

# EFFICACY OF LOW REACTIVE-LEVEL LASER THERAPY FOR PAIN ATTENUATION OF POSTHERPETIC NEURALGIA

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The efficacy of low reactive-level laser therapy (LLLT) for pain attenuation in patients with postherpetic neuralgia (PHN) was evaluated in 63 patients (25 males, 38 females with an average age of 69 years) managed at our pain clinic over the past four years. A double blind assessment of LLLT was also performed in 12 PHN patients. The LLLT system is a gallium aluminium arsenide (GaAlAs) diode laser (830 nm, 60 mW continuous wave). Pain scores (PS) were obtained using a linear analog scale (0 to 10) before and after LLLT. The immediate effect after the initial LLLT was very good (PS: 0-3) in 26, and good (PS: 7-4) in 30 patients. The long-term effect at the end of LLLT (the average number of treatments  $36 \pm 12$ ) resulted in no pain (PS: 0) in 12 patients and slight pain (PS: 1-4) in 46 patients. No complications attributable to LLLT occurred. Although a placebo effect was observed, decreases in pain scores and increases of the body surface temperature by LLLT were significantly greater than those that occurred with the placebo treatment. Our results indicate that LLLT is a useful modality for pain attenuation in PHN patients and because LLLT is a noninvasive, painless and safe method of therapy, it is well acceptable by patients.

KEY WORDS LLLT GaAlAs laser Double blind test Pain clinic PHN on postherpetic neuralgia

## Introduction

Chronic pain, especially postherpetic neuralgia (PHN), can be an extremely debilitating condition. The pain of PHN is characterized by a constant burning or aching on which may be superimposed a shooting or lancinating pain.<sup>1</sup> PHN can be diagnosed when pain persists in a dermatomal area long after the vesicular zoster eruption has healed. Although the early treatment of acute zoster with antiviral agents<sup>2</sup> and steroids<sup>3</sup> may reduce the subsequent incidence of PHN, there are still many patients referred to our pain clinic for treatment of this disorder. Treatment protocols for PHN in our institution include sympathetic block, oral pharmacological agents, transcutaneous electrical stimulation (TENS) and other. The use of low reactive-level laser therapy (LLLT) in pain management is a relatively new treatment and is used with increasing frequency in the management of chronic pain.<sup>4,5</sup> We have been using LLLT in patients with chronic pain of different origins for the past four years and

the aim of this clinical study was to evaluate the efficacy of LLLT for PHN.

## Methods

Sixty-three patients with PHN were selected for this study. Patients included 25 males and 38 females ranging in age from 33 to 91 years (mean  $69 \pm 13$  years). The LLLT system used has three gallium aluminium arsenide (GaAlAs) diode lasers and when used in continuous mode it has a maximum power output of 60 mW at 830 nm in the near infrared spectrum (model MLD-2001, Mochida, Japan). The power density is approximately  $1.2 \text{ W/cm}^2$  to  $3 \text{ W/cm}^2$  which is well below that necessary to cause a photothermal effect. A touch sensor, mounted at the tip of the probe, allows activation of the laser only when the sensor is in contact with the skin. Therefore, the eyes of patients and therapists are safe from accidental laser irradiation. Although the irradiation time and number of treatment areas and sessions depended on the size of the affected areas and the type of pain, the total irradiation time for each session was 10 to 20 min using 10 s for each painful point on the skin along the anatomical pathway of the affected nerves. LLLT was applied 2 to 3 times a week for outpatients and 4 to 6 times a week for inpatients.

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Pain scores were obtained using a linear analog scale (0–10). A score of 10 indicated maximum pain, whereas 0 correlated with no pain. The effect of LLLT was evaluated in two fashions: the immediate effect and the long-term effect (Tables 1, 2). The immediate effect of LLLT was classified as very good when pain scores were reduced from 10 before LLLT to 1–3 after LLLT; good when pain scores were reduced from 10 to 4–7; and no change when pain scores remained 8–10 after LLLT; or became worse. The effective ratio for the immediate effect was calculated as follows: patients with a good or very good effect divided by all patients  $\times 100$ .

