Stroke

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Effectiveness and Safety of Transcranial Laser Therapy for Acute Ischemic Stroke

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Background and Purpose—We hypothesized that transcranial **laser therapy** (TLT) can use near-infrared laser technology to treat acute ischemic stroke. The NeuroThera Effectiveness and Safety Trial–2 (NEST-2) tested the safety and efficacy of TLT in acute ischemic stroke.

Methods—This double-blind, randomized study compared TLT treatment to sham control. Patients receiving tissue plasminogen activator and patients with

evidence of hemorrhagic infarct were excluded. The primary efficacy end point was a favorable 90-day score of 0 to 2 assessed by the modified Rankin Scale. Other 90-day end points included the overall shift in modified Rankin Scale and assessments of change in the National Institutes of Health Stroke Scale score.

Results—We randomized 660 patients: 331 received TLT and 327 received sham; 120 (36.3%) in the TLT group achieved favorable outcome versus 101 (30.9%), in the sham group (*P*=0.094), odds ratio 1.38 (95% CI, 0.95 to 2.00). Comparable results were seen for the other outcome measures. Although no prespecified test achieved significance, a post hoc analysis of patients with a baseline National Institutes of Health Stroke Scale score of <16 showed a favorable outcome at 90 days on the primary end point (*P*<0.044). Mortality rates and serious adverse events did not differ between groups with 17.5% and 17.4% mortality, 37.8% and 41.8% serious adverse events for TLT and sham, respectively.

Conclusions—TLT within 24 hours from stroke onset demonstrated safety but did not meet formal statistical significance for efficacy. However, all predefined analyses showed a favorable trend, consistent with the previous clinical trial (NEST-1). Both studies indicate that mortality and adverse event rates were not adversely affected by TLT. A definitive trial with refined baseline National Institutes of Health Stroke Scale exclusion criteria is planned.

Neuroscience. 2007 Sep 21;148(4):907-14. Epub 2007 Jul 12

Transcranial near-infrared light therapy improves motor function following embolic strokes in rabbits: an extended therapeutic window study using continuous and pulse frequency delivery modes.

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Photon or near-infrared light therapy (NILT) may be an effective neuroprotective method to reduce behavioral dysfunction following an acute ischemic stroke. We evaluated the effects of continuous wave (CW) or pulse wave (P) NILT administered transcranially either 6 or 12 h following embolization, on behavioral outcome. For the studies, we used the rabbit small clot embolic stroke model (RSCEM) using three different treatment regimens: 1) CW power density of 7.5 mW/cm(2); 2) P1 using a frequency of 300 mus pulse at 1 kHz or 3) P2 using a frequency of 2 ms pulse at 100 Hz. Behavioral analysis was conducted 48 h after embolization, allowing for the determination of the effective

stroke dose (P(50)) or clot amount (mg) that produces neurological deficits in 50% of the rabbits. Using the RSCEM, a treatment is considered beneficial if it significantly increases the P(50) compared with the control group. Quantal dose-response analysis showed that the control group P(50) value was 1.01+/-0.25 mg (n=31). NILT initiated 6 h following embolization resulted in the following P(50) values: (CW) 2.06+/-0.59 mg (n=29, P=0.099); (P1) 1.89+/-0.29 mg (n=25, P=0.0248) and (P2) 1.92+/-0.15 mg (n=33, P=0.0024). NILT started 12 h following embolization resulted in the following P(50) values: (CW) 2.89+/-1.76 mg (n=29, P=0.279); (P1) 2.40+/-0.99 mg (n=24, P=0.134). At the 6-h post-embolization treatment time, there was a statistically significant increase in P(50) values compared with control for both pulse P1 and P2 modes, but not the CW mode. At the 12-h post-embolization treatment time, neither the CW nor the P1 regimens resulted in statistically significant effect, although there was a trend for an improvement. The results show that P mode NILT can result in significant clinical improvement when administered 6 h following embolic strokes in rabbits and should be considered for clinical development.

