NERVE REPAIR, PAIN and LASER THERAPY

Effect of low-power laser irradiation on impulse conduction in anesthetized rabbits.

J Clin Laser Med Surg. 1996 Jun;14(3):107-9.

Kasai S, **Kono T**, **Yamamoto Y**, **Kotani H**, **Sakamoto T**, **Mito M**.

Department of Surgery, Asahikawa Medical College, Hokkaido, Japan.

Low-power laser analgesic effect was generally accepted in clinical cases, whereas there was no direct evidence to indicate that low-power laser irradiation suppressed an impulse conduction within a peripheral nerve. The effect of low-power laser irradiation on electrically evoked responses within the sural nerve was electrophysiologically analyzed in anesthetized rabbits. High threshold evoked responses (conduction velocity was about 11 m/sec, unmyelinated A delta), which were induced by an electrical stimulation to the peripheral stump of the nerve, were significantly suppressed (9 to 19% inhibition) during low-power laser irradiation, which applied to the exposed sural nerve between the stimulus site and the recording site. The suppressive effect was reversible and recovered to the control level after the irradiation. Experimental evidence indicated that low-power laser irradiation suppressed the impulse conduction of unmyelinated A delta afferents in peripheral sensory nerve, which caused a pain sensation. Our data suggest that low-power laser acts as a reversible direct suppressor of neuronal activity.

PMID: 9484084 [PubMed - indexed for MEDLINE]

Effect of Ga-as laser on the regeneration of injured sciatic nerves in the rat.

In Vivo. 2004 Jul-Aug;18(4):489-95

Bae CS, **Lim SC**, **Kim KY**, **Song CH**, **Pak S**, **Kim SG**, **Jang CH**.

College of Veterinary Medicine, Biotechnology Research Institute, Chonnam National University, Gwangju, Korea.

Laser irradiation is one of the therapeutic methods for the recovery of degenerated peripheral nerves. The aim of the present study was to determine if low-power laser treatment stimulates the regeneration process of damaged nerves. A standardized crush to

the sciatic nerve was applied to cause extensive axonal degeneration. After this procedure, low-power infrared laser irradiation was administered transcutaneously to the injured sciatic nerve, 3 minutes daily to each of four treatment groups for 1, 3, 5 and 7 weeks, respectively. A nerve conduction study was done, and a morphological assessment was performed using both light and electron microscopy. With trauma of the nerve, both amplitude of compound motor action potential and nerve conduction velocity decreased significantly compared to the pre-trauma state. Morphologically, the numbers of myelinated axons and degenerated axons were decreased and increased, respectively, compared with the control. Typical aspects were of onion skin-type lamellation, fragmentation, edematous swelling and rarefaction in the myelin sheath. All these parameters recovered almost to the level of the pre-trauma state with laser irradiation, in direct proportion to the time spent for treatment. These results suggest that low-power infrared laser irradiation can relieve the mechanical damage of sciatic nerves and stimulate the regeneration of peripheral nerves.

PMID: 15369190 [PubMed - indexed for MEDLINE]

How do we selectively activate skin nociceptors with a high power infrared laser? Physiology and biophysics of laser stimulation.

Neurophysiol Clin. 2003 Dec;33(6):269-77

Plaghki L, **Mouraux A**.

Unite de readaptation (READ), Universite catholique de Louvain, 53 avenue Mounier, B-1200 Brussels, Belgium. plaghki@read.ucl.ac.be

This review presents and discusses the leading arguments justifying the use of high power laser stimulators to explore the nociceptive system. To grasp the particularity of such stimulators, fundamentals concerning the interaction of low-energy radiation with the skin will be recalled and focused on the optimal match between the wavelength of the emitting source and the thermophysical properties of the skin. This knowledge shall allow us to discuss critical characteristics of laser stimulators. Study of the cutaneous spectrum of receptors showed that laser stimulators allow the selective activation of A(delta) and C-fiber nociceptors. We will present different methods, which increase the selectivity of the laser stimulation, restricting the activation to isolated C-fiber nociceptors. These methods open new perspectives in the study of the cerebral processing of signals ascending through A(delta) and/or C nociceptors and should contribute to a better understanding of their central interaction and integration in normal and pathological states.

PMID: 14678841 [PubMed - indexed for MEDLINE]

Diode laser irradiation selectively diminishes slow component of axonal volleys to dorsal roots from the saphenous nerve in the rat.

Neurosci Lett. 1993 Oct 14;161(1):65-8.

Tsuchiya K, **Kawatani M**, **Takeshige C**, **Sato T**, **Matsumoto I**.

Department of Physiology, School of Medicine, Showa University, Tokyo, Japan.

Ga-Al-As laser irradiation (830 nm wavelength) inhibits the action potentials in the dorsal roots elicited from the saphenous nerve of the rat. Following laser irradiation to the saphenous nerve, the amplitude of slower conduction parts of action potentials (conduction velocity < 12 m/s) were suppressed. This suppression was irradiation time dependent. After 3 min irradiation, slowest conduction velocity group (< 1.3 m/s) were totally diminished and 1.3-12 m/s group were reduced to 12-67%. In contrast, faster component (> 12 m/s) was unaffected by laser irradiation. These findings suggest that laser irradiation may selectively target fibers conducting at slow velocities which include afferent axons from nociceptors.

