THE EFFECTS OF LOW POWER LASER ON ELECTROPHYSIOLOGICAL PARAMETERS OF SURAL NERVE IN NORMAL SUBJECTS: A COMPARISON BETWEEN 670 AND 780 nm WAVELENGTHS

M.R. Hadian* and B. Attarbashi Moghadam

Department of Physical Therapy and Electrophysiology, Faculty of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

Abstract- There is just one study about the effects of 830 nm low power laser (LPL) on conduction velocity of sural nerve in human. Considering the fact that the sural nerve is a pure sensory nerve, therefore, for determining the effect of LPL on electrophysiological parameters of the nerve in human, this study was carried out as a base for further basic and clinical researches. Thirty eight normal volunteer men participated (20–35 yr.) in this study. LPL (670 and 780 nm) was applied on left and right sural nerves. Electrophysiological parameters such as Onset Latency (OL), Peak Latency (PL), Negative Peak Amplitude (NPA), Peak to Peak Amplitude (PPA) and Duration were measured before and after the application of various doses (0.5, 1.5 and 2.5 J/cm²) of LPL. This study showed that both wavelengths of LPL increase the latencies and therefore reduce the nerve conduction velocity (NCV). In addition, LPL application decreased the nerve amplitudes. Among the various intensities, the application of 2.5 J/cm² was the most effective ($P< 0.001$). On the other hand, 670 nm wavelength and 2.5 J/cm² had the greatest effects on OL in comparison with 780 nm ($P< 0.04$). However, there was no significant difference between the effects of 670 and 780 nm on the other electrophysiological parameters of sural nerve.

Acta Medica Iranica, 41(3): 138-142; 2003

Key Words: Low power laser, sural nerve, electrophysiological parameters

INTRODUCTION

There is only one research about the influence of low power laser (LPL) on conduction velocity of sural nerve in human being (1) and the effects of LPL on the other electrophysiological parameters of the nerve have not been investigated. However, there are some controversial evidences about the effects of different wavelengths and doses of LPL on peripheral nerves of human; these studies were mainly performed on those nerves which contained both sensory and motor fibers. Great House et al., Walsh et al. and Bartlett et. al. reported that application of LPL had no effects on the latency of sensory branch of radial and median nerves (2- 4). However, Synder et. al., Lowe et al, Basford et. al. and Baxter et.al reported that application of LPL increased the latency of sensory branches of median nerves (5-8). Safavi showed that application of LPL increased the latency of sensory branches of radial nerves in human. Safavi also reported that there was no significant differenc between the effects of LPL on right and left radial nerves (9). Accordingly, in determining the effects of LPL on electrophysiological parameters of sural nerve in human, this study was performed as a base for further basic and clinical investigations.

Received: 5 January 2002, accepted: 6 January 2003

*** Corresponding Author:**
M.R. Hadian, Department of Physical Therapy and Electrophysiology, Faculty of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran
Tel: +98 21 7536134
Fax: +98 21 7534133
E-mail: hadian_ras@yahoo.com

MATERIALS AND METHODS

Thirty eight normal volunteer men (20-35 yr.)participated in this study. Sensory nerve action potentials (Disa, Dentech Inc. Denmark; Frequency, 20Hz-2kHz; Sensitivity: 20μVolt/Division; Sweep speed: 4ms/Division; Stimulus Duration: 0.2ms) of Sural nerves were antidromically recorded, and electrophysiological parameters such as Onset Latency (OL), Peak Latency (PL), Negative Peak Amplitude (NPA), Peak to Peak Amplitude (PPA) and Duration were measured and, Conduction Velocity (CV) were calculated (10,11). 670 and 780 nm LPL (Chatanoga, USA, Gallium- Aluminum- Arsenide, Continous waves, 3 mW) at various doses (0.5, 1.5 and 2.5 J/cm²) were transcutaneously applied on the left and right

sural nerves throughout the surface anatomical pathway. The irradiation time of laser was calculated based on the folowing formula

$$\text{Irradiation Time (s)} = \frac{\text{Energy Density (J/cm}^2\text{)} \times \text{Area of Irradiation (cm}^2\text{)}}{\text{Output Power (w)}}$$