Expert Rev Neurother. 2007 Aug;7(8):961-5.

Laser treatment for stroke.

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Low-level laser therapy is an irradiation technique that has the ability to induce biological processes using photon energy. There are studies showing proliferation and angiogenesis after irradiation in skeletal muscle post-myocardial infarction tissue cells. Most evidence of efficacy is based on the increase in energy state and the activation of mitochondrial pathways. In the brain, there is similar evidence of cellular activity with laser irradiation. In vivo studies reinforced the efficacy of this technique for a better neurological and functional outcome post-stroke. The evidence is based on in vivo animal studies of various models and one human clinical study. Although the data is very promising, some fundamental questions remain to be answered, such as the exact mechanism along the cascade of post-stroke interconnective molecular disturbance, the optimal technique and time of treatment, and the long-term safety aspects. The answers to these questions are expected to evolve within the next few years.

Stroke. 2007 Jun;38(6):1843-9. Epub 2007 Apr 26.

Infrared laser therapy for ischemic stroke: a new treatment strategy: results of the NeuroThera Effectiveness and Safety Trial-1 (NEST-1).

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BACKGROUND AND PURPOSE: The NeuroThera Effectiveness and Safety Trial-1 (NEST-1) study evaluated the safety and preliminary effectiveness of the NeuroThera Laser System in the ability to improve 90-day outcomes in ischemic stroke patients treated within 24 hours from stroke onset. The NeuroThera Laser System therapeutic approach involves use of infrared laser technology and has shown significant and sustained beneficial effects in animal models of ischemic stroke.

METHODS: This was a prospective, intention-to-treat, multicenter, international, double-blind, trial involving 120 ischemic stroke patients treated, randomized 2:1 ratio, with 79 patients in the active treatment group and 41 in the sham (placebo) control group. Only patients with baseline stroke severity measured by National Institutes of Health Stroke Scale (NIHSS) scores of 7 to 22 were included. Patients who received tissue plasminogen activator were excluded. Outcome measures were the patients' scores on the NIHSS, modified Rankin Scale (mRS), Barthel Index, and Glasgow Outcome Scale at 90 days after treatment. The primary outcome measure, prospectively identified, was successful treatment, documented by NIHSS. This was defined as a complete recovery at day 90 (NIHSS 0 to 1), or a decrease in NIHSS score of at least 9 points (day 90 versus baseline), and was tested as a binary measure (bNIH). Secondary outcome measures included mRS, Barthel Index, and Glasgow Outcome Scale. Primary statistical analyses were performed with the Cochran-Mantel-Haenszel rank test, stratified by baseline NIHSS score or by time to treatment for the bNIH and mRS. Logistic regression analyses were conducted to confirm the results.

RESULTS: Mean time to treatment was >16 hours (median time to treatment 18 hours for active and 17 hours for control). Time to treatment ranged from 2 to 24 hours. More patients (70%) in the active treatment group had successful outcomes than did controls (51%), as measured prospectively on the bNIH (P=0.035 stratified by severity and time to treatment; P=0.048 stratified only by severity). Similarly, more patients (59%) had successful outcomes than did controls (44%) as measured at 90 days as a binary mRS score of 0 to 2 (P=0.034 stratified by severity and time to treatment; P=0.043 stratified only by severity). Also, more patients in the active treatment group had successful outcomes than controls as measured by the change in mean NIHSS score from baseline to 90 days (P=0.021 stratified by time to treatment) and the full mRS ("shift in Rankin") score (P=0.020 stratified by severity and time to treatment; P=0.026 stratified only by severity). The prevalence odds ratio for bNIH was 1.40 (95% CI, 1.01 to 1.93) and for binary mRS was 1.38 (95% CI, 1.03 to 1.83), controlling for baseline severity. Similar results held for the Barthel Index and Glasgow Outcome Scale. Mortality rates and serious adverse events (SAEs) did not differ significantly (8.9% and 25.3% for active 9.8% and 36.6% for control, respectively, for mortality and SAEs).

