Photobiomodulation (PBM) / Low Level laser Therapy (LLLT)

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Notes:

Adjunctive laser-stimulated stem-cells therapy to primary reperfusion in acute myocardial infarction in humans: Safety and feasibility study.

Elbaz-Greener, G Sud, M Tzuman, O Leitman, M Vered, Z Ben, Dov N, Oron U, Blatt A

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BACKGROUND: Low-level laser therapy (LLLT) has photobiostimulatory effects on stem cells and may offer cardioprotection. This cell-based therapy may compliment primary percutaneous coronary intervention (PPCI) in patients with ST-segment elevation myocardial infarction (STEMI). OBJECTIVE: In this randomized control trial, our primary objective was to determine the safety and feasibility of LLLT application to the bone marrow in patients with STEMI undergoing PPCI. METHODS: We randomly assigned patients undergoing PPCI to LLLT or non-laser therapy (NLT). In the LLLT group, 100 s of laser therapy was applied to the tibia bone prior to PPCI, as well as 24 and 72 h post-PPCI. In the control group, the power source was turned off. The primary outcome was the difference in door-to-balloon (D2B) time, and additional outcomes included differences in circulating cell counts, cardiac enzymes, and left-ventricular ejection fraction (LVEF) at pre-specified intervals post-PPCI. RESULTS: Twenty-four patients were randomized to LLLT (N = 12) or NLT (N = 12). No adverse effects of the treatment were detected. The D2B time was not significantly different between the groups (41 ± 8 vs 48 ± 1 min; P = 0.73). Creatinine Phosphokinase area under the curve, was lower after LLLT (22 ± 10) compared to NLT (49 ± 12), but this was not statistically significant (P = 0.08). Troponin-T was significantly lower after LLLT (2.7 ± 1.4 ng/mL) in comparison to NLT (5.2 ± 1.8 ng/mL. P < 0.05). At 9 months, LVEF improved in both groups without a significant difference between LLLT (55 ± 9%) and NLT (52 ± 9%; P = 0.90). CONCLUSION: LLLT is a safe and feasible adjunctive cell-based therapy to PPCI that may benefit ischemic myocardium.

J Interv Cardiol 2018 Jul 12

https://pubmed.ncbi.nlm.nih.gov/29999208

Autologous bone-marrow stem cells stimulation reverses post-ischemic-reperfusion kidney injury in rats.

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BACKGROUND/AIMS: Low-level laser therapy (LLLT) has been found to modulate biological activity. The aim of the present study was to investigate the possible beneficial effects of LLLT application to stem cells in the bone marrow (BM), on the kidneys of rats that had undergone acute ischemia-reperfusion injury (IRI). METHODS: Injury to the kidneys was induced by the excision of the left kidney and 60 min of IRI to the right kidney in each rat. Rats were then divided randomly into 2 groups: non-laser-treated and laser-treated. LLLT was applied to the BM 10 min and 24 h post-IRI and rats were sacrificed 4 days post-IRI. Blood was collected before the sacrifice and the kidney processed for histology. RESULTS: Histological evaluation of kidney sections revealed the restored structural integrity of the renal tubules, and a significant reduction of 66% of pathological score in the laser-treated rats as compared to the non-laser-treated ones. C-kit positive cell density in kidneys post-IRI and laser-treatment was ($p = 0.05$) 2.4-fold higher compared to that of the non-laser treated group. Creatinine, blood urea nitrogen, and cystatin-C levels were significantly 55, 48, and 25% lower respectively in the laser-treated rats as compared to non-treated ones. CONCLUSION: LLLT application to the BM causes induction of stem cells, which subsequently migrate and home in on the injured kidney. Consequently, a significant reduction in pathological features and improved kidney function post-IRI are evident. The results demonstrate a novel approach in cell-based therapy for acute ischemic injured kidneys. (c) 2014 S. Karger AG, Basel.

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Low-level laser therapy during postnatal development modulates degeneration and enhances regeneration processes in the hindlimb muscles of dystrophic mice.

