FACTA UNIVERSITATIS
Series: **Medicine and Biology** Vol.13, No 1, 2006, pp. 11 - 14 UC 615.831:616.379-008.64:616.833

ELECTROPHYSIOLOGICAL EVALUATION OF LOW-INTENSITY LASER THERAPY IN PATIENTS WITH DIABETIC POLYNEUROPATHY

***Zoran Perić*[1], *Bratislav Cvetković*[2]**

[1]*Clinic for Mental Health, Neurology and Psychiatry of Developmental Age, Clinical Center Niš*
[2]*Clinic for Physical Medicine and Rehabilitation, Clinical Center Niš*

Summary. *We analyzed 45 patients (20 females), average age 55.08 years ($X \pm SD = 55.08 \pm 11.73$), who had clinical and electroneurographic (ENG) signs of painful diabetic polyneuropathy (DPN). The patients were divided into two basic groups: Group A - 30 patients with DPN who received 30 low-intensity laser therapy (LILT) treatments over the period of 12 weeks; and control Group B - 15 patients with DPN who received only vitamin therapy per os (Beviplex Drag, 3×1) within the same period. Group A was divided into two subgroups: A1 - 20 patients treated only with LILT; and A2 - 10 patients under LILT and aneurin electrophoresis and kinesitherapy treatment. The LILT device had a wavelength of 904 nm and a total power of 60 mW. All LILT treatments lasted for 1 minute per site (four paravertebral points in the lumbosacral region, three points along n.ischiadicus and two points on the dorsum of the feet). Prior to and after 12 weeks of treatment, the following parameters were determined using surface electrodes: motor (MCV) and sensory conduction velocities (SCV) values of n. peroneus (NP) and n. ulnaris (NU), their motor distal latency (MDL) values, and M-potentials amplitude of NP (registered in m.extensor digitorum brevis), as well as neural potentials of NU amplitude (registered with antidromic technique over the skin of the hand's little finger). The patients in Group A showed a significant increase in NU neural potential amplitude after LILT treatment ($p < 0.05$) and this indicated that LILT has an indirect influence upon the sensory axon function of NU in patients with painful DPN. LILT has no direct significant influence upon SCV and MCV values of NP and NU in patients with painful DPN. During the period of LILT treatment, patients with painful DPN do not need other types of physical therapies. Age has no significant influence on the analyzed electrophysiological parameters values registered before and after LILT in patients with painful DPN.*

Key words: *Laser therapy, low intensity, electrophysiological evaluation, diabetic polyneuropathy*

Introduction

Diabetic sensory and sensory-motor polyneuropathy (DPN) are the most common forms of diabetic neuropathy (DN). Patients suffering from DPN may feel a burning pain in the feet, a spontaneous, deep, and aching pain, or lightning stabs of pain. Hyperalgesia may also occur in diabetics with DPN (1). Chronic painful neuropathy symptoms can have a considerable impact on an individual's quality of life and may be associated with anxiety, depression and loss of mobility (2). Painful DPN is often resistant to treatment with analgesics and various other medicaments recommended to DPN patients for pain relief, such as phenothiazines, anticonvulsants, and tricyclic antidepressants, inducing numerous adverse effects. In this situation, non-pharmacological therapy, such as low-level laser therapy (LLLT) or low-intensity laser therapy (LILT), may be effective adjunctive or alternative treatments for painful DPN (3), and this therapy was recently classified in the group of "Other physical therapies in management of diabetic peripheral neuropathy" (4).

