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ARTICLE

Dose-dependent and Ceiling Effects of Therapeutic Laser on Myofascial Trigger Spots in Rabbit Skeletal Muscles

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ABSTRACT. Objective: To evaluate the effect of low-level laser treatment with different dosages on the irritability of myofascial trigger spots [MTrS] in rabbit skeletal muscles.

Methods: Twenty rabbits were equally divided into a low dose group and a high dose group. In each rabbit, the MTrS on the experimental side was irradiated with 660-nm continuous-wave gallium-aluminum-arsenate laser daily for six sessions. The energy per session was 27 J/cm^2 [low dose group] and 72 J/cm^2 [high dose group]. The MTrS on the other side received sham treatment. The MTrS irritability was assessed with the prevalence of endplate noise [EPN] at baseline after the first and after the last treatments.

Results: After the first laser treatment, the EPN prevalence was significantly decreased in both groups. The percentage change in the high dose group was greater than that in the low dose group. The EPN prevalence after the last laser treatment was lower than that after the first laser treatment in the low dose group, but not in the high dose group.

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Conclusions: In the present study, a dose-dependent effect of laser treatment on the MTrS irritability was demonstrated. A cumulative effect was only observed in low dose treatments. It appears that a ceiling effect may have occurred in relatively high dose laser treatment.

KEYWORDS. Low-level laser, myofascial trigger spot, dose-dependent, ceiling effect, endplate noise

INTRODUCTION

The Effectiveness of Laser Therapy

Low-level laser therapy [LLT] has been widely used in treating myofascial pain syndrome [MSP] due to myofascial trigger points [TrPs]. Various double-blind placebo control studies have demonstrated positive effects of LLT on pain relief, range of motion, or disability scale (1–7). However, other studies have reported no therapeutic effect (8, 9). Therefore, the effect of LLT irradiation on TrPs is a contentious area of research because LLT dosages in the studies have been inconsistent. Previous studies have also documented that the laser effect was related to the dosage, the wavelength, or mode of the laser (2, 10–14). Lack of the understanding in physiological and biochemical mechanisms of LLT on TrPs increases this controversy. The effects of LLT associated with various dosages, therefore, remain largely unknown.

Current Concepts of Human Trigger Points and Animal Myofascial Trigger Spots

Trigger points have been defined as hyperirritable [hypersensitive] spots in a taut band of human skeletal muscle fibers (15, 16). Similarly, the hypersensitive spot in a taut band of rabbit skeletal muscle fibers was defined as myofascial trigger spots [MTrS] (17). In human and animal studies, Hong has hypothesized that there are multiple TrP loci or MTrS loci in a TrP or MTrS region, respectively (18–24). It has been suggested that a TrP locus or MTrS locus contains both motor and sensory components. The motor component is defined as a spontaneous electrical activity [SEA] locus or the "active locus" at which endplate noise [EPN] and/or endplate spikes [EPSs] can be recorded by an electromyographic [EMG] machine (21–30). The sensory component is the sensitive locus from which focal pain, referred pain, and a local twitch response [LTR] in human or rabbit can be elicited by high-pressure mechanical stimulation. Recent human studies have demonstrated a high correlation between the irritability [pain] of a TrP and the EPN prevalence in that TrP region (30–32).

Goal of Our Study

To better understand the therapeutic mechanism of LLT on the TrP, our previous animal study found that the EPN prevalence in MTrS [MTrS irritability] could be suppressed by a 660-nm gallium-aluminum-arsenate [GaAlAs] laser after one or six treatments (33). This study is designed to further investigate the dose-dependent effect of LLT treatment.