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OBJECTIVE: The aim of the present study was to determine whether low-level laser therapy (LLLT) at early stages postpartum could affect regeneration and degenerative processes in skeletal muscles of the dystrophic mdx mouse. BACKGROUND DATA: LLLT has been found to modulate various biological processes. It was previously shown that LLLT can markedly promote the process of skeletal muscle regeneration and angiogenesis, as well as reduce apoptosis in skeletal muscle fibers in culture. METHODS AND RESULTS: Eight newborn mdx mice were used. Ga-Al-As diode laser (810 nm) was applied at a power density of10 mW/cm(2) to the surface (area of 0.0255 cm(2)) of hindlimb muscle for 120 sec (fluence of 1.2 J/cm(2)) once a week for 4 consecutive weeks, commencing 1 week post-birth. The contralateral leg served as an untreated (sham) control. Mice were euthanized 2 days following the last laser application, and the muscles were processed for histology. Histological sections were scored for degenerative muscle foci. Statistical analysis revealed a score of 2.91+/-0.17 in the control, untreated group, which was significantly higher ($p<0.001$) than the value in the laser-treated group (1.56+/-0.49), indicating less degenerative foci in the laser-treated muscles. Histology also indicated regeneration (numerous myotubes) in the laser-treated mice, and no regeneration in the non-laser-treated mice. CONCLUSIONS: The results indicate that LLLT applied to mdx mice during postnatal development may have a significant beneficial effect in the induction of regenerative capacity and reduction of degenerative muscle foci in these mice, with possible direct clinical relevance.

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Low-level visible light (LLVL) irradiation promotes proliferation of mesenchymal stem cells.

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Low-level visible light irradiation was found to stimulate proliferation potential of various types of cells in vitro. Stem cells in general are of significance for implantation in regenerative medicine. The aim of the present study was to investigate the effect of low-level light irradiation on the proliferation of mesenchymal stem cells (MSCs). MSCs were isolated from the bone marrow, and light irradiation was applied at energy densities of 2.4, 4.8, and 7.2 J/cm(2). Illumination of the MSCs resulted in almost twofold increase in cell number as compared to controls. Elevated reactive oxygen species and nitric oxide production was also observed in MSCs cultures following illumination with broadband visible light. The present study clearly demonstrates the ability of broadband visible light illumination to promote proliferation of MSCs in vitro. These results may have an important impact on wound healing.

Lasers Med Sci 2012 Sep 25

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Near infrared Transcranial Laser Therapy applied at Various Modes to Mice Following Traumatic Brain Injury Significantly Reduces Long-Term Neurological Deficits.

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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 vs. continuous) 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 one hour and up to 56 days post-trauma using a neurological severity score (NSS). The extent of recovery is expressed as dNSS, the difference between the initial score, and that at any other, later, time point. An 808nm Ga-Al-As diode laser was employed transcranially 4, 6 or 8 hrs 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 56 days post-CHI. From 5 to 28 days post-TBI, the NSS of the laser-treated mice were significantly lower ($p<0.05$) than the non-laser-treated, control mice. The percentage of surviving mice that demonstrated full recovery 56 days post-CHI, namely 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, MRI analysis demonstrated significantly smaller infarct lesion volumes in laser treated mice as compared to control. 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. Key words: low-level laser therapy; mice; traumatic brain injury; pulsed laser; motor function, MRI.

J Neurotrauma 2011 Oct 31

https://pubmed.ncbi.nlm.nih.gov/22040267

Enhanced liver regeneration following acute hepatectomy by low-level laser therapy.

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OBJECTIVE: The aim of the present study was to investigate the effect of low-level laser therapy (LLLT) on liver regeneration following hepatectomy. Background: LLLT has been found to modulate various biological processes. MATERIALS AND METHODS: Twelve mature male rats were used. The liver was exposed, and 70% of it was excised. The rats were assigned randomly to two groups: control, non-laser treated, and experimental, laser-treated (diode [Ga-Al-As] laser 804 nm) group. For determination of newly formed blood vessels and proliferating cells, 5-Bromo-2'deoxyuridine (BrdU) was injected intraperitoneally. The rats were sacrificed 2 d post hepatectomy, and histological sections from each liver were processed for analysis of new blood-vessel formation using BrdU immunostaining kit. Mesenchymal stem cells (MSCs) were assessed using c-kit immunostaining. BrdU-labeled cells were counted as for estimation of newly formed hepatic cells. RESULTS: It was found that the number of proliferating cells (BrdU positive cells) per area in the regenerating regions of the livers were significantly ($p < 0.01$) 2.6-fold higher in the laser-treated rats than in the control non-laser-treated rats. The density of the newly formed blood vessels and c-kit immunopositive cells in the regenerating area of the laser-treated livers was significantly ($p < 0.01$) 3.3- and 2.3-fold respectively higher than the control non-laser treated livers. CONCLUSION: It is concluded that LLLT following acute hepatectomy most probably stimulates a significant enhancement of liver regeneration conducive to both the formation of new hepatocytes and MSCs and angiogenesis in the regenerating liver.