(i.e. 167 seconds= 0.5 J/cm² for 670 nm and 25 seconds= 0.5 J/cm² for 780 nm) (12). Thereafter, sensory nerve action potentials (SNAPs) of the nerves were separately recorded after the application of LPL at different wavelengths and doses (e.g. 670 nm, 0.5, 1.5 and 2.5 J/cm²). Similar method was exactly repeated for 780 nm at the same doses. Throughout the experiment, room temperature was kept at 30°C and skin temperature was also monitored through the digital thermometer. For statistical analysis, SPSS for windows, version 7 (SPSS Inc., 1997); Paired t-test and Friedman Two Way ANOVA were used (13).

RESULTS

The results of application of 670 and 780 nm LPL on electrophysiological parameters of sural nerve are compared before and after the laser irradiation at different doses (Fig. 1,2,3 and 4). For convenience the effect of 670 and 780 nm are therefore described separately.

a) 670 nm (0.5,1.5 and 2.5 J/cm²)

Irradiation of 0.5 J/cm² laser had increased significantly OL (Paired t-test, P<0.04), (Fig. 1) and decreased significantly PPA (Paired t-test, P<0.01), (Fig. 4).

Irradiation of 1.5 J/cm² laser had increased significantly OL (Paired t-test, P<0.01), (Fig. 1) and decreased significantly NPA & PPA (Paired t-test, P<0.01), (Fig. 3 and 4).

Irradiation of 2.5 J/cm² laser had increased significantly OL and PL (Paired t-test, P<0.001), (Fig. 1 and 2) and decreased significantly NPA and PPA (Paired t-test, P<0.001), (Fig. 3 and 4).

b) 780 nm (0.5,1.5 and 2.5 J/cm²)

Irradiation of 0.5 J/cm² laser had increased significantly OL and PL (Paired t-test, P<0.03), (Fig. 1 and 2) and decreased significantly PPA (Paired t-test, P<0.01), (Fig. 4).

Irradiation of 1.5 J/cm² laser had increased significantly OL (Paired t-test, P<0.04), (Fig. 1) and decreased significantly NPA and PPA (Paired t-test, P<0.04), (Fig. 3 and 4).

Irradiation of 2.5 J/cm² laser had increased significantly OL and PL (Paired t-test, P<0.001), (Fig. 1 and 2) and decreased significantly NPA and PPA (Paired t-test, P<0.001), (Fig. 3 and 4).

c) Comparison among the different doses

Nonparametric Friedman two way ANOVA (13) was used to compare the effects of different doses of 670 nm on electrophysiological parameters of the nerve. The same procedure was exactly repeated for 780 nm.

Among the different doses of 670 nanometer laser, significant difference was only seen among the mids of OL (before irradiation, after irradiation of 0.5, 1.5 and 2.5 J/cm² respectively, P<0.04); furthermore, the greatest difference was seen after 2.5 J/cm² (Fig. 1).

With regard to 780 nm, significant difference was only seen among the mids of OL (before irradiation, after irradiation of 0.5,1.5 and 2.5 J/cm² respectively, P<0.04); furthermore, the greatest difference was seen after 2.5 J/cm² (Fig. 1).