The final assessment was made at the end of long-term LLLT and classified as no pain when pain scores reduced from 10 before LLLT to 0 after LLLT; slight pain when pain scores became 1 to 3; no change or worse. The effective ratio for long-term effect was calculated as follows: patients with no pain or slight pain divided by all patients  $\times 100$ . The long-term effect was also evaluated by separating the patients according to the duration and distribution of their pain and according to patient age.

A double blind crossover assessment of LLLT was performed in 12 patients with PHN who had been suffering for more than 1 year. After obtaining institutional approval and informed consent the patients were divided into two groups. Patients in group A received treatment with a placebo head for 5 min followed by a 5-min interval and then LLLT for 5 min. Patients in group B received LLLT first for 5 min followed by a 5-min interval and then the placebo treatment for 5 min. Neither the patient nor the therapist was aware of the identity of the probe heads. Pain scores and the body surface temperature measurements using thermography (NEC-Sanei, Japan) were completed before and after each treatment in patients in both groups. Statistical analysis was performed by Student's *t*-test and a value for *P* less than 0.05 was deemed statistically significant.

## Results

The average number of LLLT treatments was  $36 \pm 12$  for patients with PHN. The immediate and long-term effects of LLLT are summarized in Tables 1 and 2. The immediate effective ratio and long-term effective ratio were 90% and 89%, respectively. Although one patient complained of increased pain in the irradiated areas during LLLT, the long-term effect for this patient was good when her pain score was reduced to 3 after 48 treatments. There were no side effects attributable to LLLT in this series of patients.

The relation between the duration of PHN and the long-term effective ratio is shown in Table 3. There was no significant difference obtained between

**Table 1.** The immediate effect of LLLT

Very good	Good	No change	Worse	Total	ER(%)
27	30	5	1	63	90
	PS before LLLT			PS following LLLT	
Very good		10	→		3~0
Good		10	→		7~4
No change		10	→		10~8

$$\text{The effective ratio (ER)} = \frac{(\text{very good} + \text{good})}{\text{total}} \times 100\%$$

PS = Pain score.

**Table 2.** The long-term effect of LLLT

No pain	Slight pain	No change	Worse	Total	ER(%)
12	46	5	0	63	89
	PS before LLLT			PS following LLLT	
No pain		10	→		0
Slight pain		10	→		4~1
No change		10	→		10~8

$$\text{The effective ratio (ER)} = \frac{(\text{no pain} + \text{slight pain})}{\text{total}} \times 100\%$$

PS = Pain score.

**Table 3.** Duration of postherpetic neuralgia and LLLT effective ratio (ER)

Period	No pain	Slight pain	No change	Worse	Total	ER(%)
1m – 3m	9	9	0	0	18	100
3m – 6m	2	8	1	1	11	87
6m – 1y	1	9	1	1	11	90
1y – 5y	0	15	3	0	18	83
5y –	0	5	0	0	5	100
	12	46	5	0	63	91

the effectiveness of LLLT in patients suffering from PHN for 1 to 3 months and those in whom the disorder had persisted for more than 5 years. In both groups the effective ratio was 100%. However, in nine of 18 patients in the 1–3 months group the pain was completely relieved, while no patient in whom persistent pain was reported for more than 5 years was completely pain free. The percentage of patients with no pain is 50 in the 1 to 3 months group, 18 in the 3 to 6 months group, 9 in the 6 to 12 months and 0 for patients with PHN for over 1 year.

LLLT was most effective when pain was located in the upper and lower limbs, and least effective on

the trunk (Table 4). Although the effective ratios in patients below 60 years of age were good (100%), the treatment was less effective in older patients (Table 5). It is notable that 75% of patients below 60 years of age had no pain, but only 5% of patients over 60 years of age had no pain.

Although long-term follow-up to date has been limited, 9 younger patients who obtained complete pain relief have remained pain free. Three patients of older age group have had some recurrence of their PHN. Although the pain returned, pain scores were 3 or 4, which the patients found to be an acceptable level not requiring any treatment. About half of the patients with slight pain in older age group demonstrated an increase in pain score of 5 or 6, and LLLT was repeated.

