Low Level Laser Therapy & Nerve Regeneration clinical research

LASER THERAPY - A NEW MODALITY IN THE TREATMENT OF PERIPHERAL NERVE INJURIES

(Twenty-five years experience from basic science to clinical studies)S. Rochkind, MD Department of Neurosurgery, Tel Aviv Sourasky Medical Center, Tel-Aviv University, Tel Aviv, Israel, E-mail: rochkind@zahav.net.il Since our first publication (Rochkind 1978), we have been studying and testing low power laser irradiation as a means to treat peripheral nerves, using both in vitro and in vivo methods. We have reached the clinical stage and are treating a variety of peripheral nerve injuries. This study is a review of my personal experience over the last twenty-five years in the use of laser therapy in treating these conditions.

I. Influence of Low Power Laser Irradiation on Nerve Cells

A study was done using direct 632.8nm HeNe laser irradiation to determine the effect of focused laser beams on aggregates of rat fetal brain cells and rat adult brain. The direct HeNe laser irradiation 3.6J/cm2 caused a significant amount of sprouting of cellular processes outgrowth in aggregates, compared to small amounts produced by nonirradiated controls. This observation suggests that low power laser irradiation applied to the area of an experimentally injured nerve may induce axonal processes sprouting, thereby improving nerve tissue recovery. The mechanism of low power laser on nerve tissue is not completely understood, but some studies partially explain the photochemical effect of laser irradiation on the biological system. Cytochromes are affected, thereby stimulating redox activity in the cellular respiratory chain, thereby causing increases in ATP production which activates Na+, K+ -ATPase and other ion carriers, thereby increasing cell activation.

II. Animal Studies - influence of laser therapy on the severely injured peripheral nerve

A radiation method for treating lesions in both the peripheral and central nervous systems was proposed in 1978 by Rochkind and modified over the years. The model used in this work was the rat sciatic nerve. Low power laser irradiation then was delivered to the crushed nerve either transcutaneously or directly. The effects of this laser therapy were measured both in the short-term, i.e. minutes and in the long-term, i.e. days and months.
Short-term model: direct irradiation of the nerve was done through the open wound directly to the crushed injured nerve and the compound nerve action potential was

measured. A variety of wavelengths and powers were applied and 540nm, 632.8nm and 780nm were found most effective (p=0.01). Long-term model: We found electrophysiolgical activity dropped as expected in the non-irradiated nerves following the crush injury, but the use of low power laser irradiation prevented or decreased this phenomenon (p=0.001), both immediately after the crush and in the long term. Furthermore, this investigation showed that when laser treatment was delivered to both the crushed nerve and the corresponding segments of the spinal cord, the recovery time and the quality of regeneration of the crushed sciatic nerve improved, compared to the application of irradiation to the nerve alone. Histological studies supported the electrophysiological findings: low power laser irradiation was found to prevent or decrease scar tissue formation in the injured area. Laser irradiation enhanced axonal sprouting in the crush-injured sciatic nerve, thus accelerating recovery of the severely injured peripheral nerve. In addition, a beneficial effect of low power laser irradiation was found not only in the laser-treated nerve, but in the corresponding segments of the spinal cord as well. Such laser treatment has been found to decrease significantly then degenerative changes in the corresponding neurons of the spinal cord and induce proliferation of neuroglia, both in astrocytes and oligodendrocytes. This suggests a higher metabolism in neurons and a better ability to produce myelin under the influence of laser treatment. Also, low power laser irradiation exerts pronounced systemic effects on severely injured peripheral nerves and corresponding regions of the spinal cord.

III. Double-Blind Randomized Study Evaluating Regeneration of the Rat Sciatic Nerve after Suturing and Post-Operative Laser Therapy

