the visible light of inert gas lasers such as the Helium Neon(He-Ne), Ruby, Argon and Krypton. More recently, Gallium Arsenide (GaAs), Gallium Aluminium Arsenide(GaAlAs) IR semiconductor laser diodes have become more available. Today, He-Ne devices are still widely used, but the majority of work is done with GaAs and GaAlAs diodes with wavelengths between 820nm and 904nm[21]. Low level laser therapy(LLLT) has been applied to many musculoskeletal pain syndromes in clinical trials since the work of Mester on the biological and medical effect of LLLT in the early seventies. The studies were reviewed by Mester et al.[22].

The purpose of this study is 1) to ascertain the effect of GaAlAs diode on the trigger points, which may alter the pain threshold measured by pressure algometer clinically in a double-blind study, 2) to compare the effects of actual laser therapy with placebo therapy, and 3) to determine when the LLLT shows beneficial effect on the trigger points.

II. MATERIALS AND METHODS

Subjects

237 trigger points of 69 healthy dental students, 39 males and 30 females, at Pusan National University, were studied by pressure algometer after laser application. The mean age of male subjects was 23.7 years, ranging from 22 to 29 years, and that of female subjects was 23.3 years, ranging from 22 to 25 years.

They were randomly assigned to either a LLLT group(n=37) or a sham LLLT group (n=32). The patients have not experienced physical therapy prior to inclusion in this study.

Apparatus

The electronic algometer type I(Somedic Production, Stockholm, Sweden)[23] used in this study consists of a gun shaped application handle with a round rubber tip (diameter = 11mm) and a main body that has a digital display panel, calibration knob, control knob of application rate slope, and a patient-operated switch.

PPT was measured in Kpa by algometer. The algometer handle was applied perpendicularly to the superficial masseter, temporalis and trapezius and maintained at 30 Kpa/sec(Fig. 1).

The laser apparatus used in this study was a handylaser 50-SL® class B. It was fitted with a

Fig. 1. The electronic algometer was held perpendicularly to superficial masseter.

Fig. 2. The low level laser was held perpendicularly to the trigger point, superficial masseter.

820nm, 50mW, GaAlAs diode. The power output pcan be regulated with ease and precision using the handylaser; In 40 seconds 2 Joules are emitted with continuous beam, and when the frequency modulation is in operation 1 Joule is emitted. The laser is activated for 40 seconds and is automatically turned off. The handylaser 50-SL is also available without timer. The red pilot diode at the head of the laser indicates the direction of the visible laser beam. The GaAlAs diode used in this study is ideally suited for a double blind study since the laser light is invisible and emits no heat, sound or other physically detectable indication when it is activated. Therefore, it is possible to randomly receive placebo treatment and actual laser treatment(Fig. 2).

III. PROCEDURE

Before examination, they were instructed to push the button on the patient-operated switch as soon as they experienced pain. As the subject feels pain, he or she pushes the button on the patient-operated switch, the digital display stops immediately for about five seconds, and the red light turns on so that the operator can record the value easily. During this test, he or she who made the measurements did not see the values of the measurement.

All tests were performed with the subjects in a reclined position with the neck supported. During the measurement on the masticatory muscles the investigator applied manual counter -pressure contralaterally to stabilize the head.

For reliability, the measurements were taken three times at each marked trigger point and the mean value of the three measurements was accepted. Before treatment, on the 2nd week, on the 3rd week, and after treatment, the PPT was taken on both the LLLT and the sham LLLT group.

All of the subjects received either a LLLT or a sham LLLT. The laser was set to deliver a pulse energy at 1J per square centimeter of tissue for 40 seconds. Each marked trigger point was either irradiated with 2J per square centimeter of repetitively pulsed GaAlAs laser or received placebo application for 80 seconds. The

total energy emitted at each session was 2J and each subject was treated with 5 sessions. The probe was in contact with the skin at a right angle. To preserve the double-blind study, the subjects were positioned sitting or semi-supine so as to obscure viewing of the laser beam. The same unit was used for the placebo treatment, for which no laser beam was emitted. Each subject was treated twice at the first weeks and once a week during the following three weeks. A total treatment was 5 times during 4 weeks.