The pain scores and the body surface temperature for the two groups are summarized in Table 6. In

**Table 4.** The effect of distribution on LLLT effective ratio (ER)

Region	No pain	Slight pain	No change	Worse	Total	ER(%)
Head and neck	3	11	1	0	15	93
Upper limb	1	5	0		6	100
Thorax	5	19	2		26	91
Trunk	2	7	2		11	81
Lower limb	1	4	0		5	100
	12	46	5	0	63	91

**Table 5.** Effect of age on LLLT effective ratio (ER)

Age	No pain	Slight pain	No change	Worse	Total	ER(%)
30 - 39y	3	0	0	0	3	100
40 - 49	1	0	0		1	100
50 - 59	5	3	0		8	100
60 - 69	2	19	1		22	95
70 - 79	1	17	2		20	89
80 -	0	7	2		9	77
	12	46	5	0	63	91

**Table 6.** Effects of LLLT and placebo on pain score and body surface temperature

Group	Pain score (0 - 10)		Temperature (°C)	
	A	B	A	B
Control	10	10	33.0 ± 0.7	32.9 ± 0.7
5 min	8.5 ± 1.6	4.0 ± 2.1*†	33.1 ± 0.6	33.8 ± 0.6*†
10 min	8.0 ± 2.2	3.5 ± 2.4*†	33.0 ± 0.6	33.7 ± 0.5*†
15 min	3.0 ± 2.6*	3.5 ± 2.4*	33.6 ± 0.5*	33.7 ± 0.7*

(Mean ± S.D.).

\**P* < 0.05 compared to control values.

†*P* < 0.05 group A versus group B.

group A the placebo treatment did not improve pain scores and did not change in temperature, while LLLT decreased pain scores and increased temperature significantly (Figure 1). In group B LLLT decreased pain scores and increased temperature significantly. These changes were sustained during the placebo treatment (Figure 2).

## Discussion

Those results indicate that LLLT by GaAlAs diode laser effectively attenuates the pain of postherpetic neuralgia (PHN) and provides both immediate and long-term analgesia. However, no patient who had suffered from PHN for more than a year was classified as pain-free, while there were 12 patients with a pain score of 0 in patients suffering for less than a year. This suggests that the duration of symptoms is an important factor in pain attenuation by LLLT in PHN patients. Therefore, the early initiation of LLLT should be strongly recommended for PHN. The effective ratio of LLLT for PHN in the trunk was lower than for other regions. Although laser beams of wavelength of 830 nm are thought to best penetrate in the irradiated areas, some laser beams may be absorbed by the surrounding tissues of the affected nerves in the trunk than in the head, neck, and upper and lower limbs.

The use of LLLT for PHN was more effective in patients under 60 years than in patients over 60. This is inconsistent with the fact that intense, prolonged PHN is more common in patients over 60. Therefore, any study evaluating the efficacy of LLLT treatment should consider the age distribution of the patients.<sup>6</sup> The assessment of PHN using pain scores is useful in evaluating the efficacy of LLLT because of its simplicity and the ease of patient response. However, pain scores may also reflect individual psychological and emotional influences, because it is a purely subjective assessment. Therefore, a double blind assessment is also useful for evaluating the efficacy of LLLT. Our double blind crossover assessment clearly showed that pain scores were significantly decreased by LLLT but not by the placebo treatment. Furthermore, an increase in

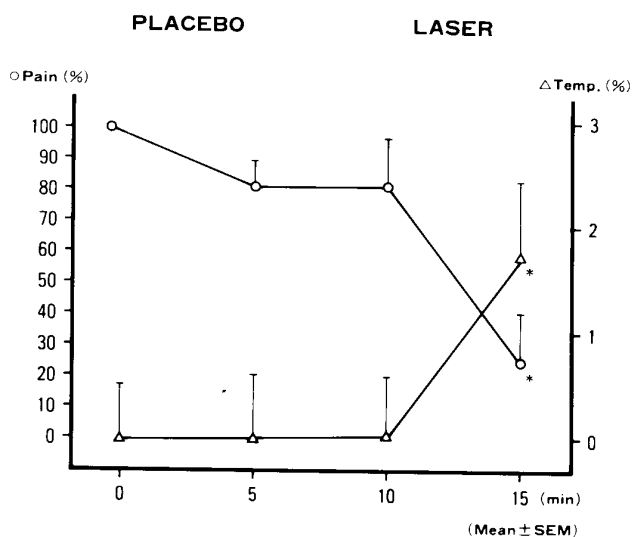


Figure 1. Percentage change in pain score and temperature by either placebo or laser in group A