CONCLUSIONS: The NEST-1 study indicates that infrared laser therapy has shown initial safety and effectiveness for the treatment of ischemic stroke in humans when initiated within 24 hours of stroke onset. A larger confirmatory trial to demonstrate safety and effectiveness is warranted.

Stroke. 2006 Oct;37(10):2620-4. Epub 2006 Aug 31

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.

Photomed Laser Surg. 2006 Aug;24(4):458-66

Effects of power densities, continuous and pulse frequencies, and number of sessions of low-level laser therapy on intact rat brain.

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OBJECTIVE: The aim of the present study was to investigate the possible short- and long-term adverse neurological effects of low-level laser therapy (LLLT) given at different power densities, frequencies, and modalities on the intact rat brain. BACKGROUND DATA: LLLT has been shown to modulate biological processes depending on power density, wavelength, and frequency. To date, few well-controlled safety studies on LLLT are available. METHODS: One hundred and eighteen rats were used in the study. Diode laser (808 nm, wavelength) was used to deliver power densities of 7.5, 75, and 750 mW/cm2 transcranially to the brain cortex of mature rats, in either continuous wave (CW) or pulse (Pu) modes. Multiple doses of 7.5 mW/cm2 were also applied. Standard neurological examination of the rats was performed during the follow-up periods after laser irradiation. Histology was performed at light and electron microscopy levels. RESULTS: Both the scores from standard neurological tests and the histopathological examination indicated that there was no long-term difference between laser-treated and control groups up to 70 days post-treatment. The only rats showing an adverse neurological effect were those in the 750 mW/cm2 (about 100-fold optimal dose), CW mode group. In Pu mode, there was much less heating, and no tissue damage was noted. CONCLUSION: Long-term safety tests lasting 30 and 70 days at optimal 10x and 100x doses, as well as at multiple doses at the same power densities, indicate that the tested laser energy doses are safe under this treatment regime. Neurological deficits and histopathological damage to 750 mW/cm2 CW laser irradiation are attributed to thermal damage and not due to tissue-photon interactions.

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

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

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BACKGROUND AND OBJECTIVES: Low-level laser therapy (LLLT) has been shown to have beneficial effects on ischemic skeletal and heart muscles tissues. The aim of the present study was to approve the effectiveness of LLLT treatment at different locations on the brain in acute stroked rats. STUDY DESIGN/MATERIALS AND METHODS: 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. RESULTS: 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. CONCLUSIONS: 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.

Progress in Low-level Laser Therapy

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Abstract
The presentation covers fundamental operating principles of some of the most widely used methods of low-level laser therapy (LLLT). It includes also recently developed LLLT technologies and medical devices such as LLLT cardiovascular and brain therapy, tissue regeneration and pain relive. The mechanism of LLLT involving interaction with mitochondria. The effects of LLLT are wavelength specific upon a known mitochondrial receptor (cytochrome C oxidase). Targeting of this receptor results in formation of adenosine triphosphate (ATP), enhanced mitochondrial survival and maintenance of cytochrome C oxidase activity

Stroke. 2004 Aug;35(8):1985-8. Epub 2004 May 20

Transcranial infrared laser therapy improves clinical rating scores after embolic strokes in rabbits.

