LLLT studies in Neuroscience

J Neurotrauma. 2012 Jan 20;29(2):401-7. Epub 2012 Jan 4.

Near infrared transcranial laser therapy applied at various modes to mice following traumatic brain injury significantly reduces long-term neurological deficits.

Oron A, Oron U, Streeter J, De Taboada L, Alexandrovich A, Trembovler V, Shohami E.

Source

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Abstract

Near-infrared transcranial laser therapy (TLT) has been found to modulate various biological processes including traumatic brain injury (TBI). Following TBI in mice, in this study we assessed the possibility of various near-infrared TLT modes (pulsed versus continuous) in producing a beneficial effect on the long-term neurobehavioral outcome and brain lesions of these mice. TBI was induced by a weight-drop device, and neurobehavioral function was assessed from 1 h to 56 days post-trauma using the Neurological Severity Score (NSS). The extent of recovery is expressed as the difference in NSS (dNSS), the difference between the initial score and that at any other later time point. An 808-nm Ga-Al-As diode laser was employed transcranially 4, 6, or 8 h post-trauma to illuminate the entire cortex of the brain. Mice were divided into several groups of 6-8 mice: one control group that received a sham treatment and experimental groups that received either TLT continuous wave (CW) or pulsed wave (PW) mode transcranially. MRI was taken prior to sacrifice at 56 days post-injury. From 5-28 days post-TBI, the NSS of the laser-treated mice were significantly lower ($p<0.05$) than those of the non-laser-treated control mice. The percentage of surviving mice that demonstrated full recovery at 56 days post-CHI (NSS=0, as in intact mice) was the highest (63%) in the group that had received TLT in the PW mode at 100 Hz. In addition, magnetic resonance imaging (MRI) analysis demonstrated significantly smaller infarct lesion volumes in laser-treated mice compared to controls. Our data suggest that non-invasive TLT of mice post-TBI provides a significant long-term functional neurological benefit, and that the pulsed laser mode at 100 Hz is the preferred mode for such treatment.

PMID: 22040267 [PubMed - in process]

low-level laser therapy applied transcranially to mice following traumatic brain injury significantly reduces long-term neurological deficits.

J Neurotrauma. 2007 Apr;24(4):651-6.Oron A, Oron U, Streeter J, de Taboada L, Alexandrovich A, Trembovler V, Shohami E.

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Abstract

Low-level laser therapy (LLLT) has been evaluated in this study as a potential therapy for traumatic brain injury (TBI). LLLT has been found to modulate various biological processes. Following TBI in mice, we assessed the hypothesis that LLLT might have a beneficial effect on their neurobehavioral and histological outcome. TBI was induced by a weight-drop device, and motor function was assessed 1 h post-trauma using a neurological severity score (NSS). Mice were then divided into three groups of eight mice each: one control group that received a sham LLLTprocedure and was not irradiated; and two groups that received LLLT at two different doses (10 and 20 mW/cm(2)) transcranially. An 808-nm Ga-As diode laser was employed transcranially 4 h post-trauma to illuminate the entire cortex of the brain. Motor function was assessed up to 4 weeks, and lesion volume was measured. There were no significant changes in NSS at 24 and 48 h between the laser-treated and non-treated mice. Yet, from 5 days and up to 28 days, the NSS of the laser-treated mice were significantly lower ($p < 0.05$) than the traumatized control mice that were not treated with the laser. The lesion volume of the laser treated mice was significantly lower (1.4%) than the non-treated group (12.1%). Our data suggest that a non-invasive transcranial application of LLLT given 4 h following TBI provides a significant long-term functional neurological benefit. Further confirmatory trials are warranted.

PMID:17439348 [PubMed - indexed for MEDLINE]

Low-level laser therapy for closed-head traumatic brain injury in mice: effect of different wavelengths.

Wu Q, Xuan W, Ando T, Xu T, Huang L, Huang YY, Dai T, Dhital S, Sharma SK, Whalen MJ, Hamblin MR. Lasers Surg Med. 2012 Mar;44(3):218-26. doi: 10.1002/lsm.22003. Epub 2012 Jan 24.