MATERIALS AND METHODS

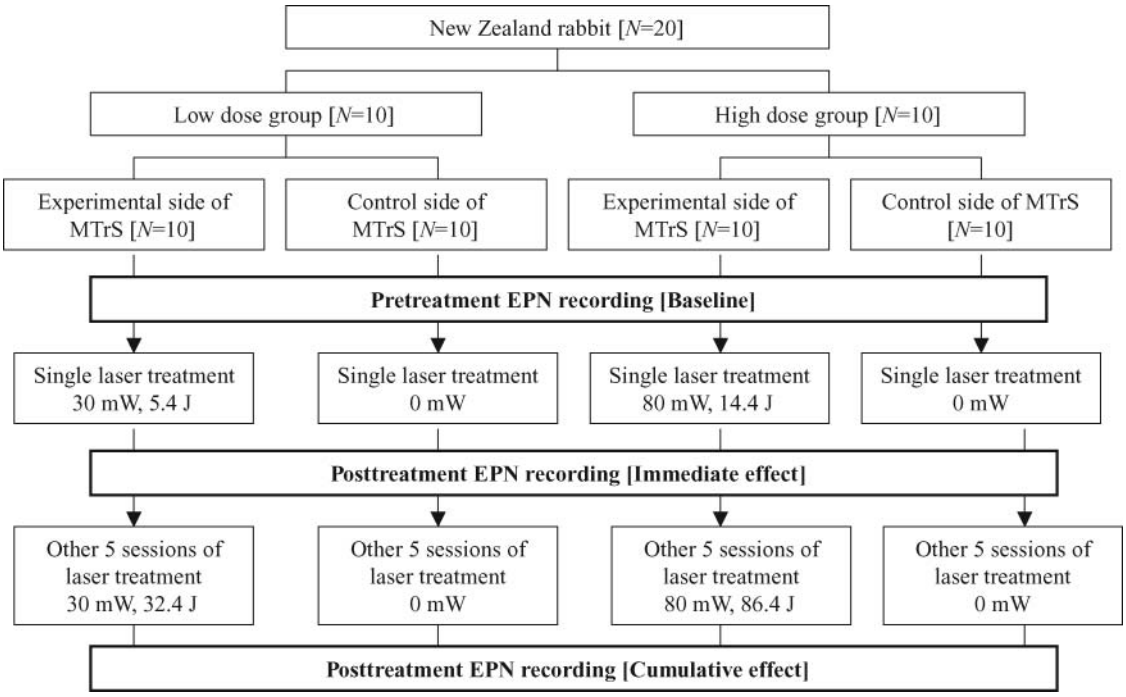
General Design

For all rabbits in each of two groups, the MTrS of the biceps femoris muscle on a randomly selected side was treated with one of two predetermined doses: 27 J/cm^2 for the low dose group and 72 J/cm^2 for the high dose group. Sham treatment was given on the other side for every rabbit. Both laser and sham treatments were given daily for six successive days [Figure 1]. The irritability of MTrS was assessed with the prevalence of EPN recorded by an EMG unit within each MTrS region before and immediately after the first and last sessions of treatment.

Animals

Twenty adult New Zealand rabbits weighing 1.7 to 2.0 kg were obtained and equally divided into two groups [10 in each group]: low-dose group and high-dose group. For each rabbit in either group, both sides of the biceps femoris muscle were exposed for EPN assessment and laser treatment. One side was randomly selected for laser irradiation with a dose of 27 J/cm^2 [low

FIGURE 1. Flow chart for the animal study. MTrS = myofascial trigger spot, EPN = endplate noise.



dose group] or 72 J/cm^2 [high dose group]. The other side was treated with sham laser irradiation [control side]. After each assessment or treatment, the skin was closed with sutures as soon as possible. The wounds were cleaned daily. The animals were also treated with cephalothin via intramuscular injection at a dose of 12.5 mg/kg every 6 hours per day for six consecutive days after the initial surgery. All of the surgical procedures were performed under aseptic condition. This study design was approved by the Committee on Animal Care and Use of Hungkuang University.

Identification of Myofascial Trigger Spots

Identification of the MTrS followed the techniques described previously (17). Before an anesthetic was given, the most tender spot of the bilateral hind legs in each rabbit was identified by finger pinch and observation of the rabbit's painful reaction [withdrawal of the lower limb, turning its head, and screaming, etc.]. This painful region, which contained the MTrS, was marked on the skin with an indelible marker as the area designated for laser application and EPN assessment.

Each rabbit was then placed under isoflurane anesthesia at a concentration of four percent for induction, followed by a maintenance concentration of one to two percent (34). Once the rabbit was anesthetized, the hair around the marked area was shaved. If necessary, the area was remarked. Under aseptic surgical procedures, the skin was incised. The biceps femoris muscle was exposed and separated from the underlying semimembranosus muscle. The biceps femoris muscle was grasped between the fingers from behind, and the muscle was palpated by gently rubbing [rolling] between the fingers to find a taut band. A taut band feels like a clearly delineated rope of muscle fibers and is roughly 2 to 3 mm or more in diameter. The fibers of the taut band are unmistakably firmer in consistency than the surrounding muscle. The MTrS region [corresponding to the marked skin area] in the taut band was then encircled with two parallel stitches with 3–0 nylon thread. This encircled area was about 0.5 cm × 0.5 cm.