Ⅳ. STATISTICAL ANALYSIS

All measurements in each group were averaged. Statistical analysis was performed to compare the increase of PPT values. To determine the significance of the differences among the measurements before treatment, on the 2nd week, on the 3rd week, and after treatment, and between the measurements in the LLLT and the sham LLLT group, and between the measurements in each group of male and female subjects, respectively, the Statview™ II was used for the unpaired and paired t-test and ANOVA with repeated measure F-test. A probability level of 0.05 was considered an acceptable level of statistical significance.

Ⅴ. RESULTS

The results are presented in table 1~12. The mean and standard deviations of the PPT in both males and females, and both LLLT and sham LLLT groups before treatment are shown in table 1 and 2. There were not statistically significant differences between individual muscles in males and females, except for the trapezius, and between the LLLT and the sham LLLT group. The order of the PPT values was trapezius, masseter and temporalis without regard to gender and both inter-groups. In general, the PPT values of the sham LLLT group, except for the masseter, were higher than those of the LLLT group before treatment(Table 1, 2).

Table 3 shows clearly the positive effect of the laser therapy on the increase of the PPT values found in the LLLT group. A statistically significant increase of the PPT values was found after the third irradiation($P<0.05$). No statistical difference was observed in the trapezius between the LLLT and the sham LLLT group. In the LLLT group, the PPT values of the trapezius were increased, but in the sham LLLT

Table 1. Pressure pain threshold of subjects before treatment.

	Male	Female	p-value
Masseter	149.07±32.20	138.32±30.63	.1680
Temporalis	141.32±43.58	125.60±35.82	.2560
Trapezius	179.11±48.60	161.84±41.03	.0326

Table 2. Pressure pain threshold of LLLT group and sham LLLT group before treatment.

	LLLT group	sham LLLT group	p-value
Masseter	143.25±37.15	142.04±21.64	.8771
Temporalis	132.86±46.57	137.69±33.12	.7269
Trapezius	165.97±43.84	178.07±48.12	.1333

Table 3. Pressure pain threshold of LLLT group and sham LLLT group after 2 weeks.

	LLLT group	sham LLLT group	p-value
Masseter	158.95±41.45	130.68±20.72	.0014
Temporalis	182.91±56.97	150.25±22.75	.0377
Trapezius	180.70±60.60	168.61±49.64	.2158

group, those were decreased.

After the forth irradiation, the PPT values of the LLLT group were significantly higher than those of the sham LLLT group($P<0.05$). Compared with the third irradiation, the PPT values of the temporalis of the sham LLLT group were increased but those were decreased in the LLLT group(Table 4).

Table 5 shows that in the comparison of the PPT values of the LLLT and the sham LLLT group after treatment, all showed significant difference($P<0.05$).

The comparison of the PPT values measured from individual muscles and the significant differences between them for each session and both groups were shown as seen in Table 6 and 7. Results of the ANOVA indicated a significant increase in PPT for the LLLT group($P<0.001$), but not for the sham LLLT group.

Comparing the p-value of the PPT of the statistically significant increase was more prominent in the LLLT group($P<0.05$). This difference increased on the fourth irradiation and after treatment($P<0.001$), but no significant increase was found within the sham LLLT group(Table 8, 9 and 10).

Table 11 and 12 show the comparison of the PPT values according to gender within each

Table 4. Pressure pain threshold of LLLT group and sham LLLT group after 3 weeks.

	LLLT group	sham LLLT group	p-value
Masseter	162.95±42.16	137.82±30.75	.0090
Temporalis	179.91±51.47	162.81±38.23	.2731
Trapezius	215.17±85.53	182.94±66.08	.0154

Table 5. Pressure pain threshold of LLLT group and sham LLLT group after treatment.