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BACKGROUND AND PURPOSE: Because photon energy delivered using a low-energy infrared laser may be useful to treat stroke, we determined whether transcranial laser therapy would improve behavioral deficits in a rabbit small clot embolic stroke model (RSCEM). METHODS: In this study, the behavioral and physiological effects of laser treatment were measured. The RSCEM was used to assess whether low-energy laser treatment (7.5 or 25 mW/cm2) altered clinical rating scores (behavior) when given to rabbits beginning 1 to 24 hours postembolization. Behavioral analysis was conducted from 24 hours to 21 days after embolization, allowing for the determination of the effective stroke dose (P50) or clot amount (mg) that produces neurological deficits in 50% of the rabbits. Using the RSCEM, a treatment is considered beneficial if it significantly increases the P50 compared with the control group. RESULTS: In the present study, the P50 value for controls were 0.97+/-0.19 mg to 1.10+/-0.17 mg; this was increased by 100% to 195% (P50=2.02+/-0.46 to 2.98+/-0.65 mg) if laser treatment was initiated up to 6 hours, but not 24 hours, postembolization (P50=1.23+/-0.15 mg).

Laser treatment also produced a durable effect that was measurable 21 days after embolization. Laser treatment (25 mW/cm2) did not affect the physiological variables that were measured. CONCLUSIONS: This study shows that laser treatment improved behavioral performance if initiated within 6 hours of an embolic stroke and the effect of laser treatment is durable. Therefore, transcranial laser treatment may be useful to treat human stroke patients and should be further developed.

Vopr Kurortol Fizioter Lech Fiz Kult. 2003 Mar-Apr;(2):19-20.

[Magnetic and laser therapy of acute ischemic stroke]

[Article in Russian]

Samosiuk NI.

The paper presents the technique of frequency-modulated magnetolaser therapy (FMMLT) used in combined treatment of 121 patients with ischemic stroke in acute period. The results were compared with those in the control group of 30 patients who received conventional drug treatment. The results of the comparison allowed the author to recommend FMMLT in ischemic stroke especially in the period of "therapeutic window".

Lasers Surg Med 2002 31:283-8

Treatment of experimentally induced transient cerebral ischemia with low energy laser inhibits nitric oxide synthase activity and up-regulates the expression of transforming growth factor-beta 1.

Leung MC, Lo SC, Siu FK, So KF

BACKGROUND AND OBJECTIVES: Nitric oxide (NO) has been shown to be neurotoxic while transforming growth factor-beta 1 (TGF-beta1) is neuroprotective in the stroke model. The present study investigates the effects of low energy laser on nitric oxide synthase (NOS) and TGF-beta1 activities after cerebral ischemia and reperfusion injury. STUDY DESIGN/MATERIALS AND METHODS: Cerebral ischemia was induced for 1 hour in male adult Sprague-Dawley (S.D.) rats with unilateral occlusion of middle cerebral artery (MCAO). Low energy laser irradiation was then applied to the cerebrum at different durations (1, 5, or 10 minutes). The activity of NOS and the expression of TGF-beta1 were evaluated in groups with different durations of laser irradiation. RESULTS: After ischemia, the activity of NOS was gradually increased from day 3, became significantly higher from day 4 to 6 ($P < 0.001$), but returned to the normal level after day 7. The activity and expression of the three isoforms of NOS were significantly suppressed ($P < 0.001$) to different extents after laser irradiation. In addition,

laser irradiation was shown to trigger the expression of TGF-beta1 ($P < 0.001$). CONCLUSIONS: Low energy laser could suppress the activity of NOS and up-regulate the expression of TGF-beta1 after stroke in rats.

Vopr Kurortol Fizioter Lech Fiz Kult. 2000 May-Jun;(3):17-21.

[The optimization of an early rehabilitation program for cerebral stroke patients: the use of different methods of magneto- and laser therapy]

[Article in Russian]

Kochetkov AV, **Gorbunov FE**, **Minenkov AA**, **Strel'tsova EN**, **Filina TF**, **Krupennikov AI**.