Cold Laser Irradiation

A continuous 660-nm GaAlAs diode laser [Aculas-Am series, multi-channel low-level laser therapy system; Konftec Corporation,

Taipei, Taiwan] was used in this study. After sterilization, the hand-held delivery probe was placed lightly on the MTrS [the marked region encircled by the 3–0 nylon suture stitches]. The spot size was approximately 0.2 cm^2. The output power of the laser irradiation on the experimental side in the low dose group was 30 mW per session [energy per session: 5.4 J, energy density: 27 J/cm^2, irradiation time: 180 seconds]. The energy intensity applied on the experimental side in high dose group was 80 mW per session [energy per session: 14.4 J, energy density: 72 J/cm^2, irradiation time: 180 seconds]. The output of the equipment was checked by the laser check power meter [Coherent, Santa Clara, CA, US]. A similar procedure was applied to the control side, but the laser dose was adjusted to 0. The animals were treated daily for a total of six sessions of treatment. The cumulative laser energy on the experimental side was 32.4 J for the low dose group and 86.4 J for high dose group [Figure 1].

Settings for the Electromagnetic Recording Device

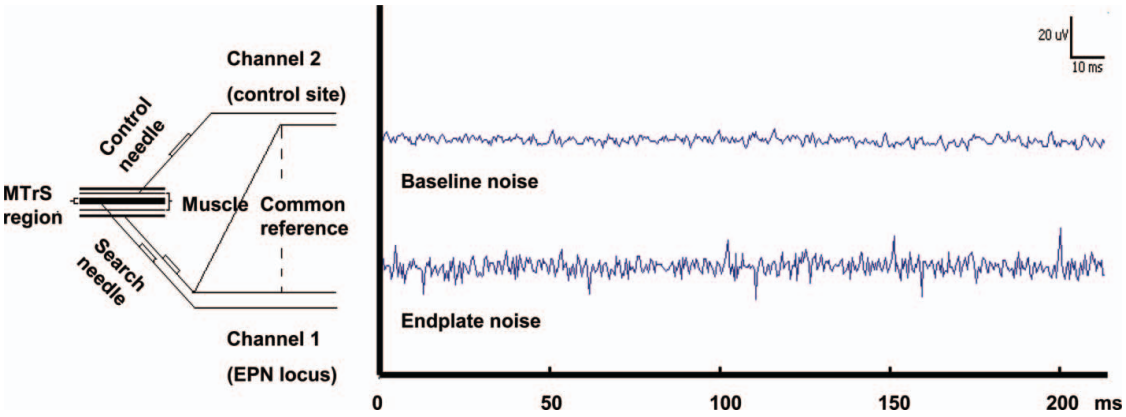
For EPN assessment, an EMG machine [Dantec Elektronik, Skovlund, Denmark] with monopolar needle electrodes [37-mm, disposable, teflon-coated, model 902-DMF37-TP; VIASYS/Cardinal Healthcare, Dublin, OH, US] were used. The search needle [for EPN recording] was inserted into the MTrS region and was connected to channel 1 of the EMG machine. The control needle was inserted into the non-taut band region near the MTrS in the same muscle and was connected to channel 2. A common reference needle [for both channels] was placed on the incised skin [Figure 2]. The sensitivity was set at 20 μV per division. The sweeping speed of the screen was set at 10 milli second per division. The montage was completed by proximal application of the 2-cm-diameter disc ground electrode to the subcutaneous tissue. The benefits of these settings were (1) to identify the low-amplitude EPN potentials as clearly as possible and (2) to provide an equally sensitive control channel that could demonstrate the lack of activity in nearby muscle fibers.

Assessment of the Endplate Noise Prevalence

This procedure was conducted as described previously (25) and was performed by an investigator who was blind to the laser treatment. The search needle for EPN recording was inserted parallel to the direction of the muscle fibers into the MTrS region, at an angle approximately 60° to the surface of the muscle. After initial insertion, the needle was advanced very slowly while being slowly rotated. Each advance was about 1 mm. Large advances were avoided because of the minute size of an active locus and the likelihood of inducing a LTR instead of finding a locus of EPN.