	LLLT group	sham LLLT group	p-value
Masseter	176.50±53.55	128.79±34.81	.0001
Temporalis	191.91±66.21	153.75±31.53	.0408
Trapezius	220.49±76.96	175.07±62.77	.0003

Table 6. Pressure pain threshold of LLLT group in each muscle with time.

	pre-treatment	2weeks later	3weeks later	post-treatment	F-value	p-value
Masseter	143.25±37.15	158.95±41.45	162.95±42.16	176.50±53.55	9.740	<.0001
Temporalis	132.86±46.57	182.91±56.97	179.91±51.47	191.91±66.21	14.303	<.0001
Trapezius	165.97±43.84	180.70±60.60	215.17±85.53	220.49±76.96	26.601	<.0001

Table 7. Pressure pain threshold of sham LLLT group in each muscle with time.

	pre-treatment	2weeks later	3weeks later	post-treatment	F-value	p-value
Masseter	142.04±21.64	130.68±20.72	137.82±30.75	128.79±34.81	1.829	.1485
Temporalis	137.69±33.12	150.25±22.75	162.82±38.23	153.75±31.53	2.631	.0615
Trapezius	178.07±48.12	168.61±49.64	182.94±66.08	175.07±62.77	2.362	.0729

Table 8. Comparison of the p-value of LLLT group and sham LLLT group in masseter muscle with time.

sham LLLT group \ LLLT group	pre-treatment	2weeks later	3weeks later	post-treatment
pre-treatment		.0221	.0038	.0001
2weeks later	.0188		.4665	.0062
3weeks later	.5903	.2686		.0034
post-treatment	.0767	.7798	.1306	

Table 9. Comparison of the p-value of LLLT group and sham LLLT group in temporalis muscle with time.

sham LLLT group \ LLLT group	pre-treatment	2weeks later	3weeks later	post-treatment
pre-treatment		.0002	.0002	.0002
2weeks later	.0831		.6789	.2938
3weeks later	.0174	.1851		.1812
post-treatment	.1467	.7240	.3058	

Table 10. Comparison of the p-value of LLLT group and sham LLLT group in trapezius muscle with time.

sham LLLT group \ LLLT group	pre-treatment	2weeks later	3weeks later	post-treatment
pre-treatment		.0247	<.0001	<.0001
2weeks later	.0573		<.0001	<.0001
3weeks later	.4264	.0050		.3948
post-treatment	.6363	.2647	.1187	

group. In the LLLT group, the significant differences were found between pre-treatment and post-treatment($P<0.05$), and the PPT values of the male subjects are significantly increased. In the sham LLLT group, we found little changein the PPT values between pre-treatment and post-treatment.

VI. DISCUSSION

The importance of pain and dysfunction originating from myofascial trigger points is gaining increased recognition by clinicians. Most often assessment of pain has been based on the subjective experience of the patient and thus, is

Table 11. Pressure pain threshold between pre-treatment and post-treatment in LLLT group according to gender.

		Male	Female	p-value
Masseter	pre-treatment	155.20±39.24	136.08±34.67	.1162
	post-treatment	203.40±58.17	160.36±44.30	.0119
Temporalis	pre-treatment	140.92±51.18	119.75±37.27	.3240
	post-treatment	217.54±69.60	150.25±31.92	.0193
Trapezius	pre-treatment	175.15±41.47	154.42±44.67	.0486
	post-treatment	242.97±68.65	192.19±78.53	.0053

Table 12. Pressure pain threshold between pre-treatment and post-treatment in sham LLLT group according to gender.

		Male	Female	p-value
Masseter	pre-treatment	142.00±20.87	142.07±23.02	.9937
	post-treatment	133.00±37.12	125.13±33.54	.5608
Temporalis	pre-treatment	141.89±32.49	132.29±35.70	.5830
	post-treatment	164.67±35.23	139.71±20.55	.1192
Trapezius	pre-treatment	183.39±55.58	170.69±35.04	.3092
	post-treatment	194.61±71.00	148.00±35.27	.0031

not measured objectively.