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Abstract

BACKGROUND AND OBJECTIVES:

Traumatic brain injury (TBI) affects millions worldwide and is without effective treatment. One area that is attracting growing interest is the use of transcranial low-level laser therapy (LLLT) to treat TBI. The fact that near-infrared light can penetrate into the brain would allow non-invasive treatment to be carried out with a low likelihood of treatment-related adverse events. LLLT may treat TBI by increasing respiration in the mitochondria, causing activation of transcription factors, reducing inflammatory mediators and oxidative stress, and inhibiting apoptosis.

STUDY DESIGN/MATERIALS AND METHODS:
We tested LLLT in a mouse model of closed-head TBI produced by a controlled weight drop onto the skull. Mice received a single treatment with continuous-wave 665, 730, 810, or 980 nm lasers (36 J/cm(2) delivered at 150 mW/cm(2)) 4-hour post-TBI and were followed up by neurological performance testing for 4 weeks.
RESULTS:
Mice with moderate-to-severe TBI treated with 665 and 810 nm laser (but not with 730 or 980 nm) had a significant improvement in Neurological Severity Score that increased over the course of the follow-up compared to sham-treated controls. Morphometry of brain sections showed a reduction in small deficits in 665 and 810 nm laser treated mouse brains at 28 days.
CONCLUSIONS:
The effectiveness of 810 nm agrees with previous publications, and together with the effectiveness of 660 nm and non-effectiveness of 730 and 980 nm can be explained by the absorption spectrum of cytochrome oxidase, the candidate mitochondrial chromophore in transcranialLLLT.

 PMID: 22275301 [PubMed - in process]

Comparison of therapeutic effects between pulsed and continuous wave 810-nm wavelength laserirradiation for traumatic brain injury in mice.

Ando T, Xuan W, Xu T, Dai T, Sharma SK, Kharkwal GB, Huang YY, Wu Q, Whalen MJ, Sato S, Obara M, Hamblin MR. PLoS One. 2011;6(10):e26212. Epub 2011 Oct 18.

Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, Massachusetts, United States of America.

Abstract
BACKGROUND AND OBJECTIVE:
Transcranial low-level laser therapy (LLLT) using near-infrared light can efficiently penetrate through the scalp and skull and could allow non-invasive treatment for traumatic brain injury (TBI). In the present study, we compared the therapeutic effect using 810-nm wavelength laser light in continuous and pulsed wave modes in a mouse model of TBI.
STUDY DESIGN/MATERIALS AND METHODS:
TBI was induced by a controlled cortical-impact device and 4-hours post-TBI 1-group received a sham treatment and 3-groups received a single exposure to transcranial LLLT, either continuous wave or pulsed at 10-Hz or 100-Hz with a 50% duty cycle. An 810-nm Ga-Al-As diode laser delivered a spot with diameter of 1-cm onto the injured head with a power density of 50-mW/cm(2) for 12-minutes giving a fluence of 36-J/cm(2). Neurological severity score (NSS) and body weight were measured up to 4 weeks. Mice were sacrificed at 2, 15 and 28 days post-TBI and the lesion size was histologically analyzed. The quantity of ATP production in the brain tissue was determined immediately after laser irradiation. We examined the role of LLLT on the

psychological state of the mice at 1 day and 4 weeks after TBI using tail suspension test and forced swim test.

RESULTS:

The 810-nm laser pulsed at 10-Hz was the most effective judged by improvement in NSS and body weight although the other laserregimens were also effective. The brain lesion volume of mice treated with 10-Hz pulsed-laser irradiation was significantly lower than control group at 15-days and 4-weeks post-TBI. Moreover, we found an antidepressant effect of LLLT at 4-weeks as shown by forced swim and tail suspension tests.

CONCLUSION:

The therapeutic effect of LLLT for TBI with an 810-nm laser was more effective at 10-Hz pulse frequency than at CW and 100-Hz. This finding may provide a new insight into biological mechanisms of LLLT. PMC. PMCID: PMC2672926

Low infra red laser light irradiation on cultured neural cells: effects on mitochondria and cell viability after oxidative stress

Alessandro Giuliani,[1] Luca Lorenzini,[1] Michele Gallamini,[2] Alessandro Massella,[1] Luciana Giardino,[1,3] and Laura Calzà[1,3] Published online 2009 April 15 10.1186/1472-6882-9-8 BMC Complement Altern Med. 2009; 9: 8.