When the search needle approached an active locus, continuous distant electrical activity [i.e., EPN] could be heard [Figure 2]. The search needle was then pressed laterally in three directions, one of which often resulted in the appearance of EPN. If not, the search needle was advanced a

FIGURE 2. The method of electrode probing into the muscle and a typical electromyographic recording of endplate noise. MTrS = myofascial trigger spot, EPN = endplate noise.



minimum distance, which might then result in appearance of EPN. A site was designated an EPN locus when spontaneous continuous low-voltage potentials of at least 10 μV were maintained for at least 30 seconds. Since EPN locus could not usually be found in the control site, we did not expect to see any change of EPN. Instead, only baseline noise was recorded at the control site.

After five advances in one direction [one track], the search needle was withdrawn to its starting point and then redirected to penetrate unexplored muscle tissue on a second track. In total, 25 different loci along five tracks were explored in one MTrS region. For each rabbit, both sides of the biceps femoris muscle were assessed. This procedure was performed before and immediately after the first and the last sessions of laser treatment.

Data Analysis

Data for EPN occurrences within each MTrS in both sides were collected before treatment and immediately after the first and last laser treatments for each rabbit in both groups. The EPN prevalence in each MTrS region was calculated using the following equation:

$$\text{EPN prevalence}\,[\%] = [\text{EPN occurrences}]/[25\ \text{loci in one MTrS region}] \times 100\%.$$

The percentage change in the values after treatment compared to the pretreatment value was utilized for statistical analysis, using the following formula:

$$\text{Change}\,[\%] = [\text{posttreatment value} - \text{pretreatment value}]/[\text{pretreatment value}] \times 100\%.$$

A repeated-measures analysis of variance was used to compare values before the treatment with those after the first and last treatments in the same side of each group. Bonferroni's modified test was used as the post-hoc test. A paired *t*-test was used to compare values between the control and experimental sides in the same group. An independent *t*-test was used to compare values either on the control sides or the experimental sides between two groups. $P < 0.05$ was considered to be statistically significant. All statistical analyses were performed using the Statistical Package for the Social Sciences Version 12.0 for Windows [SPSS Inc., Chicago, IL, US].

RESULTS

Immediate and Dose-dependent Effects

As shown in Table 1, the mean EPN prevalence before treatment was approximated 50 to

TABLE 1. Comparison of Endplate Noise Prevalence Before Treatment and After the First and Last Sessions of Laser Treatment

			Immediate effect		Cumulative effect	
Group	Side	Pre [%]	Im [%]	Change$_i$ [%]	Last [%]	Change$_l$ [%]
Low-dose	Control	52.00 ± 13.06	47.60 ± 13.79	6.43 ± 26.90	40.40 ± 10.74	16.34 ± 38.53
	Experimental	58.80 ± 11.93	38.80 ± 7.55^b	30.48 ± 23.62^c	24.80 ± 7.96	53.93 ± 24.73
p value[a]		0.188	0.066	0.011^d	0.005^e	0.019^d
High-dose	Control	50.80 ± 11.00	46.40 ± 7.35	0.85 ± 44.23	47.20 ± 11.44	3.29 ± 26.45
	Experimental	56.00 ± 10.15	26.80 ± 11.63^b	52.06 ± 19.75^c	26.80 ± 9.62	50.84 ± 19.50
p value[a]		0.413	0.004	0.015^d	0.002^e	$< 0.001^e$

Values are mean $\pm$ standard deviation or *p* value.

[a]Paired *t*-test was used to compare the values between control and experimental side in each group.

[b,c]Independent *t* test was used to compare the values in experimental side between two groups. $P < 0.05$.

[d]$p < 0.05$.

[e]$p < 0.01$.

EPN = endplate noise, Pre = EPN prevalence in experimental side before laser treatment, Im = EPN prevalence in experimental side immediately after the first session of laser treatment, Last = EPN prevalence in experimental side after the sixth session of laser treatment, Change$_i$ = difference between pretreatment value and the value after the first session of laser treatment, Change$_l$ = difference between pretreatment value and the value after the sixth session of laser treatment.

60 percent in each group. There were no significant differences in the pretreatment values of EPN prevalence between the two sides in the same group or the same side in the two groups [$P > 0.05$]. After the first treatment, there was no significant difference between the pretreatment and the posttreatment data for EPN prevalence on the control side in the low dose group [$P > 0.05$, Figure 3]. Similarly, there was no significant difference between the pretreatment and the posttreatment data for EPN prevalence on the control side in the high dose group [$P > 0.05$, Figure 4]. In contrast, the mean EPN prevalence on the experimental side was significantly decreased after the first treatment in both groups [$P = 0.006$ in the low dose group, Figure 3; $P < 0.001$ in the high dose group, Figure 4]. After the data were normalized to percent change, the values on the experimental side in the high dose group were significantly greater than in the low dose group [$P = 0.040$].