The therapeutic effect of low power laser irradiation on peripheral nerve regeneration after complete transection and direct anastomosis of the rat sciatic nerve was studied recently. A 780nm laser wavelength was applied transcutaneously 30 minutes daily for 21 consecutive days to corresponding segments of the spinal cord and to the injured sciatic nerve immediately after closing the wound. Positive somato-sensory evoked responses were found in 55% of the irradiated rats and in 11% of the non-irradiated rats.
Immuno-histochemical staining in the laser-treated group showed more intensive axonal growth and better quality of the regenerative process due to an increased number of large and medium diameter axons. IV. Clinical Pilot Studies The group of patients who were treated in the Department of Neurosurgery at Tel Aviv Sourasky Medical Center had been suffering from severe peripheral nerve and brachial plexus injuries for more than two years. Each of the 59 patients received laser treatment CW, 780nm, five hours daily for 21 consecutive days with the use of a laser system specially developed for our treatment method. Criterion for laser treatment in these cases was as follows: patients who suffered from partial motor and sensory disturbances and where surgery was not indicated. Fifty-six percent of the laser-treated patients showed good to excellent results in their motor function. V. Clinical Double-Blind Placebo-Controlled, Randomized Study of Low Power Laser in the Treatment of Peripheral Nerve Injures Since our previous pilot clinical results were positive, a final evaluation of the response to treatment was in order. Therefore, we performed a double-blind, placebo-controlled randomized study of patients who had been suffering from incomplete peripheral nerve and brachial plexus injuries from 6 months up to several years after injury. The protocol of this study was done with the permission of the Helsinki Committee of the Tel Aviv Sourasky Medical Center and with the approval of the Ministry of Health of Israel and by a grant from the Rehabilitation Department of the Ministry of Defence of Israel. The

study evaluated the functional recovery of these patients after undergoing low power laser or placebo
treatment. Recovery was classified by comparing each of the deficits present before and after surgery. The post-laser or post-placebo grade was determined by the change in strength compared to the pretreatment levels. In almost all cases, the level of motor function was minimal to poor pre-treatment. In the laser-treated group, statistically significant improvement was found in motor functional activity P=0.0001, compared to the placebo group). The electrophysiological findings also showed statistically significant improvement in the laser-treated group. Our twenty-five years of experience indicates that Laser Therapy is a low-cost, non-invasive method and will be recognized as standard additional treatment for improving the functional recovery of patients with peripheral nerve and brachial plexus injuries. According to our clinical experience, the main advantages of Laser Therapy are the enhancement and acceleration of the recovery of injured nerve tissue. The therapeutic results show that an objective progressive improvement appears in nerve function, leading to a significant and earlier recovery.

Laser Therapy.1997; 9 (4): 151. An innovative approach to induce regeneration and the repair of spinal cord injury.

Rochkind S, Shahar A. Nevo Z.

An Israeli research group has investigated an innovative method of repairing injured spinal cords. In a rat model the spinal cords were transected in 31 animals (betweenT7/T8). In vitro constructed composite implants were used in the transected area. Theseimplants contained embryonal spinal cord neuronal cells dissociated from rat fetuses,cultured on biodegradable microcarriers. After being embedded in hyaluronic acid theimplants were ready to be placed into the injured area. The whole lesion area was coveredwith a thin coagulated fibrin-based membrane. Control animals underwent the samelaminectomy but did not receive any implant. In all animals the wound was closednormally. Laser therapy was started immediately after surgery. It was continued daily fortwo weeks using 780 nm, 200 mW, 30 minutes daily. One group received the implantbut no laser. During the 3-6 months follow up, 14 of the 15 animals that received laser(A) showed different degrees of active movements in one or both legs, compared to 4 of9 animals in the group who had received implants but no laser (B). In the group receivingno implant and no laser (C), 1 out of 7 showed some motor movements in one leg.Somatosensory evoked potentials were elicited in 10 of the 15 rats in group A at threemonths, and on one side in one animal in group B. Axon sprouting was observed as soonas three days post surgery, in group A only.

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New hope for patients with spinal cord injuries.

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fetuses, cultured on biodegradable microcarriers. After being embedded in hyaluronic acid the implants were ready to be placed into the injured area. The whole lesion area was covered with a thin coagulated fibrin-based membrane. Control animals underwent the same laminectomy but did not receive any implant. In all animals the wound was closed normally. Laser therapy was started immediately after surgery. It was continued daily for two weeks using 780 nm, 200 mW, 30 minutes daily. One group received the implant but no laser. During the 3-6 months follow up, 14 of the 15 animals that received laser (A) showed different degrees of active movements in one or both legs, compared to 4 of 9 animals in the group who had received implants but no laser (B). In the group receiving no implant and no laser (C), 1 out of 7 showed some motor movements in one leg. Somatosensory evoked potentials were elicited in 10 of the 15 rats in group A at three months, and on one side in one animal in group B. Axon sprouting was observed as soon as three days post surgery, in group A only.
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