

Spinal Cord – Cerebral Injury

LIGHT THERAPY (LLLT) ALTERS GENE EXPRESSION AFTER ACUTE SPINAL CORD INJURY

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Secondary injury in the spinal cord, which results in axonal degeneration, scar and cavity formation and cell death, occurs around the site of the initial trauma and is a primary cause for the lack of axonal regeneration observed after spinal cord injury (SCI). The immune response after SCI is under investigation as a potential mediator of secondary injury. Treatment of SCI with 810 nm light suppresses the immune response and improves axonal regeneration.

We hypothesize that these beneficial effects observed in the injured spinal cord are accompanied by alterations in gene expression within the spinal cord, particularly of those genes involved in secondary injury and the immune response. To test this hypothesis, a dorsal hemisection at vertebral level T9 was performed. The injured spinal cord from rat was then exposed to laser light (810nm, 150mW, 2,997 seconds, 0.3cm² spot area, 1589 J/cm²) and spinal cord samples, including the injury site, were harvested at 6 and 48 hours and 4 days post-injury. Total RNA was extracted and purified from the lesioned spinal cord and cDNA copies were either labeled with [³²P] for microarray analysis or amplified and analyzed with a polymerase chain reaction (PCR).

Microarray results revealed a suppression of genes involved in the immune response and excitotoxic cell death at 6 hours post-injury, as well as cell proliferation and scar formation at 48 hours post-injury in the light treated group. Analysis of the PCR products revealed that light treatment resulted in a significant suppression of expression of genes that normally peak between 6 and 24 hours post-injury, including the pro-inflammatory cytokine interleukin 6 (IL6), the chemokine monocyte chemoattractant protein 1 (MCP-1) and inducible nitric oxide synthase (iNOS; $p < 0.05$). Genes expressed earlier than 6 hours post-injury, such as IL1b, tumor necrosis factor α (TNF α) and macrophage inflammatory protein 1a (MIP-1a) were not affected by light treatment.

Although the precise role some of these genes play in axonal regeneration after spinal cord injury is currently unclear, these data demonstrate that light therapy has an anti-inflammatory effect on the injured spinal cord, and may reduce secondary injury, thus providing a possible mechanism by which light therapy may result in axonal regeneration.

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 (between T7/T8). In vitro constructed composite implants were used in the transected area. These implants contained embryonal spinal cord neuronal cells dissociated from rat 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.

Neurol Res. 2002 Jun;24(4):355-60.

Transplantation of embryonal spinal cord nerve cells cultured on biodegradable microcarriers followed by low power laser irradiation for the treatment of traumatic paraplegia in rats.

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This pilot study examined the effects of composite implants of cultured embryonal nerve cells and laser irradiation on the regeneration and repair of the completely transected spinal cord. Embryonal spinal cord nerve cells dissociated from rat fetuses and cultured on biodegradable microcarriers and embedded in hyaluronic acid were implanted in the completely transected spinal cords of 24 adult rats. For 14 consecutive post-operative

days, 15 rats underwent low power laser irradiation (780 nm, 250 mW), 30 min daily. Eleven of the 15 (73%) showed different degrees of active leg movements and gait performance, compared to 4 (44%) of the 9 rats with implantation alone. In a control group of seven rats with spinal cord transection and no transplantation or laser, six (86%) remained completely paralyzed. Three months after transection, implantation and laser irradiation, SSEPs were elicited in 69% of rats ($p = 0.0237$) compared to 37.5% in the nonirradiated group. The control group had no SSEPs response. Intensive axonal sprouting occurred in the group with implantation and laser. In the control group, the transected area contained proliferating fibroblasts and blood capillaries only. This suggests: 1. These in vitro composite implants are a regenerative and reparative source for reconstructing the transected spinal cord. 2. Post-operative low power laser irradiation enhances axonal sprouting and spinal cord repair.

ACTA LASER BIOLOGY SINICA Vol. 8, No.2, 1999

Vascular Low Level Laser Irradiation Therapy in Treatment of Brain Injury

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Abstract: To evaluate the effect and mechanism of Vascular Low Level Laser Irradiation Therapy on brain injury. In this study thirty-eight SpragueDawley rats received Feeney's brain impact through a left lateral craniectomy under anesthesia. Control and treatment group are set up. According to the time exposed to laser and irradiating postinjury, the treatment group is divided in four subgroups by design. Semiconductor laser was used with a power of 5mW to irradiate straightly Rat's femur venous. The Y Water maze was used to assess cognitive performance. Superoxide dismutase(SOD) activity and the level of metabolic production of free radical MDA in Brain and erythrocyte were measured to determinate the level of free radical. We find Vascular Low Level Laser Irradiation Therapy can improve posttraumatic memory deficits. SOD activity is higher in treatment groups than the control group meanwhile the level of MDA is lower. These findings suggest that Vascular Low Level Laser Irradiation produced a significant reduction in free radical's damage to the brain postinjury.

Specific Effects of Laserpuncture on the Cerebral Circulation

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Paper received 10 May 1999; accepted after revision 23 August 1999.

Abstract . Acupuncture is a form of traditional Chinese medicine that has developed over thousands of years. We studied the effects of laser puncture, needle acupuncture, and

light stimulation on cerebral blood flow in 15 healthy volunteers (mean age 25.0 ± 1.9 years, 5 female, 10 male) with non-invasive transcranial Doppler sonography. In addition 40-Hz stimulus-induced brain oscillations, heart rate, blood pressure, peripheral and cerebral oxygen saturation, and the bispectral index of the EEG were recorded.

Stimulation with light significantly increased blood flow velocity in the posterior cerebral artery ($p < 0.01$, ANOVA). Similar but less pronounced effects were seen after needle acupuncture ($p < 0.05$, ANOVA) and laserpuncture (n.s.) of vision-related acupuncture points. Furthermore both, laserpuncture and needle acupuncture, led to a significant increase in the amplitudes of 40-Hz cerebral oscillations. Stimulation of vision-related acupuncture points with laser light or needle acupuncture elicits specific effects in specific areas of the brain. The results indicate that the brain plays a key intermediate role in acupuncture. However, brain activity of itself does not explain anything about the healing power of acupuncture.

Keywords: Acupuncture; Brain; 40 Hz brain oscillations; Cerebral blood flow velocity; Laserpuncture; Light stimulation; Middle cerebral artery (MCA); Posterior cerebral artery (PCA); Transcranial Doppler sonography (TCD)