Cumulative and Ceiling Effects

After a total of six sessions of laser treatment on the experimental side in the low dose group, the mean EPN prevalence was significantly lower than both the pretreatment value and the value after the first treatment [$P < 0.05$, Figure 3]. As shown in Figure 4, the mean EPN prevalence on the experimental side in the high dose group after the last treatment was significantly lower than the pretreatment value [$P < 0.001$] but was not significantly different from that after the first treatment [$P > 0.05$]. After the data were normalized to percent change, there was no statistical difference on the experimental side between the two groups [$P > 0.05$]. In other words, the ceiling effect was found when LLT was applied on MTrS after six sessions of treatment in the high dose group. The calculated dose of LLT on irritability of EPN was 14.4 J per session.

FIGURE 3. Endplate noise prevalence in the low dose group at baseline and after the first and sixth sessions of laser treatment. Values are mean ± standard deviation. A repeated-measures analysis of variance was used to compare the values either in the experimental side or the control side. Bonferroni's modified test was used as the post-hoc test. EPN = endplate noise, $^{*}p < 0.05$.

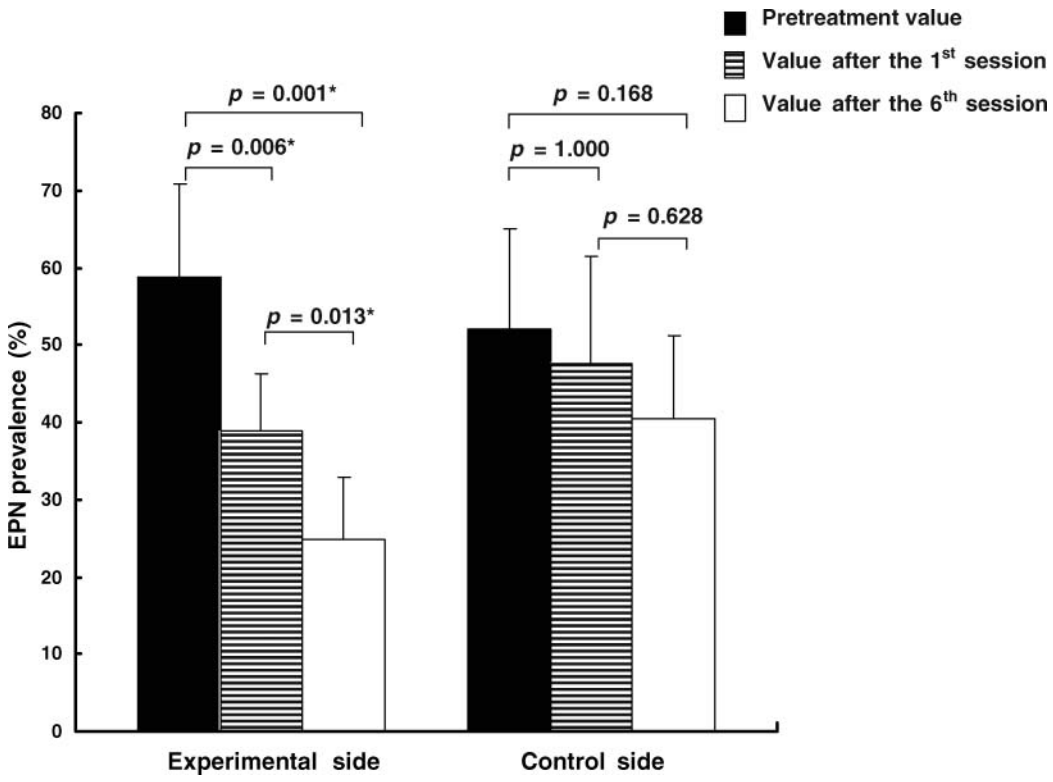
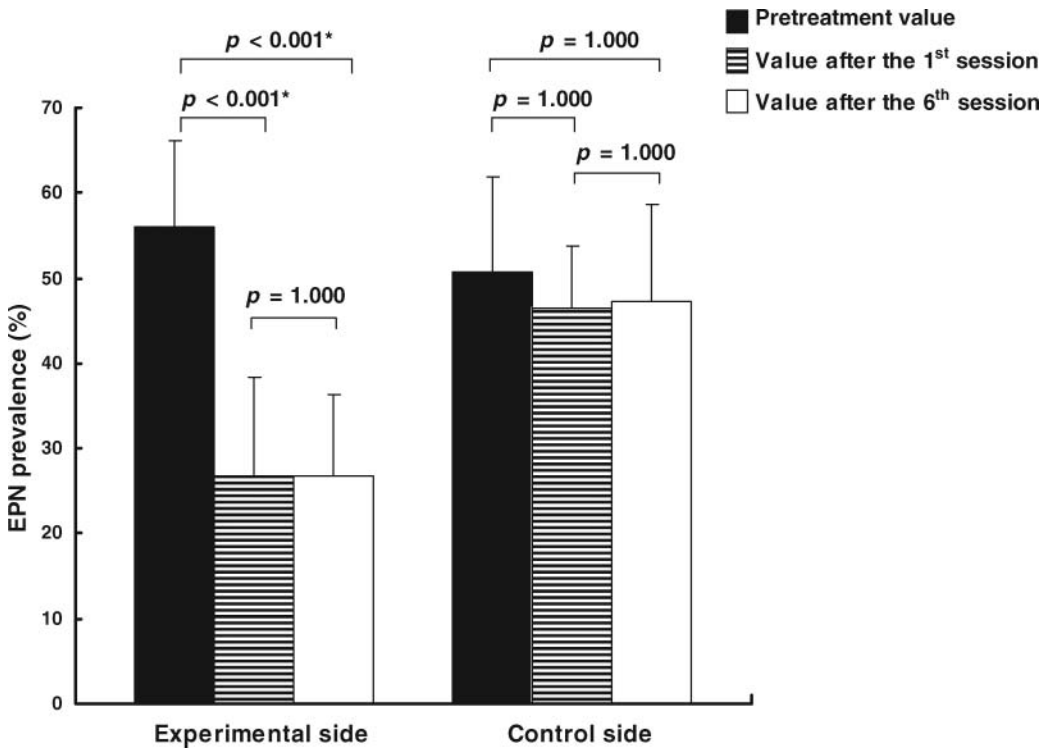