Abstract

Background

Considerable interest has been aroused in recent years by the well-known notion that biological systems are sensitive to visible light. With clinical applications of visible radiation in the far-red to near-infrared region of the spectrum in mind, we explored the effect of coherent red light irradiation with extremely low energy transfer on a neural cell line derived from rat pheochromocytoma. We focused on the effect of pulsed light laser irradiation vis-à-vis two distinct biological effects: neurite elongation under NGF stimulus on laminin-collagen substrate and cell viability during oxidative stress.

Methods

We used a 670 nm laser, with extremely low peak power output (3 mW/cm^2) and at an extremely low dose (0.45 mJ/cm^2). Neurite elongation was measured over three days in culture. The effect of coherent red light irradiation on cell reaction to oxidative stress was evaluated through live-recording of mitochondria membrane potential (MMP) using JC1 vital dye and laser-confocal microscopy, in the absence (photo bleaching) and in the presence (oxidative stress) of H_2O_2, and by means of the MTT cell viability assay.

Results

We found that laser irradiation stimulates NGF-induced neurite elongation on a laminin-collagen coated substrate and protects PC12 cells against oxidative stress.

Conclusion

These data suggest that red light radiation protects the viability of cell culture in case of oxidative stress, as indicated by MMP measurement and MTT assay. It also stimulates neurite outgrowth, and this effect could also have positive implications for axonal protection.

Ultra-low-level laser therapy.

Baratto L, Calzà L, Capra R, Gallamini M, Giardino L, Giuliani A, Lorenzini L, Traverso S. Lasers Med Sci. 2011 Jan;26(1):103-12. Epub 2010 Sep 18.

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Abstract

A growing number of laboratory and clinical studies over the past 10 years have shown that low-level laser stimulation (633 or 670 nm) at extremely low power densities (about 0.15 mW/cm(2)), when administered through a particular emission mode, is capable of eliciting significant biological effects. Studies on cell cultures and animal models as well as clinical trials give support to a novel therapeutic modality, which may be referred to as ultra low level laser therapy (ULLLT). In cultured neural cells, pulsed irradiation (670 nm, 0.45 mJ/cm(2)) has shown to stimulate NGF-induced neurite elongation and to protect cells against oxidative stress. In rats, anti-edema and anti-hyperalgesia effects following ULLL irradiation were found. Clinical studies have reported beneficial effects (also revealed through sonography) in the treatment of musculoskeletal disorders. The present paper reviews the existing experimental evidence available on ULLLT. Furthermore, the puzzling issue of the biophysical mechanisms that lie at the basis of the method is explored and some hypotheses are proposed. Besides presenting the state-of-the-art about this novel photobiostimulation therapy, the present paper aims to open up an interdisciplinary discussion and stimulate new research on this subject.

PMID:20852910[PubMed - indexed for MEDLINE]

Effects of 660 and 780 nm low-level laser therapy on neuromuscular recovery after crush injury in rat sciatic nerve.

Lasers Surg Med. 2010 Nov;42(9):673-82. Gigo-Benato D, Russo TL, Tanaka EH, Assis L, Salvini TF, Parizotto NA

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Abstract

BACKGROUND AND OBJECTIVE:

Post-traumatic nerve repair is still a challenge for rehabilitation. It is particularly important to develop clinical protocols to enhance nerve regeneration. The present study investigated the effects of 660 and 780 nm low-level laser therapy (LLLT) using different energy densities (10, 60, and 120 J/cm²) on neuromuscular and functional recovery as well as on matrix metalloproteinase (MMP) activity after crush injury in rat sciatic nerve.