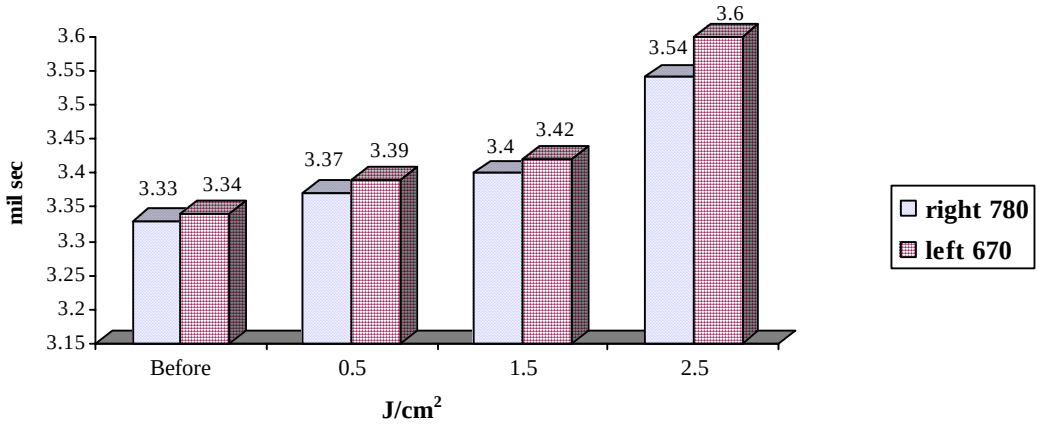

Fig. 1. Comparison of onset latencies before and after the irradiation of LPL at different doses and wavelengths

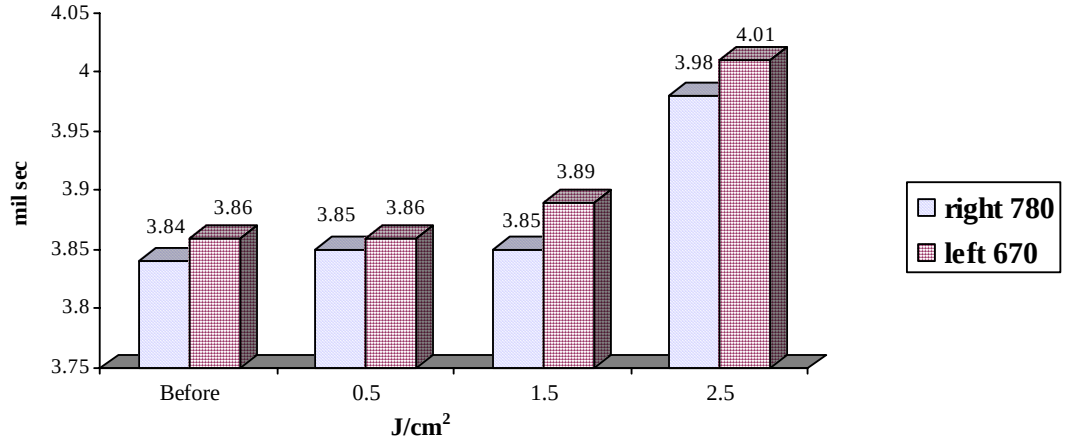

Fig. 2. Comparison of peak latencies before and after the irradiation of LPL at different doses and wavelengths

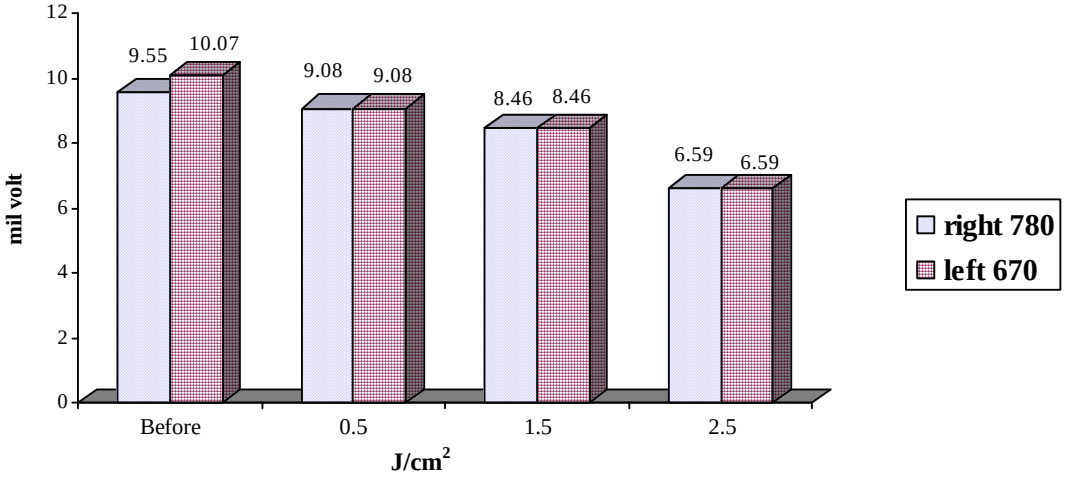

Fig. 3. Comparison of negative peak amplitudes before and after the irradiation of LPL at different doses and wavelengths