Magnetotherapy and laser therapy were used in complex and complex-combined regimens in 75 patients after cerebral ischemic or hemorrhagic stroke starting on the poststroke week 4-5. Clinico-neurologic, neurophysiological and cerebrohemodynamic findings evidence for the highest effectiveness of neurorehabilitation including complex magneto-laser therapy in hemispheric ischemic and hemorrhagic stroke of subcortical location in the absence of marked clinico-tomographic signs of dyscirculatory encephalopathy. Complex-combined magneto-laser therapy is more effective for correction of spastic dystonia. Mutual potentiation of magnetotherapy and laser therapy results in maximal development of collateral circulation and cerebral hemodynamic reserve (84% of the patients). Complex effects manifest in arteriodilating and venotonic effects. Complex magneto-laser therapy is accompanied by reduction of hyperthrombocythemia and hyperfibrinogenemia.

Lik Sprava. 1996 Jul-Sep;(7-9):142-5.

[The treatment of patients with chronic cerebral circulatory failure by using laser puncture and the microclimate of the biotron]

[Article in Ukrainian]

Macheret IeL, **D'iachenko OIe**, **Korkushko OO**.

A mode is proposed of treatment of chronic cerebrovascular disorders, such as initial manifestations of cerebral blood supply insufficiency (IMBSI) and dyscirculatory encephalopathy (DE) stage I-II in hypertensive disease, involving the use of laser puncture and microclimate of biotron. All patients (n = 162) were exposed to laser puncture (10-12 procedures). Laser puncture treatments were devised according to classical approaches of reflexotherapy, using determinants of electropuncture diagnostic method by Riodoraku. The treatments were carried out with the aid of infrared portable laser "Biomed-001". IMBSI patients presenting with vegetovascular dystonia and about

70% of IMBSI patients presenting with hypertensive disease derived benefit from a course of laser puncture, as evidenced by REG, EEG, acupuncture diagnosis, iridodiagnosis according. In DE stage I-II patients and about 30% IMBSI patients presenting with hypertensive disease good therapeutic effect occurred after treatment in a ward with a stable microclimate of biotron. The proposed method can be used for treating chronic cerebrovascular disorders and administering stroke prophylaxis.

Zhongguo Zhong Xi Yi Jie He Za Zhi. 2000 Apr;20(4):264-6.

[Effect of intravascular laser irradiation of blood and traditional Chinese medical therapy on immune function in senile cerebral infarction patients of kidney deficiency type]

[Article in Chinese]

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OBJECTIVE: To observe the effect of intravascular laser irradiation of blood (ILIB) therapy on cellular immunity, change of T-lymphocyte subsets and humoral immunity in senile cerebral infarction patients of Kidney deficiency type. METHODS: Seventy-five patients were divided randomly into the ILIB group and the control group treated by conventional medicine (CM). Serum CD3, CD4, CD8, IgG, IgA, IgM, C3 and C4 levels of patients were determined before and after treatment for self-control and comparing between various groups and that of normal control. RESULTS: Before treatment, in patients of both groups, the levels of CD3, CD4, CD4/CD8, C3 were all lower than normal levels significantly, C4 and IgM higher than normal ($P < 0.05$, $P < 0.01$), the level of IgG lowered in patients inclined to Kidney-Yang deficiency and raised in those inclined to Kidney-Yin deficiency ($P < 0.01$). After treatment, in the ILIB group, CD3, CD4 and CD4/CD8 raised significantly ($P < 0.05$, $P < 0.01$), IgG and C3 varied towards normal control ($P < 0.01$, $P < 0.05$), and C4 lowered but without significance. In the control group, the indexes changed also toward normal but without significance except the change of IgG ($P < 0.05$). As for IgA and IgM, marked changes were not found in both groups in comparison between before and after treatment. CONCLUSION: ILIB therapy could bi-directionally regulate cellular and humoral immunity in senile cerebral infarction patients of Kidney deficiency type, which was similar to the function in supplementing Qi and invigorating Kidney of Chinese herbal medicine.