MATERIALS AND METHODS:

Rats received transcutaneous LLLT irradiation at the lesion site for 10 consecutive days post-injury and were sacrificed 28 days after injury. Both the sciatic nerve and tibialis anterior muscles were analyzed. Nerve analyses consisted of histology (light microscopy) and measurements of myelin, axon, and nerve fiber cross-sectional area (CSA). S-100 labeling was used to identify myelin sheath and Schwann cells. Muscle fiber CSA and zymography were carried out to assess the degree of muscle atrophy and MMP activity, respectively. Statistical significance was set at 5% ($P \leq 0.05$).

RESULTS:

Six hundred sixty nanometer LLLT either using 10 or 60 J/cm² restored muscle fiber, myelin and nerve fiber CSA compared to the normal group (N). Furthermore, it increased MMP-2 activity in nerve and decreased MMP-2 activity in muscle and MMP-9 activity in nerve. In contrast, 780 nm LLLT using 10 J/cm² decreased MMP-9 activity in nerve compared to the crush group (CR) and N; it also restored normal levels of myelin and nerve fiber CSA. Both 60 and 120 J/cm² decreased MMP-2 activity in muscle compared to CR and N. 780 nm did not prevent muscle fiber atrophy. Functional recovery in the irradiated groups did not differ from the non-irradiated CR.

CONCLUSION:

Data suggest that 660 nm LLLT with low (10 J/cm²) or moderate (60 J/cm²) energy densities is able to accelerate neuromuscular recovery after nerve crush injury in rats.

PMID:20976807[PubMed - indexed for MEDLINE]

Effect of laser therapy (660 nm) on recovery of the sciatic nerve in rats after injury through neurotmesis followed by epineural anastomosis.

dos Reis FA, Belchior AC, de Carvalho Pde T, da Silva BA, Pereira DM, Silva IS, Nicolau RA. Lasers Med Sci. 2009 Sep;24(5):741-7. Epub 2008 Dec 23.

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Abstract

The aim of this study was to analyze the influence of aluminum gallium arsenide (AlGaAs) laser (660 nm) on the myelin sheath and functional recovery of the sciatic nerve in rats. The sciatic nerves of 12 Wistar rats were subjected to injury through neurotmesis and epineural anastomosis, and the animals were divided into two groups:

group 1 was the control and group 2, underwent low-level laser therapy (LLLT). After the injury, AlGaAslaser at 660 nm, 4 J/cm(2), 26.3 mW and beam area of 0.63 cm(2) was administered to three equidistant points on the injury for 20 consecutive days. In the control group the mean area of the myelin impairment was 0.51 (+/- 0.11) on day 21 after the operation, whereas this value was 1.31 (+/- 0.22) in the LLLT group. Student's t-test revealed a P value = 0.0229 for the mean area values of the myelin sheath between the LLLT and control groups. Comparison of the sciatic functional index (SFI) showed that there was no significant difference between the pre-lesion value in the laser therapygroup and the control group. The use of AlGaAs laser (660 nm) provided significant changes to the morphometrically assessed area of the myelin sheath, but it did not culminate in positive results for functional recovery in the sciatic nerve of the rats after injury through neurotmesis.

PMID:19104907[PubMed - indexed for MEDLINE]

Influence of laser (660 nm) on functional recovery of the sciatic nerve in rats following crushing lesion.

Belchior AC, dos Reis FA, Nicolau RA, Silva IS, Perreira DM, de Carvalho Pde T. Lasers Med Sci. 2009 Nov;24(6):893-9. Epub 2009 Feb 6.

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Abstract

With the aim of accelerating the regenerative processes, the objective was to study the influence of gallium-aluminum-arsenide (GaAlAs) laser (660 nm) on functional and histomorphological recovery of the sciatic nerve in rats. The sciatic nerves of 12 Wistar rats were crushed divided into two groups: control and laser therapy. For the latter, GaAlAs laser was utilized (660 nm, 4 J/cm(2), 26.3 mW and 0.63 cm(2) beam), at three equidistant points on the lesion, for 20 days. Comparison of the sciatic functional index (SFI) showed that there was a significant difference only between the pre-lesion value of the laser therapy group and that after the 21st day in the control group. It was concluded that the parameters and methods utilized demonstrated positive results regarding the SFI over the time period evaluated.PMID:19198971[PubMed - indexed for MEDLINE]

Comparative effects of wavelengths of low-power laser in regeneration of sciatic nerve in rats following crushing lesion.