FIGURE 4. Endplate noise prevalence in the high dose group at baseline and after the first and sixth sessions of laser treatment. Values are mean ± standard deviation. A repeated-measures analysis of variance was used to compare the values either in the experimental side or the control side. Bonferroni's modified test was used as the post-hoc test. EPN = endplate noise, $^{*}p < 0.05$.



DISCUSSION

The results of this animal study demonstrate that a 660-nm GaAlAs laser can suppress irritability in the MTrS region, on the basis of an assessment of EPN prevalence. The degree of suppression of EPN prevalence was affected by the dose provided by the laser treatment. After a single session of LLT with an energy density of 27 J/cm^2 and 72 J/cm^2, the EPN prevalence on experimental side was decreased with the degree of decrease proportionate to the dose. For either dose, an immediate effect with dose dependency was found. After completion of the six sessions of laser treatment, the reduction in EPN prevalence persisted in the low dose group [with a cumulative energy of 32.4 J]. This finding indicates a cumulative effect of laser therapy. On the other hand, when the cumulative energy in the high dose group reached 86.4 J after six sessions of treatment, the reduction in EPN prevalence achieved a plateau. It appears that a ceiling effect exists in high dose laser therapy.

The Issue of Laser Dose

The optimal therapeutic dose of LLT for MPS is still uncertain. In the literature, positive effects of LLT at a various range of doses have been reported. Hakguder et al. (3) reported a study in which 62 patients with MPS having an active TrP in the neck or upper back regions were randomly divided into two groups and received stretching exercises with or without LLT. The TrP was treated with a 780-nm GaAsAl laser with a continuous power output of 5 mW for 196 seconds each session, for 10 sessions. Calculated laser energy on each point was 0.98 J per session and the cumulative energy was 9.8 J for 10 sessions. The outcome measurements included visual analog scale [VAS], algometry on the TrP, algometric difference, thermographic difference, and thermal asymmetry, recorded at baseline, immediately after and three weeks after completion of therapy. Group comparisons revealed significant improvements in all parameters in the laser group. In another study by Djavid et al. (7), an