Laser is an acronym for "light amplification by stimulated emission of radiation". Therapeutic laser applications can be of high power (for vascular abnormalities, laser angioplasty, the CO_2 laser, excimer laser, etc.), medium power (photodynamic therapy, photoangioplasty) and LILT. LILT devices are usually HeNe or diode lasers, or light-emitting diodes, producing red or infrared radiation of low enough power (2-200 mW) and emitting little or no physiologically significant heating. There is clear evidence that LILT has effects at the cellular level and that different wavelengths have different effects (5). Since 1960, LILT has been used clinically in more than 85 institutions in over 37 countries, mostly in Eastern Europe and Asia, and particularly in Russia. Many studies about LILT have been published in regional or national publications in various countries (6), including ours as well (7,8), but they are not indexed in Medline or similar databases. We used Medline database to search for possible applications of LILT therapy in DPN and found only two articles (3,9), one of them being a case report (9). In two articles (3,7), pain scores and nerve conduction velocities were examined, but we

did not find any article with a detailed electrophysiological analysis of LILT influence upon the sensory and motor axons function of peripheral nerves in patients with DPN.

Subjects and Methods

We analyzed 45 patients (20 females) with clinical and electroneurographic (ENG) signs of painful DPN, average age 55.08 years (X ± SD = 55.08 ± 11.73). The patients were divided into two basic groups: 30 patients with DPN received 30 LILT treatments over the period of 12 weeks (Group A), and 15 patients with DPN were treated only with vitamin therapy per os (Beviplex Drag, 3×1) during the same period (control Group B). Group A was further divided into two subgroups: 20 patients were treated only with LILT (Group A1) and 10 patients received LILT as well as aneurin electrophoresis (aneurin amp 250 mg/2 ml) and kinesitherapy (exercises one hour every day, five days per week) (Group A2). All the patients with diabetes and other diseases likely to confound the assessment of neuropathy were excluded from the study. The LILT device had a wavelength of 904 nm and a total power of 60 mW. All LILT treatments lasted for one minute per site (four paravertebral points in the lumbosacral region, three points along n.ischiadicus and two points on the dorsum of the feet). Prior to and after 12 weeks of treatment, the following parameters were determined using surface electrodes: motor (MCV) and sensory conduction velocities (SCV) values of n. peroneus (NP) and n. ulnaris (NU), their motor distal latency (MDL) values and M-potential amplitude of NP (registered in m.extensor digitorum brevis), as well as neural potential amplitude of NU (registered with antidromic technique over the skin of the hand's little finger). The M and neural potential amplitude was measured from positive to negative peaks of potentials. The values of skin temperature of the patients' hands and feet were maintained at 32°C.

We performed a statistical analysis to determine the arithmetical mean value (X) and standard deviation (SD) of the registered electrophysiological parameters. The results were evaluated for statistical significance using a Student's t-test. We also determined Pearson correlation (sig.2-tailed) coefficient (r) between the registered electrophysiological parameters and the age of the patients.

Results

1. Mean values (X±SD) of electrophysiological parameters before and after LILT in patients with DPN (Group A and Subgroups A1 and A2)

The patients in Group A showed a significant increase in NU neural potential amplitude after LILT treatment ($p < 0.05$). In Subgroup A1 we also registered a significant increase in NU neural potential amplitude after LILT treatment ($p < 0.05$), but not in Subgroup A2. LILT treatment had no significant influence ($p > 0.05$) upon other analyzed electrophysiological parameters values in Group A (see Table 1).

Table 1. Mean values (X±SD) of electrophysiological parameters in patients with DPN (Group A).