While trigger points may develop anywhere throughout the length of a muscle, they do tend to reside in grossly reproducible areas, with individual variability in terms of their specific locations. Since there are no laboratory or radiographic changes associated with myofascial pain and trigger points sensitivity, diagnosis and treatment evaluation depends on an accurate hands on examination of the muscle to locate focal tenderness in palpable muscle bands. Precise information on predetermined trigger point locations and examination techniques can be obtained from Travell and Simmons[1]. Once located, quantification of the tenderness of a trigger point is impressive with manual palpation alone. Both in clinical practice and experimentally it would be of great value to have a reliable, yet simple method to quantify trigger point sensitivities once they have been manually located. The pressure algometer may be suited for this purpose[12].

The first generation of pressure algometers in the 1930s to 1960s, were rather than crude instruments working on a spring load principle[8]. More recent models working on mechanical force gauges include those of Fischer[24], and Tunks et al.[13] Electronic pressure algometers working in strain gauge principle have also been developed[6].

The reliability of PPT measurements can be affected by several factors. These factors include the size of contact area and the rate of application. The PPT increases as the area of contact decreases and increases with the increasing rate of application[6,25]. The inter-muscle regional differences in both temporalis and masseter muscles have been reported[11]. The differences in pressure thresholds between males and females were assessed in normal muscles by Fischer[24]. Reeves et al.[12] demonstrated a high degree of validity and reliability of the instrument in the detection of myofascial trigger points in temporomandibular muscles.

In this study, the application rate used was 30Kpa/sec recommended by manufacturer. To apply the pressure with a uniform rate, a visual signal was given to the investigator if these values were exceeded. The appropriate application rate should be fast enough to avoid prolonged pressure to the tissue and fatigue of the investigator. Also, it should be slow enough to allow the investigator to apply pressure with a constant rate for sufficient time so that the true PPT should not be overestimated due to reaction time of each patient[26]. Furthermore, it has been emphasized that a constant pressure rate is necessary to obtain a good reliability with the algometer[10,27].

When laser radiation contacts the surface of the skin, common physical phenomena including reflection, absorption, and dispersion occur. The resonance of human tissue is such that it absorbs the light of laser quite well. It has been found that 99 percent of the laser radiation will be absorbed in the skin. This absorption will occur in at least the first 3.6mm of tissue[28]. The use of light on human tissue will cause absorption and dispersion of the light in the tissue, with variability depending upon the composition of that tissue. Most types of tissue are not homogeneous and the multiple components of tissue composition have very different absorbing and diffusing characteristics. The physiologic variability of tissue's effect depends upon wave length, energy and exposure time[29].

The use of laser is widely recommended for clinical use, especially in the treatment of ulcerative or inflammatory disease, functional disorders, and chronic pain conditions. The recommendations are primarily based on positive clinical experience rather than classical placebo controlled clinical trials. Only a limited number of controlled studies have been performed[30]. Of these, few indicate positive results in pain treatment[17,31-33], whereas several recent studies fail to show any difference between laser and placebo treatment[30,34,35].

A double blinded controlled study in 1989 by Snyder-Mackler et al.[31] found that there were both a statistically significant reduction of pain and increased skin resistance at the trigger points in the group that was irradiated with a 0.95mW He-Ne CW laser. Olavi et al.[17] suggested that a higher power 904nm IR laser had an effect at the trigger points and that significantly increased in pain threshold. In 1988, Bezuur et al.[32] found that the infrared laser irradiated the TMJ area was effective and significantly increased the maximum mouth opening in the arthrogenous patients but no significant increase of the maximum mouth opening was found in the myogenous patients.

A double blind, cross-over study in 1992 by Thorsen et al.[34] reported that a 830nm GaAlAs diode laser had no beneficial effects between LLLT and placebo for myofascial pain. The report of Waylonis et al.[35] in 1988 suggested that no difference in pain response and treatment effectiveness was noted in the treated and placebo groups that were irradiated with low

output He-Ne laser.