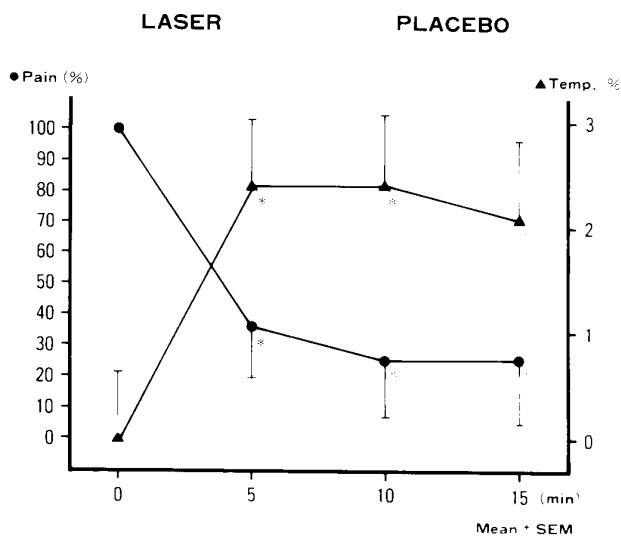


Figure 2. Percentage change in pain score and temperature by either laser or placebo in group B

body surface temperature by LLLT was helpful to objectively assess the effect of LLLT.

Although the mechanism of analgesia produced by LLLT is not clear yet, the increased blood flow in the irradiation areas, as shown by an increase in the body surface temperature, may be important and our previous study utilizing a laser Doppler blood-flow meter also showed that LLLT (GaAlAs diode laser) increased the cutaneous blood flow by 30% above control in patients with PHN.<sup>7</sup> The increased blood flow produced by LLLT may contribute to pain reduction as do sympathetic blocks, by producing vasodilation and a subsequent increase in the transfer of pain mediating substances.<sup>8</sup>

Also, Choi *et al.* reported that He-Ne laser relaxed spastic skeletal muscles in humans,<sup>9</sup> which is also helpful for pain attenuation of PHN. However, these facts are not sufficient to explain the immediate effect of LLLT and an acupuncture-like effect of LLLT might also be expected. The analgesic action of GaAlAs laser can be antagonized by naloxone.<sup>10</sup> It has recently been reported that LLLT can reduce the pain-producing action of bradykinin in rat peripheral nerve tissue,<sup>11</sup> and it was also thought to assist with the pain reduction process that the irradiation of rat saphenous nerve achieved.<sup>12</sup> Walker and Akhanjee reported that He-Ne laser decreased somatosensory evoked potentials by

irradiation on the pathway of painful stimuli.<sup>13</sup> They also reported that the central nervous system was photosensitive because LLLT suppressed the epileptiform activity in hippocampal slices of rats.<sup>14</sup> Further investigations in effects of LLLT on nervous tissue will help us understand the mechanism of LLLT for pain attenuation more precisely.

There are many reported treatments for PHN including pharmacologic agents, regional analgesics, electrical stimulation, acupuncture and even surgical intervention.<sup>1</sup> However, no consistently reliable therapy for PHN has been found. This is because PHN, like most pain caused by damage to nervous system, does not respond to treatment in the same way as pain resulting from other types of tissue damage. In our patients, PHN responded well to LLLT, which suggests that LLLT may promote healing of nerve tissue damaged by *Herpes zoster*,<sup>15</sup> and that repeated irradiation should be suggested for pain attenuation of PHN.<sup>16</sup>

In this study limited follow-up showed that the pain attenuation achieved by LLLT has been maintained in the majority of patients with an associated improvement in the quality of life. However, in PHN any treatments should have a low risk of morbidity because of low probability of long-term benefit. In this regard, LLLT is a noninvasive, painless and safe method of treatment and should be recommended as an early intervention for pain therapy of PHN.