PMID: 8255549 [PubMed - indexed for MEDLINE]

The effect of infrared laser on sensory radial nerve electrophysiological parameters

Electromyogr Clin Neurophysiol. 2005 Sep-Oct;45(6):353-6.

Safavi-Farokhi Z, Bakhtiary AH.

Physiotherapy Department, Rehabilitation Faculty, Semnan University of Medical Sciences, Iran. ziasafavi@yahoo.com

OBJECTS: It has been claimed that laser may have bio-stimulation effect on the nerve tissues. This study has been designed to investigate the effect of different doses of infra-red (IR) laser exposure on the electrophysiological parameters of sensory nerves. METHODS AND SUBJECTS: Forty healthy subjects (20-35 years old) with no history of neurological conditions participated in this study. IR laser (780 nm, 20 mw) was applied over five blocks (1 cm2 each and 0.5 J/cm2) of 5 cm length of the left and right superficial radial nerve. The IR laser radiation was started from proximal to distal in the right hand and vise versa in the left hand. Antidromic sensory nerve conduction velocity was evaluated before and after first (0.5 J), third (1.5 J) and fifth (2.5 J) exposures. During the test, we measured the onset and peak latency, amplitude and duration of sensory action potentials. RESULTS: Paired t-test was used to assess the difference between pre- test and post- test data. After IR laser exposure with all doses, significant increased in latencies was observed (P < 0.001), while significant decreased in amplitude and duration was found only in the group who received the doses of 1.5 and 2.5 J of exposure (P < 0.001). There was no difference between right and left hands. CONCLUSION: Our results showed that the minimal dose of IR laser may not produce enough effects on the sensory nerves, while the higher doses such as 1.5 and 2.5 J may activate the mechanism of nerve blockage.

PMID: 16315972 [PubMed - indexed for MEDLINE]

Lack of effect of pulsed low-intensity infrared (820 nm) laser irradiation on nerve conduction in the human superficial radial nerve

Lasers Surg Med. 2000;26(5):485-90

Walsh DM, **Baxter GD**, **Allen JM**.

Rehabilitation Sciences Research Group, University of Ulster at Jordanstown, Newtownabbey, Co. Antrim BT37 0QB, Northern Ireland. dm.walsh@ulst.ac.uk

STUDY OBJECTIVE: This research study was designed to study the effect of IR laser on nerve conduction and skin temperature of the skin overlying the superficial nerve investigated. EXPERIMENTAL METHODS: Thirty-two human volunteers with out neurological problems or disease were randomly assigned to either placebo, laser 1 (9.12 Hz), laser 2 (73 Hz), or control groups (n = 8 all groups). The laser used in the study was a GaAlAs laser diode (820 nm, 50 mW peak). The skin overlying the right superficial radial nerve was irradiated at three points (1.2 J per point; energy density, 9.55 J/cm(2)). Recordings of antidromic sensory nerve action potentials were obtained from the superficial radial nerve before laser exposure and at 5, 10, and 15 minutes after irradiation. Skin temperature was monitored with superficial dual thermistors. TEST RESULTS: The study failed to show significant differences between groups for negative peak latency and skin temperature data after laser exposure. CONCLUSION: This study

has demonstrated that very low fluence laser irradiation with pulsing modulation does not produce any specific neurophysiologic effects in this model of nerve function.

PMID: 10861704 [PubMed - indexed for MEDLINE]

Comment: Although this study demonstrates that LLLT does not effect NCV or temperature, it conclusions do not apply to higher power lasers in neuromusculoskeletal therapy. JMT

Monochromatic infrared irradiation (890 nm): effect of a multisource array upon conduction in the human median nerve.

J Clin Laser Med Surg. 2001 Dec;19(6):291-5.

Noble JG, **Lowe AS**, **Baxter GD**.

Rehabilitation Sciences Research Group, University of Ulster at Jordanstown, Newtownabbey, Northern Ireland.

OBJECTIVE: Antidromic conduction studies in the human median nerve were used to assess the neurophysiological effects of irradiation of the skin overlying the nerve using a novel treatment unit comprising a multisource monochromatic infrared diode array (Equilight, Denver, CO). MATERIALS AND METHODS: Healthy human volunteers (n = 40) were recruited and randomly allocated to one of four groups: control, placebo, or one of two treatment groups (1.7 and 4.0 J/cm2). After baseline recordings of negative peak latency (NPL) were completed on the nondominant arm, subjects were treated according to group allocation. Recordings were subsequently repeated at 5-min intervals over a 45-min period. RESULTS: Analysis of negative peak latency difference scores (ANOVA) demonstrated significant differences in NPL between groups and over time ($p < 0.05$). While in the control and placebo groups NPL values remained relatively stable, in the two treatment groups such values decreased marginally, with the greatest effects observed in the 4.0 J/cm2 group (e.g., at 5 min, differences in NPL [mean +/- SEM]: control group, 0.02+/-0.03 msec; treatment group 2, 4 J/cm2, -0.07+/-0.03 msec). Similar significant differences were observed in skin temperature; correlation analysis indicated a weak (but expected) positive linear relationship between skin temperature and nerve conduction velocity ($r = 0.125$). CONCLUSION: These results suggest that irradiation at the parameters and under the conditions used here produce a direct neurophysiological effect. The magnitude of such effects are in keeping with previous findings using single source arrays at higher radiant exposures or thermal effects of the treatment unit.

PMID: 11776446 [PubMed - indexed for MEDLINE]