Photomed Laser Surg 2010 Oct 28(5) 675-8

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Ga-As (808 nm) laser irradiation enhances ATP production in human neuronal cells in culture.

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NHNP were grown in tissue culture and were treated by Ga-As laser (808 nm, 50 mW/cm(2), 0.05 J/cm(2)), and ATP was determined at 10 min after laser application.

The quantity of ATP in laser-treated cells was 7513 +/- 970 units, which was significantly higher (p < 0.05) than the non-treated cells, which comprised 3808 +/- 539 ATP units.

Laser application to NHNP cells significantly increases ATP production in these cells. These findings may explain the beneficial effects of low-level laser therapy (LLLT) in stroked rats. Tissue culture of NHNP cells might offer a good model to study the mechanisms associated with promotion of ATP production in the nervous system by LLLT.

Photomed Laser Surg 2007 Jun 25(3) 180-2

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

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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 LLLT procedure 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.

J. Neurotrauma, 2007 Apr 24(4) 651-6

https://pubmed.ncbi.nlm.nih.gov/17439348

Low-level laser therapy applied transcranially to rats after induction of stroke significantly reduces long-term neurological deficits.

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BACKGROUND AND PURPOSE: Low-level laser therapy (LLLT) modulates various biological processes. In the present study, we assessed the hypothesis that LLLT after induction of stroke may have a beneficial effect on ischemic brain tissue. METHODS: Two sets of experiments were performed. Stroke was induced in rats by (1) permanent occlusion of the middle cerebral artery through a craniotomy or (2) insertion of a filament. After induction of stroke, a battery of neurological and functional tests (neurological score, adhesive removal) was performed. Four and 24 hours poststroke, a Ga-As diode laser was used transcranially to illuminate the hemisphere contralateral to the stroke at a power density of 7.5 mW/cm2. RESULTS: In both models of stroke, LLLT significantly reduced neurological deficits when applied 24 hours poststroke. Application of the laser at 4 hours poststroke did not affect the neurological outcome of the stroke-induced rats as compared with controls. There was no statistically significant difference in the stroke lesion area between control and laser-irradiated rats. The number of newly formed neuronal cells, assessed by double immunoreactivity to bromodeoxyuridine and tubulin isotype III as well as migrating cells (doublecortin immunoactivity), was significantly elevated in the subventricular zone of the hemisphere ipsilateral to the induction of stroke when treated by LLLT. CONCLUSIONS: Our data suggest that a noninvasive intervention of LLLT issued 24 hours after acute stroke may provide a significant functional benefit with an underlying mechanism possibly being induction of neurogenesis.

Stroke 2006 Oct 37(10) 2620-4

https://pubmed.ncbi.nlm.nih.gov/16946145

Transcranial application of low-energy laser irradiation improves neurological deficits in rats following acute stroke.

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Stroke was induced in 169 rats that were divided into four groups: control non-laser and three laser-treated groups where laser was employed ipsilateral, contralateral, and both to the side of the induced stroke. Rats were tested for neurological function.

In all three laser-treated groups, a marked and significant improvement in neurological deficits was evident at 14, 21, and 28 days post stroke relative to the non-treated group.

These observations suggest that LLLT applied at different locations in the skull and in a rather delayed-phase post stroke effectively improves neurological function after acute stroke in rats.

Lasers Surg Med 2006 Jan 38(1) 70-3

https://pubmed.ncbi.nlm.nih.gov/16444697

A preliminary investigation into light-modulated replication of nanobacteria and heart disease.

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OBJECTIVE: The purpose of this preliminary study is to evaluate the effect of various wavelengths of light on nanobacteria (NB). BACKGROUND DATA: NB and mitochondria use light for biological processes. NB have been described as multifunctional primordial nanovesicles with the potential to utilize solar energy for replication. NB produce slime, a process common to living bacteria. Slime release is an evolutionary important stress-dependent phenomenon increasing the survival chance of individual bacteria in a colony. In the cardiovascular system, stress-induced bacterial colony formation may lead to a deposition of plaque. METHODS: Cultured NB were irradiated with NASA-LEDs at different wavelengths of light: 670, 728 and 880 nm. Light intensities were about 500k Wm (-2), and energy density was 1 x 10(4) J m(-2). RESULTS: Monochromatic light clearly affected replication of NB. Maximum replication was achieved at 670 nm. CONCLUSIONS: The results indicate that suitable wavelengths of light could be instrumental in elevating the vitality level of NB, preventing the production of NB-mediated slime, and simultaneously increasing the vitality level of mitochondria. The finding could stimulate the design of cooperative therapy concepts that could reduce death caused by myocardial infarcts.