Lasers Med Sci. 2010 May;25(3):423-30. Epub 2010 Feb 6.Barbosa RI, Marcolino AM, de Jesus Guirro RR, Mazzer N, Barbieri CH, de Cássia Registro Fonseca M.

Department of Biomechanics, Medicine and Rehabilitation of the Locomotor Apparatus, Medical School of Ribeirão Preto, University of São Paulo, Av. Bandeirantes 3900, Ribeirão Preto 14049-900, SP, Brazil. ribarbosa@hcrp.fmrp.usp.br

Abstract

Peripheral nerves are structures that, when damaged, can result in significant motor and sensory disabilities. Several studies have used therapeutic resources with the aim of promoting early nerve regeneration, such as the use of low-power laser. However, this laser therapy does not represent a consensus regarding the methodology, thus yielding controversial conclusions. The objective of our study was to investigate, by functional evaluation, the comparative effects of low-power laser (660 nm and 830 nm) on sciatic nerve regeneration following crushing injuries. Twenty-seven Wistar rats subjected to sciatic nerve injury were divided into three groups: group sham, consisting of rats undergoing simulated irradiation; a group consisting of rats subjected to gallium-aluminum-arsenide (GaAlAs) laser at 660 nm (10 J/cm(2), 30 mW and 0.06 cm(2) beam), and another one consisting of rats subjected to GaAlAs laser at 830 nm (10 J/cm(2), 30 mW and 0.116 cm(2)). Laser was applied to the lesion for 21 days. A sciatic functional index (SFI) was used for functional evaluation prior to surgery and on days 7, 14, and 21 after surgery. Differences in SFI were found between group 660 nm and the other ones at the 14th day. One can observe that laser application at 660 nm with the parameters and methods utilised was effective in promoting early functional recovery, as indicated by the SFI, over the period evaluated.

PMID:20135336[PubMed - indexed for MEDLINE]

Chapter 25: Phototherapy in peripheral nerve injury: effects on muscle preservation and nerve regeneration.

Rochkind S, Geuna S, Shainberg A. Int Rev Neurobiol. 2009;87:445-64.

Division of Peripheral Nerve Reconstruction, Department of Neurosurgery, Tel Aviv Sourasky Medical Center, Tel Aviv University, Israel.

Abstract

Posttraumatic nerve repair and prevention of muscle atrophy represent a major challenge of restorative medicine. Considerable interest exists in the potential therapeutic value of laser phototherapy for restoring or temporarily preventing denervated muscle atrophy as well as enhancing regeneration of severely injured peripheral nerves. Low-power laser irradiation (laser phototherapy) was applied for treatment of rat denervated muscle in order to estimate biochemical transformation on cellular and tissue levels, as well as on rat sciatic nerve model after crush injury, direct or side-to-end anastomosis, and neurotube reconstruction. Nerve cells' growth and axonal sprouting were investigated in embryonic rat brain cultures. The animal outcome allowed clinical double-blind, placebo-controlled randomized study that measured the effectiveness of 780-nm laser phototherapy on patients suffering from incomplete peripheral nerve injuries for 6 months up to several years. In denervated muscles, animal study suggests that the function of denervated muscles can be partially preserved by temporary prevention of denervation-induced biochemical changes. The function of denervated muscles can be restored, not completely but to a very substantial degree, by laser treatment initiated at the earliest possible stage post injury. In

peripheral nerve injury, laser phototherapy has an immediate protective effect. It maintains functional activity of the injured nerve for a long period, decreases scar tissue formation at the injury site, decreases degeneration in corresponding motor neurons of the spinal cord, and significantly increases axonal growth and myelinization. In cell cultures, laser irradiation accelerates migration, nerve cell growth, and fiber sprouting. In a pilot, clinical, double-blind, placebo-controlled randomized study in patients with incomplete long-term peripheral nerve injury, 780-nm laser irradiation can progressively improve peripheral nerve function, which leads to significant functional recovery. A 780-nm laser phototherapy temporarily preserves the function of a denervated muscle, and accelerates and enhances axonal growth and regeneration after peripheral nerve injury or reconstructive procedures. Laser activation of nerve cells, their growth, and axonal sprouting can be considered as potential treatment for neural injury. Animal and clinical studies show the promoting action of phototherapy on peripheral nerve regeneration, which makes it possible to suggest that the time for broader clinical trials has come.