810-nm continuous-wave GaAlAs laser with an energy density of 27 J/cm^2 [spot size of 0.2211 cm^2] was applied for patients with chronic low back pain. Eight points in the paravertebral region [L2 to S2–S3] were treated for 20 minutes each session and a total of 12 sessions in six weeks were given. Calculated laser energy on each point was 5.97 J per session and the cumulative energy of 12 sessions on each point was 71.6 J. VAS, lumbar range of motion, and the Oswestry disability index were measured at baseline and the sixth and 12th weeks. This study found that there was no greater effect of laser therapy plus exercise compared with exercise for any outcome at the sixth week. However, patients in the laser therapy plus exercise group had reduced pain, increased lumbar range of active flexion, and reduced disability scores compared to those in the exercise group at the 12th week. A long-term effect of LLT was demonstrated in this study. A much higher dose of LLT was applied in another study of 90 patients with chronic neck pain (6). All subjects were randomized to receive a course of 14 treatments over seven weeks with either active or sham laser treatment to tender areas of the neck. An 830-nm continuous-wave laser with a power density of 0.67 W/cm^2 was used. Tender points in the neck were treated for 30 seconds per point with up to 50 points per patient. Calculated laser energy at each point was 7.09 J per session and the cumulative energy at each point after 14 treatments was 99.33 J. This study demonstrated that the pain intensity [VAS, Northwich Park neck pain questionnaire, McGill pain questionnaire-VAS], quality of life [short-form 36-physical score], and disability scores [neck pain and disability scale, self-assessed improvement] were significantly improved in the laser group. In another study, Wang (1) investigated the dose effect of LLT using different irradiation times for two groups. A pulsed-mode [20-kHz] GaAs laser with an average power output of 95 mW and a spot size of 0.125 cm^2 was used for patients with chronic myofascial pain. The irradiation time was 20 seconds in one group and 40 seconds in the other group. Six sessions of laser treatment were given. Calculated laser energy for each group was 1.9 J and 3.8 J per session. The subcutaneous energy, which was 10 percent of the surface energy, was 0.19 J and 0.38 J per session. There were no significant differences in the changes in VAS or number of TrPs between these two groups after treatment. A dose-dependent effect was not found. However, the dose of the laser in both groups was lower than those in most of the studies described above and those in the present study. The wavelength and mode of LLT were different from the instrument used in the present study.

In an animal study, it is difficult to measure the pain intensity. As EPN prevalence in the TrP region is highly correlated with both pain intensity and pain pressure threshold in human studies (32), the prevalence of EPN in the MTrS region was used in the present study to assess the efficacy of LLT in rabbits. In the authors' previous study (33), it was demonstrated that the EPN prevalence was reduced by 660-nm continuous-wave GaAlAs laser treatment [power output: 30 mW per session, energy density: 9 J/cm^2, spot size: 0.2 cm^2, irradiation time: 60 seconds], both after one and six sessions of treatment [energy per session: 1.8 J, cumulative energy: 10.8 J]. In the present study, the laser cumulative energy in both groups was among the energy used in the studies that showed positive effect of LLT (3, 6, 7). The EPN prevalence was suppressed after one and six sessions of treatment [energy per session: 5.4 J, cumulative energy: 32.4 J], and the degree of suppression was proportionate to the dosage in the low dose group. This finding suggests a dose-dependent effect. However, this proportionately suppressive effect on EPN prevalence was not found in the high dose group after high dose treatment for six sessions [energy per session: 14.4 J, cumulative energy: 86.4 J], indicating a ceiling effect in the high dose group.

Possible Mechanisms of Low-level Laser Therapy in Treating Trigger Points

Suppression of MTrS irritability may be only one of the therapeutic mechanisms of LLT in treating MPS. In the present study, a ceiling effect was found in the high dose group. To understand the results of this study further, one must understand that LLT conforms to the Arndt-Schultz principle, which implies that very low doses of laser treatment have no effect on cells, low doses stimulate cell processes, high doses inhibit cell processes, and that even higher doses result in photodynamic damage to cells. The results of this study appear to confirm this principle. That is, higher doses or excessive power output may suppress the induction of cumulative

activation of central hormonal/opioid pathways capable of regulating MTrS irritability. In other words, MTrS irritability was decreased but could not entirely be inhibited after six sessions of laser treatments, which may lead to incomplete relaxation of the muscle involved. This may also explain why the range of motion was not improved after laser treatment in some clinical studies (2, 5).