INTRAVASCULAR LASER THERAPY ON THE CEREBRAL CIRCULATION ISCHEMIC DISTURBANCES

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The dynamics of clinical and pathophysiological alterations on the various forms of cerebral circulation ischemic disturbances (CCID) was investigated in the course of helium-neon laser therapy (HNL). There were treated 600 patients. Clinical, vegetative, and neurophysiological pattern indices were examined. Results of the complex investigation reliably testified that vegetative indices play the important role in CCID pathogenesis, accompanied by pathologic neuro-dynamic disbalance formation. Patients with phase somatovegetative hyperactivity prevailed. Clinical effect of HNL correlated with system vegetative dynamic, its effectiveness was higher in the patients with initial sympathicotonia. HNL was not effective on cholinergic influences. After HNL positive neuro-physiological changes were registered in patients with initial adrenergic activity, there were no changes at cholinergic intensity or slight modulate effect was observed. HNL improved blood circulation, blood filling was increased in the affected vascular basin, the increased cerebral arteries tone decreased, pulse blood filling increased, venous circulation was improved. Therefore, HNL has neurodynamic effect, relaxes sympathicotonic influences and has vagotrope regulatory effect. Photoneurodynamic HNL influence renders trophotroimages action, preventing or reducing cerebral tissue ischemization at all stages of cerebro-vascular diseases with sympatic pattern and is not expedient on neurodynamic disbalance in the form of parasympathicotonia. HNL allows to receive stable therapeutic effect in patients with initial cerebral blood supply insufficiency, transient disturbances of cerebral blood circulation, slight insult, ischemic insult in the acute phase, discirculatory encephalopathy at the first stage.

Laser Acupuncture to Treat Paralysis in Stroke Patients, CT Scan Lesion Site Study

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Purpose:

1) To study the effectiveness of low-level laser stimulation of acupuncture points to treat paralysis in stroke patients; 2) To examine the relationship between neuroanatomical lesion sites on CT scan and potential for improvement following laser acupuncture treatments. We have conducted previous research with needle stimulation of acupuncture points in the treatment of paralysis in stroke patients (1-3).

Subjects:

Seven stroke patients participated (ages 48-71 years when entering the study; 5 men, 2 women). Five cases had single left hemisphere stroke; two cases, single right hemisphere stroke. Five patients were treated for residual arm/leg paralysis; they had

greatly reduced arm and leg power (and severely reduced or no voluntary isolated finger movement). Two cases were treated only for hand paresis; they had good arm and leg power, but they had mildly reduced isolated finger movement. CT scans were obtained on all patients after at least 3 months poststroke.

Six patients began receiving the laser acupuncture treatments during the chronic phase poststroke (10 months to 6.5 years). These times are beyond the spontaneous recovery period of up to 6 months poststroke (4, 5). One hand paresis case began receiving treatments during the acute phase poststroke (1 month poststroke). Because all patients were beyond the spontaneous recovery period except for one, each patient served as his/her own control. No sham laser treatments were administered. None of the stroke patients was receiving physical therapy or occupational therapy treatments during the course of the laser acupuncture treatments.

Method:

A 20 mW Gallium Aluminum Arsenide (780 nm) near-infrared, diode laser (Uni-laser, Denmark) with 1 mm diameter aperture, was used for 20-40 seconds (51-103 J/cm^2) on each acupuncture point. The laser was used for 20 seconds on shallow points (hands and face), and 40 seconds on deeper acupuncture points (arms and legs). The points used on the paralyzed arm included: LI 4 (Hegu), LI 11 (Quchi), LI 15 (Jianyu), TW 5 (Waiguan), TW 9 (Sidu), and three distal Baxie points in the web-spaces between the fingers. The points used on the paralyzed leg included: ST 31 (Biguan), ST 36 (Zusanli), GB 34 (Yanglingquan), GB 39 (Xuanzhong), and LIV 3 (Taichong). Points used on the non-paralyzed side included LI 4 (Hegu) and ST 36 (Zusanli). These points include some of those used in our previous research where needle acupuncture was used to treat paralysis in stroke patients (1-3). If facial paralysis was present, the following points on the paralyzed side were used: ST 4 (Dicang), ST 6 (Jiache), ST 7 (Xiaguan), LI 20 (Yingxiang), and SI 18 Quanliao).