PMID:19682654[PubMed - indexed for MEDLINE]

Laser phototherapy (780 nm), a new modality in treatment of long-term incomplete peripheral nerve injury: a randomized double-blind placebo-controlled study

. Photomed Laser Surg. 2007 Oct;25(5):436-42. Rochkind S, Drory V, Alon M, Nissan M, Ouaknine GE.

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Abstract

OBJECTIVE:

The authors conducted this pilot study to prospectively investigate the effectiveness of low-power laser irradiation (780 nm) in the treatment of patients suffering from incomplete peripheral nerve and brachial plexus injuries for 6 months up to several years.

BACKGROUND DATA:

Injury of a major nerve trunk frequently results in considerable disability associated with loss of sensory and motor functions. Spontaneous recovery of long-term severe incomplete peripheral nerve injury is often unsatisfactory.

METHODS:

A randomized, double-blind, placebo-controlled trial was performed on 18 patients who were randomly assigned placebo (non-active light: diffused LED lamp) or low-power laser irradiation (wavelength, 780 nm; power, 250 mW). Twenty-one consecutive daily sessions of laser or placebo irradiation were applied transcutaneously for 3 h to the injured peripheral nerve (energy density, 450 J/mm(2)) and for 2 h to the corresponding segments of the spinal cord (energy density, 300 J/mm(2)). Clinical and electrophysiological assessments were done at baseline, at the end of the 21 days of treatment, and 3 and 6 months thereafter.

RESULTS:
The laser-irradiated and placebo groups were in clinically similar conditions at baseline. The analysis of motor function during the 6-month follow-up period compared to baseline showed statistically significant improvement (p = 0.0001) in the laser-treated group compared to the placebo group. No statistically significant difference was found in sensory function. Electrophysiological analysis also showed statistically significant improvement in recruitment of voluntary muscle activity in the laser-irradiated group (p = 0.006), compared to the placebo group.
CONCLUSION:
This pilot study suggests that in patients with long-term peripheral nerve injury noninvasive 780-nm laser phototherapy can progressively improve nerve function, which leads to significant functional recovery.

PMID:17975958[PubMed - indexed for MEDLINE

Further development of reconstructive and cell tissue-engineering technology for treatment of complete peripheral nerve injury in rats.

Rochkind S, Astachov L, el-Ani D, Hayon T, Graif M, Barsky L, Alon M, Odvak I, Nevo Z, Shahar A. Neurol Res. 2004 Mar;26(2):161-6.

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Abstract
In this work we evaluated the efficacy of biodegradable composite co-polymer guiding neurotube, based on tissue-engineering technology, for the treatment of complete peripheral nerve injury where the nerve defect is significant. The right sciatic nerve of 12 three-month-old rats was completely transected and peripheral nerve segment was removed. A 2.2-cm biodegradable co-polymer neurotube containing viscous gel (NVR-N-Gel) with survival factors, neuroprotective agents and Schwann cells was placed between the proximal and the distal parts of the transected nerve for reconnection a 2-cm nerve defect. The proximal and distal parts of the nerve were fixed into the neurotube using 10-0 sutures. Ultrasound observation showed growth of the axons into the composite neurotube 2 months after the surgery. Electrophysiological study indicated compound muscle action potentials in nine out of 12 rats, 2-4 months after peripheral nerve reconstructive surgery. The postoperative follow-up (up to 4 months) on the operated rats that underwent peripheral nerve reconstruction using composite co-polymer neurotube, showed beginning of re-establishment of active foot movements. The tube was dissolved and nerve showed complete reconnection. Histological observation of the nerve showed growth of myelinated axons into the site where a 2-cm nerve defect replaced by composite co-polymer neurotube and into the distal part of the nerve. In CONCLUSION: (1) an innovative composite neurotube for reconstruction of significant loss of peripheral nerve segment is described; (2) a viscous gel, containing survival factors, neuroprotective agents and Schwann cells served as a regenerative

environment for repair. Further investigations of this reconstructive procedure are being conducted.