J Clin Laser Med Surg 2003 Aug 21(4) 231-5

https://pubmed.ncbi.nlm.nih.gov/13678461

Low-energy laser irradiation promotes the survival and cell cycle entry of skeletal muscle satellite cells.

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Low energy laser irradiation (LELI) has been shown to promote skeletal muscle cell activation and proliferation in primary cultures of satellite cells as well as in myogenic cell lines. Here, we have extended these studies to isolated myofibers. These constitute the minimum viable functional unit of the skeletal muscle, thus providing a close model of in vivo regeneration of muscle tissue. We show that LELI stimulates cell cycle entry and the accumulation of satellite cells around isolated single fibers grown under serum-free conditions and that these effects act synergistically with the addition of serum. Moreover, for the first time we show that LELI promotes the survival of fibers and their adjacent cells, as well as cultured myogenic cells, under serum-free conditions that normally lead to apoptosis. In both systems, expression of the anti-apoptotic protein Bcl-2 was markedly increased, whereas expression of the pro-apoptotic protein BAX was reduced. In culture, these changes were accompanied by a reduction in the expression of p53 and the cyclin-dependent kinase inhibitor p21, reflecting the small decrease in viable cells 24 hours after irradiation. These findings implicate regulation of these factors as part of the protective role of LELI against apoptosis. Taken together, our findings are of critical importance in attempts to improve muscle regeneration following injury.

J Cell Sci 2002 Apr 1 115(Pt 7) 1461-9

https://pubmed.ncbi.nlm.nih.gov/11896194

Attenuation of infarct size in rats and dogs after myocardial infarction by low-energy laser irradiation.

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BACKGROUND AND OBJECTIVE: The aim of the present study was to investigate the possibility that low-energy laser irradiation attenuates infarct size formation after induction of chronic myocardial infarction (MI) in small and large experimental animals. STUDY DESIGN/MATERIALS AND METHODS: Laser irradiation was applied to the infarcted area of rats and dogs at various power densities (2.5 to 20 mW/cm(2)) after occlusion of the coronary artery. RESULTS: In infarcted laser-irradiated rats that received laser irradiation immediately and 3 days after MI at energy densities of 2.5, 6, and 20 mW/cm(2), there was a 14%, 62% (significant; $P < 0.05$), and 2.8% reduction of infarct size (14 days after MI) relative to non--laser-irradiated rats, respectively. In dogs, a 49% (significant; $P < 0.01$) reduction of infarct size was achieved. CONCLUSION: The results of the present study indicate that delivery of low-energy laser irradiation to infarcted myocardium in rats and dogs has a profound effect on the infarct size after MI.

Lasers Surg Med 2001 28(3) 204-11

https://pubmed.ncbi.nlm.nih.gov/11295753

Low-energy laser irradiation reduces formation of scar tissue after myocardial infarction in rats and dogs.

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BACKGROUND: Low-energy laser irradiation (LELI) has been found to attenuate various biological processes in tissue culture and experimental animal models. The aim of the present study was to investigate the effect of LELI on the formation of scar tissue in experimentally induced chronic infarct in rats and dogs. METHODS AND RESULTS: Myocardial infarction (MI) was induced in 50 dogs and 26 rats by ligation of the left anterior descending coronary artery. After induction of MI, the laser-irradiated (LI) group received laser irradiation (infrared laser, 803-nm wavelength) epicardially. Control MI-induced non-laser irradiated (NLI) dogs were sham-operated, and laser was not applied. All dogs were euthanized at 5 to 6 weeks after MI. Infarct size was determined by TTC staining and histology. The laser treatment (P:<0.05) lowered mortality significantly, from 30% to 6.5%, after induction of MI. The infarct size in the LI dogs was reduced significantly (P:<0.0001) (52%) compared with NLI dogs. Histological observation of the infarct revealed a typical scar tissue in NLI dogs and cellularity in most of the LI dogs. Only 14+/-3% of the mitochondria in the cardiomyocytes in the ischemic zone (4 hours after MI) of LI MI-induced rats were severely damaged, compared with 36+/-1% in NLI rats. Accordingly, ATP content in that zone was 7.6-fold (significantly) higher in LI than in NLI rats. CONCLUSIONS: Our observations indicate that epicardial LELI of rat and dog hearts after chronic MI caused a marked reduction in infarct size, probably due to a cardioprotective effect of the LELI.

Circulation 2001 Jan 16 103(2) 296-301

https://pubmed.ncbi.nlm.nih.gov/11208692