Parameter	Group A (N = 30)		p	Subgroup A1 (N = 20)		p	Subgroup A2 (N = 10)		p
	before LILT	after LILT		before LILT	after LILT		before LILT	after LILT	
1. NPDML (ms)	4.33 ± 0.79	4.32 ± 0.81	n.s.s.	4.29 ± 0.81	4.26 ± 0.96	n.s.s.	4.40 ± 0.79	4.44 ± 0.21	n.s.s.
2. NPMCV (m/s)	40.99 ± 6.98	41.56 ± 6.13	n.s.s.	41.47 ± 8.05	42.38 ± 6.94	n.s.s.	39.89 ± 3.78	39.70 ± 3.36	n.s.s.
3. NPM-Amp (mV)	2.38 ± 1.34	2.07 ± 1.62	n.s.s.	2.40 ± 1.51	2.32 ± 1.70	n.s.s.	2.34 ± 0.97	1.90 ± 1.05	n.s.s.
4. NPSCV(m/s)	36.67 ± 4.43	37.01 ± 4.61	n.s.s.	36.69 ± 5.22	37.31 ± 5.08	n.s.s.	36.61 ± 1.95	36.35 ± 3.58	n.s.s.
5. NUMDL (ms)	2.83 ± 0.49	2.94 ± 0.64	n.s.s.	2.95 ± 0.54	2.92 ± 0.71	n.s.s.	2.53 ± 0.21	2.98 ± 0.46	n.s.s.
6. NUMCV (m/s)	50.08 ± 6.82	50.61 ± 4.99	n.s.s	51.29 ± 7.31	50.57 ± 5.88	n.s.s.	47.13 ± 4.64	50.71 ± 1.86	n.s.s.
7. NUSCV (m/s)	52.05 ± 12.23	54.20 ± 10.71	n.s.s	50.46 ± 14.02	54.22 ± 12.04	n.s.s.	55.91 ± 5.04	54.16 ± 7.30	n.s.s.
8. NUN-Amp (μV)	9.80 ± 7.92	14.32 ± 8.25	p<0.05	10.39 ± 8.66	16.04 ± 9.01	p<0.05	8.35 ± 6.09	10.17 ± 5.16	n.s.s.

N=number
p = n.s.s- not statistically significant (p>0.05)

2. Mean values of electrophysiological parameters in patients with DPN (Group B)

There were not significant differences ($p > 0.05$) between the analyzed electrophysiological parameters values before and after B-vitamin per os therapy (see Table 2).

Table 2. Mean values (X±SD) of electrophysiological parameters in patients with DPN (Group B)

N	Parameter	Before B-vitamin therapy	After B-vitamin therapy	p
1.	NPDML (ms)	5.02 ± 2.11	4.80 ± 1.73	n.s.s.
2.	NPMCV (m/s)	40.46 ± 6.56	41.67 ± 6.07	n.s.s.
3.	NPM-Amp (mV)	2.24 ± 0.94	2.22 ± 1.03	n.s.s.
4.	NPSCV(m/s)	39.68 ± 7.38	38.40 ± 5.38	n.s.s.
5.	NUMDL (ms)	3.09 ± 0.58	2.93 ± 0.49	n.s.s.
6.	NUMBP (m/s)	51.53 ± 8.51	51.26 ± 5.51	n.s.s.
7.	NUSCV (m/s)	55.95 ± 10.12	54.96 ± 8.56	n.s.s.
8.	NUN-Amp (μV)	9.46 ± 7.24	9.39 ± 7.74	n.s.s.

N=number
p=n.s.s- not statistically significant (p>0.05)

3. Pearson correlations (r) (sig.2-tailed) between electrophysiological parameters values and the age of patients with DPN

No significant correlation ($p > 0.05$) was observed between the registered electrophysiological parameters values (Group A, Subgroups A1 and A2, Group B) and the age of DPN patients.