The patients were tested a few days prior to the first laser acupuncture treatment, and within a few days after completing the 20th, 40th and/or 60th laser acupuncture treatment. P.T. and O.T. testers were blinded; testers were part of a needle acupuncture study with real or sham or no acupuncture. Some patients received only 20 or 40 treatments. The number of treatments a patient received (20, 40 or 60) was based solely on patient availability and transportation issues. All patients were offered a maximum of 60 laser treatments. The patients were treated 2 - 3 times per week, for 3 - 4 months.

For patients with arm/leg paralysis, improvement was defined as a minimum increase of at least 10% isolated active range of motion, on at least one arm/leg test, following 20, 40 or 60 laser acupuncture treatments. For the patients treated for hand paresis, improvement was defined as an increase of at least 1 lb., on at least one hand strength test, following 20, 40 or 60 laser acupuncture treatments.

Results:

Overall, 5/7 patients (71.4%) treated with laser acupuncture showed improvement. Four of the six chronic stroke patients (66%) showed improvement. The single acute stroke patient (hand paresis case) also showed improvement.

Three of the five arm/leg cases showed a minimum of at least 10% improvement in isolated active range of motion on knee flexion; knee extension and/or shoulder abduction (range, +11 to +28%; mean, +15.8%, S.D., 7.08).

The two cases with hand paresis each showed improvement in hand strength. For the chronic hand paresis case (33 months poststroke), grip strength, pre- treatment, 62.7 lbs., post- 20 treatments, 68.4 lbs; strength in first 2 fingers opposing thumb (3-Jaw Chuck), pre- 12, post- 18 lbs.; strength in index finger opposing thumb (Tip Pinch), pre- 8, post- 11 lbs; and strength in thumb opposing the lateral surface of index finger (Lateral Pinch) pre- 12, post- 14 lbs. For the acute hand paresis case (starting at 1 month poststroke), grip strength, pre- 32.2, post- 20 Tx.'s, 47.7 lbs.; 3-Jaw Chuck, pre- 0, post- 11.3 lbs.; Tip Pinch, pre- 0, post- 10.7 lbs; Lateral Pinch, pre- 3.7, post- 14.7 lbs.

The five cases who showed improvement following the laser acupuncture treatments

had either no lesion in, or lesion in less than half of the motor pathway areas, including the periventricular white matter (PVWM) area on CT scan. The PVWM area is located adjacent to the body of the lateral ventricle, superior to the posterior limb, internal capsule. The two arm/leg cases who showed no improvement following the laser acupuncture treatments had lesion in more than half of the motor pathway areas, including the PVWM area. These behavioral and neuroanatomical findings are similar to our previous research using needle acupuncture to treat paralysis in stroke patients.

The PVWM area appears to be the most important area to examine on CT scan or MRI scan, in understanding whether a stroke patient is likely to benefit from needle or laser acupuncture to help reduce the severity of paralysis. This area contains many important intra- and inter-hemispheric pathways including, in part: 1) The descending pyramidal fibers from motor cortex, where the pathways for the leg are more medial. 2) The body of the caudate nucleus. 3) The mid-callosal pathways. 4) The medial subcallosal fasciculus containing connections to caudate from supplementary motor area and cingulate gyrus. 5) The occipito-frontal fasciculus. 6) The superior lateral thalamic peduncle which includes projections from dorsomedial nucleus and anterior nucleus to cingulate and projections from the ventrolateral nucleus to motor cortex.

Thus, even within this small PVWM region there are numerous motor systems that might, if incompletely damaged, respond to needle or laser acupuncture. These systems include dorsal striatum, supplementary motor area, or the frontal-striatal-ventrolateral thalamic-frontal loop, as well as the descending pyramidal system.