PMID:15072635[PubMed - indexed for MEDLINE]

Neuroscience Letters. 2007 Jan 16;411(3):189-93. Epub 2006 Nov 22.

Neural correlates of transmeatal cochlear laser (TCL) stimulation in healthy human subjects.

Department of Radiology II, Division of Neuroradiology, University Hospital of Innsbruck, Medical University Innsbruck, Anichstrasse 35, 6020 Innsbruck, Austria; fMRI-Lab, Department of Psychiatry, Medical University Innsbruck, 6020 Innsbruck, Austria.

Transmeatal cochlear laser (TCL) treatment has recently been proposed as a therapeutic procedure for cochlear dysfunction such as chronic cochlear tinnitus or sensorineural hearing loss. The aim of this study was to investigate whether TLC has any influence on the central nervous system using functional MRI with healthy young adults. The laser stimulation device was placed on the tympanic membrane of both ears. A laser stimulation run and a placebo run were performed in random order. The participants were unable to differentiate between verum and placebo stimulation. In the comparison of verum to placebo runs, we observed significant activations within the left superior frontal gyrus, the right middle and medial frontal gyrus, the right superior parietal lobule, the left superior occipital gyrus, the precuneus and cuneus bilaterally, the right anterior and the left and right middle and posterior cingulate gyrus and the left thalamus. This network of brain areas corresponds well to results from previous PET studies of patients with tinnitus. Though TCL seems to have a clinically measurable effect on the central nervous system the neurophysiological mechanism leading to the observed activated neuronal network remains unknown.

Promotion of regenerative processes in injured peripheral nerve induced by low-level laser therapy.

Mohammed IF, Al-Mustawfi N, Kaka LN. Photomed Laser Surg. 2007 Apr;25(2):107-11.

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Abstract

OBJECTIVE:

This study aimed to assess in vitro the influence of low-level laser therapy (LLLT) on the regenerative processes of a peripheral nerve after trauma.

BACKGROUND DATA:
In peripheral nerve injury initiated after severing due to accident or by a surgeon during operation, photomodulation by light in the red to near-infrared range (530-1000 nm) using low-energy lasers has been shown to accelerate nerve regeneration.

METHOD:
Twenty-four New Zealand adult male rabbits were randomly assigned to two equal groups (control and laser-treated). General anesthesia was administered intramuscularly, and exploration of the peroneal nerve was done in the lateral aspect of the left leg. Complete section of the nerve was performed, which was followed by suturing of the neural sheath (epineurium). Irradiation was carried out directly after the operation and for 10 consecutive days. The laser used was diode with wavelength of 901 nm (impulsive) and power of 10 mW; it was a square-shaped window type (16 cm(2)), and its energy was applied by direct contact of the instrument's window to the site of the operation. Three rabbits from each group were sacrificed at the end of weeks 2, 4, 6, and 8, and specimens were collected from the site of nerve suturing and sent for histopathological examination.

RESULTS:
Two important factors were examined via histopathology: diameter of the nerve fibers and individual internodal length. Compared to the control group, significant variations in regeneration were observed, including thicker nerve fibers, more regular myelin layers, clearer nodes of Ranvier with absence of short nodes in the treated group. Variations between the two groups for diameter were significant for the 2(nd) week ($p < 0.05$), highly significant for the 4(th) and 6(th) weeks, respectively ($p < 0.01$), and very highly significant for the 8(th) week ($p < 0.001$). Variations between the two groups for internodal length were highly significant for the 2(nd) and 4(th) weeks ($p < 0.01$), and very highly significant for the 6(th) and 8(th) weeks ($p < 0.001$).

CONCLUSION:
This experiment affirms the beneficial effect of LLLT on nerve regeneration, since LLLT produced a significant amount of structural and cellular change. The results of the present study suggest that laser therapy may be a viable approach for nerve regeneration, which may be of clinical relevance in scheduled surgery or microsurgery.

PMID:17508846[PubMed - indexed for MEDLINE]