Discussion

After 30 LILT treatments during a three-month period, we registered a significant increase in NU neural potential amplitude ($p < 0.05$) in patients with painful DPN (Group A). In Subgroup A1 we also registered a significant increase in NU neural potential amplitude ($p < 0.05$) after LILT treatment, but not in Subgroup A2 (see Table 1). The neural potential amplitude value (measured as described above) indicates the number of peripheral nerve sensory axons of a great and the greatest diameter (25-40% of all myelinated sensory axons of the peripheral nerve) with normal function (10). The temperature of the hand's and the feet's skin was maintained at 32°C during electrophysiological examinations. We did not find similar results in the literature. Those results suggest an indirect influence of LILT upon the sensory axon function of NU in patients with painful DPN, because LILT treatments were applied on paravertebral points in the lumbosacral region, along n.ischiadicus, and on the dorsum of the feet. The mechanism of this influence is not clear. Recently, many mechanisms of LILT actions were presented in literature, the important ones including inflammatory, analgesic and reflexogenic effects, stabilization of lipid peroxidation, stimulation of reparation process, and immune response (6). Two mechanisms are relevant for possible explanation. The analgesic effect is associated with the activation of neuron metabolism, increased endorphin release and increase in pain threshold. The reflexogenic effect is associated with the irritation of nerve endings, excitation of nerve centers and stimulation of physiological function. These actions of LILT may contribute to the increase in NU neural potential amplitude. We suppose that the increase in neural potential amplitude of NU after LILT may be related to pain relief in patients with painful DPN. Recent study results have not provided sufficient evidence in order for LILT to be recommended in the case of painful DPN symptoms, since these results demonstrated a clinically significant pain relief in all analyzed patients, including the placebo group (3). But in this study, LILT was applied during 4 weeks, an interval three times shorter than the one in our study, and the patients used analgesic medications during the examinations, so these factors limited the study's results. The most interesting is the action of LILT on stabilization of lipid peroxidation with reactivation of superoxide dismutase and catalase enzymes. These enzymes are scavengers of free radicals which, being antioxidants, reduce oxidative stress in diabetic neuropathy.

We registered that other analyzed electrophysiological parameters did not show a significant difference in their values before and after LILT in patients with painful DPN. We found that LILT has no direct significant influence on SCV and MCV values of NP and NU in patients with painful DPN. This finding corresponds with the results obtained by other authors (3). We found that the M potential amplitude of NP was reduced after LILT in Subgroup A2, although not significantly (see Table 1). The M potential amplitude value (measured as described above) indicates the number of peripheral nerve motor axons and the number of activated muscle fibers (10). Besides LILT, patients in Subgroup A2 received aneurin electrophoresis and kinesitherapy. This finding indicates that, during the period of LILT treatment, patients with painful DPN do not need other types of physical therapies.

We found that the age of patients with painful DPN has no significant influence on the analyzed electrophysiological parameters values registered before and after LILT. LILT can, therefore, be applied at different patients' ages. But we have to know contraindications to the use of LILT, including malignant tumors (located in the irradiated area), epilepsy, irradiation of the thyroid gland region, irradiation of the abdomen during pregnancy, light hypersensitivity, thrombosis in the pelvic vein or deep vein of the legs (6).

Conclusion

1. LILT has an indirect influence on the sensory axons function of NU in patients with painful DPN, significantly increasing the neural potential amplitude of NU after LILT, but the mechanism of this influence is not clear.

2. The increase in the neural potential amplitude of NU after LILT may be associated with pain relief in patients with painful DPN.

3. LILT has no direct significant influence on SCV and MCV values of NP and NU in patients with painful DPN.

4. During the period of LILT treatment, patients with painful DPN do not need other types of physical therapies.

5. Age has no significant influence on the analyzed electrophysiological parameters values registered before and after LILT in patients with painful DPN.

References

1. Nash TP. Treatment options in painful diabetic neuropathy. Acta Neurol Scand 1999; 173: 36-42.

2. Benbow SJ, Wallymahmed ME, Macfarlane I.A. Diabetic peripheral neuropathy and quality of life. Q J Med 1998; 91: 733-737.