In this study, one of the popular 820nm GaAlAs diode laser was used at the sensitive trigger points in a double blind study and the effect of LLLT and sham LLLT were assessed by pressure pain threshold measurements. A significant increase of the PPT values was found on the third day of laser exposure in the LLLT group($P<0.05$), increasing even more from the fourth day until the last laser session($P<0.001$). In the LLLT group, there were statistically significant differences compared pre-treatment with post-treatment between males and female. In the group of patients who submitted to placebo treatment, there was in fact no significant increase of the PPT values. Our findings are in accordance with the results of several studies[17,31-33].

Hansen and Thoroe[30] have suggested that no statistically significant difference between the analgesic effect of the laser and placebo irradiation was found and placebo was superior to laser stimulation. This difference cannot be explained, as the placebo response is supposed to be determined by several independent factors as the setting of the study, the doctor-patient relationship and the belief and anticipation of the patients. However, in this study, there was no placebo response in the sham LLLT group. The PPT values measured from individual muscles except for the temporalis were decreased during and after treatment. In the temporalis, the placebo response was slightly observed although it might be a temporary effect without any statistical significance.

The results of this study indicate that laser therapy is effective in the trigger point, and it may speed up the healing process with a faster relief in patients.

A minimum of the three times treatments has been suggested for assessing the efficacy of laser treatment, and a 5-session course has been recommended.

There is a need for further study to establish the effect of various frequency, energy dosage and irradiation schedules in reaction to pain conditions of any kind. Also, the long-term laser effects need to be evaluated.

Ⅶ. CONCLUSIONS

Measurement of pressure pain threshold over trigger points irradiated with GaAlAs diode laser displayed a significant increase in the pain threshold after treatment.

The obtained results were as follows:

1. The PPT values before treatment are not statistically significant differences in both males and females and both the LLLT and the sham LLLT group.
2. While in the LLLT group, the PPT measured from individual muscles, are significantly increased from the third day of laser exposure, the 2nd week after laser application ($P<0.05$), no statistical difference are observed during each session in the sham LLLT group.
3. With respect to gender, the PPT values of the sham LLLT group are not statistically significant in both pre-treatment and post-treatment, and those of the LLLT group are insignificant before treatment. However, the PPTs in male subjects are significantly higher than those in female after treatment($P<0.05$).

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국문초록

구강안면동통 환자의 발통점에 대한 저출력 레이저치료의 임상적 효과에 대한 연구

부산대학교 치과대학 구강내과학 교실

고 명 연 · 박 준 상 · 조 수 현

구강안면동통환자의 발통점에 대한 보존적 치료방법중 저출력레이저의 효과를 평가하기 위해 교근, 측두근과 승모근에 발통점을 가진 치과대학생 69명을 무작위로 분류하여 37명에게는 GaAlAs 반도체 레이저를 조사하였고 나머지 32명은 레이저를 실제로 조사하지 않고 대조군으로 삼았다.

50mW, 820nm의 GaAlAs 반도체 레이저를 이용하여, 4주 동안 첫 주는 2회, 이후 3주 동안 1회씩 총 5회 조사하였고 전자통각계를 이용하여 압력통각역치를 측정한 후 이를 대조군과 비교한 바 다음과 같은 결과를 얻었다.

1. 남녀 및 조사군과 비조사군의 치료 전 압력통각역치는 차이가 없었다.
2. 조사군의 각 근육에서 측정한 압력통각역치는 레이저 치료 2주 후부터 유의하게 높아졌으나 비조사군에서는 차이가 없었다.
3. 비조사군의 치료 전, 후 압력통각역치에는 성 차가 없었다. 반면 조사군의 압력통각역치는 치료 전에는 성 차가 없었으나 치료 후에는 남성이 여성보다 유의하게 높았다.