One patient with severe arm/leg paralysis did have improvement in her facial paralysis with good control of food and liquids in the left side of her mouth for the first

time poststroke (4 years poststroke). She also improved in walking, with a "loosening" of the left Achilles tendon.

The author has observed that red-beam laser stimulation (4.59 J/cm^2) on the Jing-Well points on the fingers (LU 11, Shaoshang; LI 1, Shangyang; PC 9, Zhongchong; TW 1, Guanchong; HRT 9, Shaochong; SI 1, Shaoze), in combination with the use of a microamps TENS device (MicroStim 100 TENS, Tamarac, FL) placed on the hand (HRT 8, Shaofu; and TW 5; Waiguan), is helpful in treating hand paresis and reducing hand spasticity in stroke patients (6, p. 40, Naeser Laser HAND Treatment Program). This method is also helpful in the prevention/ reduction of contractures of the hand, in patients with severe hand paralysis (personal observation).

Discussion:

The use of low-level laser for long-term treatment is especially desirable for chronic stroke patients with hand paresis. The patient can be trained to treat him/herself at home, using an inexpensive 5mW red-beam diode, laser pointer and a microamps TENS device (MicroStim 100, Tamarac, FL). See Websites listed below.

Acupuncture studies using needle acupuncture have observed the best outcome levels when acupuncture treatments were initiated at less than 3 months poststroke (7, 8), and especially when the acupuncture treatments were initiated at less than 24 hours and 36 hours poststroke (9, 10).

This is the first study to examine the effect of low-level laser therapy on acupuncture points to treat paralysis in stroke patients where lesion location was known for each patient. Results suggest that low-level laser therapy on acupuncture points is effective to help reduce the severity of paralysis in stroke patients, especially those with mild-moderate paralysis. The treatments should be initiated as soon as possible poststroke, even within 24 hours poststroke. A comprehensive rehabilitation program of P.T., O.T. plus needle and/or laser acupuncture is recommended.

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Additional Information:

www.Acupuncture.com/Acup/Naeser.htm and www.Acupuncture.com/Acup/laser.htm

See also: Naeser MA: Neurological Rehabilitation: Acupuncture and Laser Acupuncture to Treat Paralysis in Stroke and Other Paralytic Conditions and Pain in Carpal Tunnel Syndrome. Chapter in National Institutes of Health Consensus Development Conference on Acupuncture sponsored by the Office of Alternative Medicine and the Office of Medical Applications of Research. Bethesda, MD, November 3-5, 1997. pp. 93-109

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[Protective effect of low-level laser irradiation on acupuncture points combined with iontophoresis against focal cerebral ischemia-reperfusion injury in rats]

[Article in Chinese]

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OBJECTIVE: To investigate the effects of low-level laser irradiation on acupuncture points combined with iontophoresis against brain damage after middle cerebral artery occlusion (MCAO) in rats.
METHODS: Sixty-nine SD rats were randomly divided into five groups, including normal group, sham operation group, model group, electro-acupuncture group and low-level laser irradiation on acupuncture points combined with iontophoresis group (LLLI group). The cerebral ischemia-reperfusion (I/R) model was established by thread embolism of middle cerebral artery. The rats in the LLLI group, as well as the electro-acupuncture group were given treatment as soon as the occlusion finished (0 hour) and 12, 24 hours after the occlusion. We observed the changes of neurological deficit scores and the body weight of the rats at different time. The activity of superoxide dismutase (SOD) and the content of malondialdehyde (MDA) in the ratos brain tissue were tested.
RESULTS: The neurological deficit score of the LLLI group was significantly lower than that of the model group. The body weight and the activity of SOD of the rats decreased slightly, and the content of MDA decreased significantly after the treatment.
CONCLUSION: The low-level laser irradiation on acupuncture points combined with iontophoresis can prevent focal cerebral ischemia-reperfusion injury. One of its mechanisms may be increasing the activity of SOD and decreasing the damage of the oxidation products to the body.