3. Zinman HL, Ngo M, Ng TE, Nwe KT, Gogov S, Bril V. Low-intensity laser therapy for painful symptoms of diabetic sensorimotor polyneuropathy: a controlled trial. Diabetes Care 2004; 27: 921-924.
4. Boulton MJA. Management of diabetic peripheral neuropathy. Clinical Diabetes 2005; 23: 9-15.
5. Cotton MA. A Review of the principles and use of lasers in lower limb problems. Int J Low Extrem Wounds 2004; 3: 133-142.
6. Moshkovska T, Mayberry J. It is time to test low-level laser therapy in Great Britain. Postgrad Med J 2005; 81: 436-441.
7. Lazović M, Antić S, Kocić M, Perić Z. Importance of the small power laser application to the patients suffering from diabetic neuropathy. Acta Medica Medianae 1999; 4: 29-36. (in Serbian)
8. Cvetković B. Effects of physical therapy in patients with diabetic polyneuropathy. MSc thesis. Medical Faculty, Niš, 2002. (in Serbian)
9. Schindl A, Schindl M, Pernerstorfer-Schon H, et al. Diabetic neuropathic foot ulcer: successful treatment by low-intensity laser therapy. Dermatology 1999; 198: 314-316.
10. Perić Z. Clinical electromyoneurography. Prosveta, Niš, 2003. (in Serbian)

ELEKTROFIZIOLOŠKA EVALUACIJA TERAPIJE LASEROM MALE SNAGE KOD BOLESNIKA SA DIJABETESNOM POLINEUROPATIJOM

Zoran Perić[1], Bratislav Cvetković[2]

[1]Klinika za zaštitu mentalnog zdravlja i neuropsihijatriju razvojnog doba,Klinički centar Niš
[2]Klinika za fizikalnu medicinu i rehabilitaciju,Klinički centar Niš

Kratak sadržaj: *U ovom istraživanju analizirano je 45 pacijenata (20 ženskog pola), prosečne starosti 55.08 godina ($X \pm SD = 55.08 \pm 11.73$), sa kliničkim i elektroneurografskim (ENG) znacima bolne dijabetesne polineuropatije (DPN). Pacijenti su podeljeni u dve osnovne grupe: grupu A - sa 30 pacijenata sa DPN koji su imali 30 tretmana laserom male snage (LILT) u periodu od 12 nedelja i kontrolnu grupu B - sa 15 pacijenata sa DPN koji su u istom vremenskom peruodu uzimali samo vitaminsku terapiju per os (Drag. Beviplex, 3×1). Grupa A je podeljena u dve podgrupe: Podgrupu A1 - sa 20 pacijenata koji su imali samo LILT i Podgrupu A2- sa 10 pacijenata koji su pored LILT imali tretman elektroforezom aneurina i koneziterapiju. Korišćeni laserski uređaj je imao talasnu dužinu 904 nm i ukupnu izlaznu snagu 60 mW. Svi LILT tretmani su trajali 1 minut po mestu aplikacije (4 paravertebralne tačke u lumbosakralnom predelu, 3 tačke duž n.ischiadicusa i 2 tačke na dorzumu stopala). Pre i 12 nedelja nakon početka tretmana, korišćenjem površinskih elektroda određivani su sledeći parametri: motorne (MCV) i senzitivne brzina provođenja (SCV) n. peroneusa (NP) i n. ulnarisa (NU), vrednost njihovih motornih distalnih latenci (MDL) i amplitude M-potencijala NP (registrovanog u m.extensor digitorum brevis), kao i amplitude neuralnog potencijala NU (registrovanog antidromnom tehnikom na nivou kože petog prsta šake). Pacijenti u Grupi A imali su značajno povećanje amplitude neuralnog potencijala NU nakon primene LILT ($p<0.05$), što je ukazivalo na indirektan uticaj LILT na funkciju senzitivnih aksona NU kod bolesnika sa bolnom DPN. LILT nema značajan direktan uticaj na vrednosti SCV i MCV NP i NU kod bolesnika sa bolnom DPN. Tokom perioda LILT kod pacijenata sa bolnom DPN nije potrebno aplikovati i druge vrste fizikalne terapije. Starost ispitanika nema značajan uticaj na vrednosti analiziranih elektrofizioloških parametara koji su određivani pre i posle LILT kod bolesnika sa bolnom DPN.*

Ključne reči: *Terapija laserom, mala snaga, elektrofiziološka evaluacija, dijabetesna polineuropatija*