As previous studies have demonstrated that effectiveness of pain control was greater than that of range of motion (2, 5), other mechanisms of pain relief by LLT may exist. In the literature, most studies have investigated the therapeutic effects of LLT based on an animal model of inflammation (11–13, 35–39). Hagiwara et al. (39) found that β-endorphin precursors, proopiomelanocortin, and corticotrophin releasing factor were enhanced after the blood was pretreated by LLT [830-nm GaAlAs laser, total dose of 300 J, irradiation time of 3 minutes]. This increased peripheral endogenous opioid production provided an analgesic effect by LLT. Ferreira et al. (35) evaluated the analgesic effect of LLT with a helium-neon 632.8-nm laser [power output of 12 mW, energy density of 2.5 J/cm^2, irradiation time of 80 seconds] in an acute inflammatory rat model. They concluded that LLT inhibits the sensitization increase of nociceptors in the inflammatory process. The analgesic effect apparently involves a hyperalgesic mediator [i.e., PGE2] rather than peripheral opioid receptors. Aimbire et al. (12) demonstrated that LLT had a dose-dependent effect on reducing tumor necrosis factor alpha expression after acute immunocomplex lung injury in rats. Although it has been suggested that TrP is not an inflammatory lesion [as the major characteristics of TrP are referred pain and LTR and no inflammatory reaction can be found in histological studies] (21, 23), a recent study by Shah et al. (40) found that bradykinin, substance P, tumor necrosis factor alpha, interleukin [IL]-1β, IL-6, IL-8, norepinephrine, and serotonin were significantly greater in the locality of an active TrP. Although the inflammatory reaction in the TrP region may be a secondary phenomenon [focal ischemia due to compression of the taut band], the mechanism described above may partially explain the pain relief obtained through LLT treatment of MPS.

It has been hypothesized that MPS can be modeled as an energy crisis in which excessive release of acetylcholine from a dysfunctional nerve ending leads to sustained contraction of the involved muscle fibers (41). This sustained contractile activity would markedly increase metabolic demands and would squeeze the network of capillaries that supply the nutritional and oxygen needs of this region. The combination of increased metabolic demand and impaired blood supply could contribute to a severe but local energy crisis. In an animal study of ischemic injured muscle, Avni et al. (42) found that LLT induced the synthesis of antioxidants and other cytoprotective proteins [i.e., heat shock protein] to prevent degeneration following ischemia/reperfusion injury. This may be one of the therapeutic effects of treating MPS.

Hong has suggested that a TrP contains multiple sensitive loci [nociceptors] that are sensitive to mechanical stimulation (18–20). Consequently, activation of nociceptors at these sensitive loci may transmit impulses via the pain pathway to the brain and may inhibit pain perception through the mechanism of hyperstimulation analgesia [counter irritation].

In this study, it was designed so the MTrS in the experimental side of the rabbit's leg received laser therapy, but MTrS in the control side only received sham treatment. The EPN prevalence was assessed by one of our authors who was blinded to the side of laser application. The results of control sides in the low-dose and the high-dose group revealed a tendency toward decrease of EPN prevalence, though not statistically significant. It seemed that systemic effect of laser irradiation, dry needling effect [which was due to the needling procedure of EPN assessment], or time effect may also exist. However, we cannot clarify which is the main factor leading to decreased EPN prevalence in the control sides. In contrast, the only different factor in both experimental sides is the dose of laser treatment. As we mentioned before, dose-dependent, cumulative, and ceiling effect were found in this study. All these findings show the local effect of laser irradiation is the main factor of irradiation on MTrS.

Clinical Application and Future Work

During the past few decades, the number of double blind, randomized controlled clinical trials of LLT application to MPS has increased (1–9). However, standardized parameters for

LLT have not been developed. Variable wavelengths, energy intensities, and modes of LLT and outcome measurements were used in previous studies. The results of the efficacy of LLT applied to MPS have been inconsistent.

Our study determined that the range of doses provided by LLT is one of the factors that affect MTrS irritability. However, it is still unknown whether this effect exists for other wavelengths or modes when the same energy intensity is given, and therefore, further studies are necessary in the future. We still cannot judge what level of EPN prevalence can achieve an ideal pain-relieving effect because it is hard to measure a pain scale in an animal model. As in human subjects, the same question still remains because EPN prevalence is varied [in a wide range] in latent MTrPs [tender but not painful] (30–32). Therefore, further studies are necessary.

CONCLUSIONS

In the present study, the electrophysiological changes after LLT was applied to MTrS in rabbits were investigated. The results demonstrated the effectiveness of gallium-aluminum-arsenium laser irradiation on MTrS irritability with both a dose-dependent effect and a ceiling effect. The dose-dependent effect was found when a relatively low dose was given, and the ceiling effect appeared when a relatively high dose was applied.

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