In conclusion, LLLT by GaAlAs diode laser is an alternative modality for pain attenuation of PHN.

## References

1. Laeser, J. D. (1990). *Herpes zoster* and postherpetic neuralgia. *The Management of Pain*, 2nd Edn (ed. Bonica, J. J.) pp. 257–263. Lea & Febiger, Philadelphia.
2. Huff, J. C. (1987). Oral acyclovir therapy of acute *Herpes zoster*: a multicentre study. *Research and Clinical Forums* **2**, 37–43.
3. Keczek, K. and Basheer, A. M. (1980) Do corticosteroids prevent post-herpetic neuralgia? *British Journal of Dermatology* **102**, 551–559.
4. Okada, K., Oshiro, T., Kato, Y. and Shibasaki, M.

- (1983). The gallium aluminum arsenide diode laser in pain therapy. *Japanese Journal of Anesthesiology* **32**, 246–252 (abstract in English).
5. Oshiro, T. (1988). Practical application of the contact technique. *Low Level Laser Therapy: A Practical Introduction* (eds Oshiro, T. and Calderhead, R. G.) pp. 86–115. John Wiley, Chichester.
6. Brown, G. R. (1976). *Herpes zoster*: Correlation of age, sex, distribution, neuralgia, and associated disorders. *Southern Medical Journal* **69**, 576.
7. Nishida, N., Takigawa, C., Goda, Y., Kemmotsu, O., Fugii, H. and Asakura, T. (1988). Laser therapy for postherpetic neuralgia. *Pain Clinic* **8**, 6–11 (abstract in English).
8. Kamikawa, K. (1983) Development of laser acupuncture systems and their clinical applications. *New Frontiers in Laser Medicine and Surgery* (ed. Atsumi, K.) pp. 489–498. Excerpta Medica, Amsterdam.
9. Choi, J. J., Srikantha, K. and Wu, W. H. (1986). A comparison of electroacupuncture, transcutaneous electrical nerve stimulation and laser photostimulation on pain relief and glucocorticoid excretion. *Acupuncture Electro Therapy Research* **11**, 45–51.
10. Yamamoto, H., Ozaki, A., Iguchi, N. and Kinoshita, S. (1988) Antinociceptive effects of laser irradiation of Hoku point in rats. *Pain Clinic* **8**, 43–48 (abstract in English).
11. Maeda, T. (1989). Morphological demonstration of low reactive laser therapeutic pain attenuation effect of the gallium aluminum arsenide diode laser. *Laser Therapy* **1**, 23–26.
12. Kudoh, C., Inomata, K., Okajima, K., Motegi, M. and Ohshiro, T. (1989) Low level laser therapy pain attenuation mechanism: histochemical and biochemical effects of 830 nm gallium aluminum arsenide diode laser radiation on rat saphenous nerve Na-K-ATPase activity. *Laser Therapy* **1**, 3–6.
13. Walker, J. B. and Akhanjee, L. K. (1985). Laser-induced somatosensory evoked potentials: evidence of photosensitivity in peripheral nerves. *Brain Research* **344**, 281–285.
14. Walker, J. B., Swartwelder, H. S. and Bondy, S. C. (1989). Suppression of hippocampal epileptiform activity *in vitro* after laser exposure. *Laser Therapy* **1**, 19–21.
15. Mester, E. (1980) Laser application in promoting wound-healing. *Lasers in Medicine* (ed. Koebner, H. K.) pp. 190–213. John Wiley, Chichester.
16. Iijima, K., Shimoyama, N., Shimoyama, M., Yamamoto, T., Shimizu, T. and Mizuguchi, T. (1989). Effect of repeated irradiation of low-power He-Ne laser in pain relief from postherpetic neuralgia. *The Clinical Journal of Pain* **5**, 271–274.