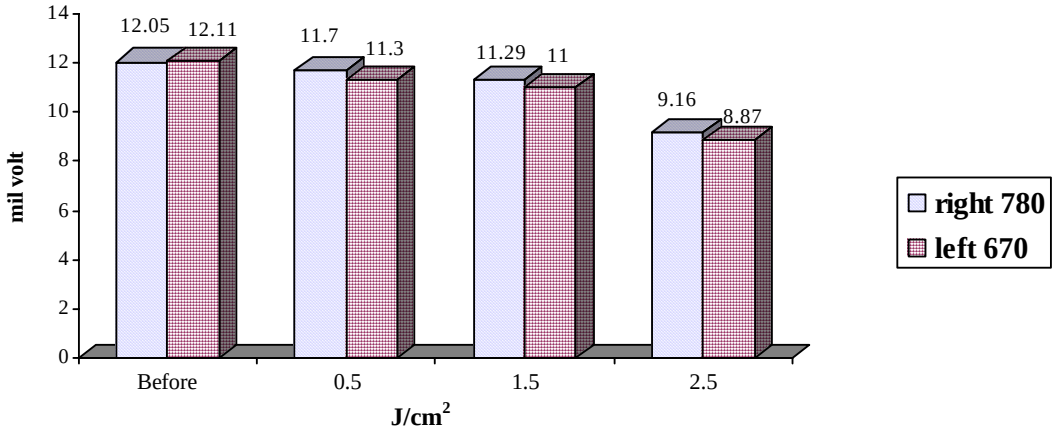

Fig. 4. Comparison of peak to peak amplitudes before and after the irradiation of LPL at different doses and wavelengths

d) Comparison among the different wavelengths

Paired t-test was used to compare the effects of 670 and 780 nm. Application of 2.5 J/cm² had significantly increased OL ($P<0.04$), (Fig. 1); while, no significant differences were seen among the other parameters and doses.

DISCUSSION

There is no research about the influence of 670 and 780 nm laser at various doses on sensory nerve of human in the literature. The only citation is about the effects of 830 nm laser on NPL parameter of SNAPs at 0.5,1 and 1.5 J/cm^2 (1). As mentioned earlier, the effects of LPL on other electrophysiological parameters of sensory nerve in human have not been investigated. The results of this study showed that the application of continuous beam of Gallium-Aluminum- Arsenide laser with 670 nm (3 mW) and 780 nm (20 mW) at maximum intensity (2.5 J/cm^2, in this study) had significant effects on all electrophysiological parameters of sural nerve with the exception of the duration. These findings are in accordance with Synder et al., Lowe et al., Basford et.al, Baxter et. al. and Safavi who also reported that application of LPL increased the latency of sensory branches of median and radial nerves (5-9). However, Great House et al., Walsh et al. and Bartlett et al. reported that application of pulsed beam (904 and 820 nm) had no effect on latency, amplitude and NPL of sensory branch of radial nerve (2-4). This controversy might be due to the fact that these authors used pulsed beam, 904 and 820 nm wavelengths. Application of both wavelengths of the LPL had increased the OL and PL of SNAPs. This finding shows that nerve conduction is affected with laser beam. This might be due to indirect effects of laser on increment of ATP production in cells and correspondingly activation of Na^+ ion channels. Alternatively, bioelectric and bioenergetic effects of laser on ions transition through the cell membrane can affect cell membrane potentials. Indeed, there are some reports regarding hyperpolarization of cell membrane and increment of threshold of afferent fibers (14-17). 670 nm LPL (2.5 J/cm²) was more effective than the same dose of 780 nm laser on electrophysiological parameters of sural nerve. Lesser depth of penetration of 670 nm laser might have a greater effect on the sural nerve because it lies superficially on the lateral aspect of the ankle. The above findings might be useful in pain management (18-20). Application of LPL might cause presynaptic inhibition of those afferent fibers that signal pain to the central nervous system. However, further studies should be performed in normal and patient subjects.

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