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Guest Editorial

Nonsurgical Laser Treatment (NSLT) of Central and Peripheral Nervous System Injuries

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The lasers used in nonsurgical procedures have biomodulatory effects on all human tissues and have been demonstrated on experimental animals and humans at a cellular level, having a measurable effect on almost all cell and tissue types, including the central and peripheral nervous system. Detailed information now exists on the anti-inflammatory, analgesic, and regenerative effects that have been proven in many tissue types, including neurons in culture in both animals and humans, and biomodulatory effects on the muscle tone of voluntary muscles.[1–4]

In 1979, Judith Walker underlined the analgesic and anti-inflammatory effects of nonsurgical lasers on neuromas associated with lower limb amputation. In 1975, V.M. Inyushin and P.R. Chekurov underlined the anti-inflammatory effects of laser on bone–joint–muscle–tendon diseases; J. Goldman, on blood parameters of rheumatoid arthritis; in 1971, R. Fork, on the regeneration of peripheral nerves in animal models. Many other authors have studied and are studying the possible effects of laser on the regeneration of the central and peripheral nervous system.[2–6]

In our institute, in common with Japanese authors, we began to treat subjects with lesions of the central nervous system (CNS) using low incident laser energy, trying to exploit the power of these systems at the anti-inflammatory, regenerative, and analgesic levels. From 2003, we started to treat subjects with traumatic spinal cord injuries (SCIs) and brain injuries (BIs), and others with central nerve degenerative lesions (multiple sclerosis, amyotrophic lateral sclerosis, demyelinating leukodystrophy, and syndromes of the lower motor neurons). Indeed, before we started, Prof. Yoshimi Asagai[1] in Japan routinely treated children with hereditary spastic cerebral palsy with low-level laser therapy (LLLT), reporting excellent results, as well as many other Japanese authors.

At a clinical level, one big problem is that each traumatic CNS injury is always different, regarding both the loss of function and the selection of the most appropriate treatment. For this reason, statistical criteria are less valid, because many variable parameters are involved concomitantly. However, some international criteria based on international scales of clinical evaluation are followed by the scientific community, such as the American Spinal Cord Injuries Association (ASIA) Impairment Scale (AIS) for the subjective evaluation of sensor and motor function, Ashworth Scale, for the evaluation of muscle tone, the Franklin Scale, the Glasgow Coma Scale, and others.

In contrast, in medicine and biology, any clinical trial must always follow three fundamental criteria: the precepts of the Helsinki Declaration and European Community (EC) Guidelines; Virchow's approach: ''At first we study the facts, then the causes of facts''; and the WHO approach.'' We must study and verify each substance, energy, and tool, which modify a physiological process of the human body.

From 2004 until 2015, we enrolled 289 patients with traumatic spinal cord injuries (TSCI), which had occurred at least 1 year before laser treatment and documented each case with computed tomography (CT), nuclear magnetic resonance (NMR), evoked somato-sensory potential (ESSP), and evoked somato-motor potential (ESMP), rather than the clinical international scales. All patients had total and/or subtotal sensory and motor paralysis under a lesion level classified as AIS A. The lasers used were 808, 10,600, and 1064 nm, applied with a first cycle of 20 sessions, 4 a day. We used more wavelengths concomitantly because each wavelength has different penetration depths, targets, and absorption characteristics in the tissue. We use the laser for different goals, namely anti-inflammatory, regenerative, and influencing muscle tone. From 2013, before laser treatment under the level of the lesion, muscle activity was tested also with a surface electromyography (sEMG) system. Clinical evaluations always included examination and assessment of superficial and deep tactile and thermal sensory levels under the level of the lesion.

A therapy protocol was used according to the clinical conditions of each patient. Dosage was adjusted following the clinical results. The same clinical evaluations and sEMG examinations were repeated at the end of each cycle of treatment. The cycles of treatment were replicated in average every 2 months. A group of patients stopped the therapy for a longer time interval for practical reasons, such as diseases that overlapped, support from a family member or other third party was impossible, and more.

Results were regarded as positive if the sensory sensibility increased by a minimum of two metamers under the level of the lesion. sEMG showed modifications in CNS–muscle conduction spikes, under the same level. Regarding the state of the TSCI, after each cycle of 20 sessions, patients showed improvements in motor function and voluntary command.

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Follow-up was positive after 1 year. Patients who interrupted the therapy for many months have maintained the improvement that they obtained, but have not experienced any further improvement. When they underwent further laser therapy, further improvements were obtained. This fact could signify that the improvements were associated with the laser therapy and not with spontaneously occurring phenomena.

We treated degenerative SCIs and BIs with the same approach. The number of patients treated was less, 15 in total. Each patient had good clinical results initially, but follow-up after 3 months was always negative. Each patient relapsed into the same clinical situation as before laser treatment. For this reason, we stopped treating similar patients until we could identify a more effective approach.

Some U.S. authors[4] have reported successful treatment of degenerative brain diseases with LLLT, which they have called transcranial laser therapy. From the published details, Alzheimer's disease, poststroke lesions, and Parkinson's disease were treated, and the preliminary results seem positive. We need to see how this approach proceeds in larger patient populations and longer follow-up periods, before we can come to any definitive conclusions. Experiments on human cadavers have shown the penetration range of some laser wavelengths, particularly those in the near-infrared, through the skull, and some concentration of the laser energy into some layers of the intracranial nervous tissue. Naturally, these experiments could not show the dynamic absorption of the light by the target tissue, because the patients were already cadavers without functioning vasculature and nervous systems, but the results did serve to demonstrate that transcranial penetration of low incident levels of laser energy of appropriate wavelengths into the cerebral cortex does occur.

However, very interesting results have been reported in the literature, and by ourselves, in subjects with cranial trauma lesions, such as complications after stroke and cranial subdural hematomas. In these subjects, we treated the energetic general system of the patients, not only the site of the lesion, because it is often located very deeply in the cranic box. For instance, in 2008 we treated a 48-year-old subject who was totally hemiplegic, and whose left temporoparietal lobe failed to show any response on electroencephalogram (EEG) stimulation after a traumatic hematoma occurred 20 years previous to our treating him with laser therapy.

After some months of treatment, the EEG readings started to show a return of response after stimulation with a dramatic reduction in the patient's hemiplegia, which quite totally disappeared. In addition, ideation, memory, and other normal functions were restored, including a normal libido. Lasers were used to irradiate only the coherence domains of the nervous system. Coherence domains (the name used today in physics, but the term chakras was used by old cultures and science) give a bioenergetics field that surrounds us all as living human beings. We have treated more patients with traumatic BIs, such as postictus and post-accidental trauma, with good and documented results.

Regarding the hypothesis for the action mechanisms of laser therapy in these lesions, we can definitely achieve anti-inflammatory, antiedema, and hyperemic effects: these have been well demonstrated in the literature. We can thus obtain some decompression of the neural tissue around the target lesion, and this could justify our preliminary results. Continuing with the therapy, we have also stimulation of nerves and regeneration of progenitor cells, with new tissue welding or neoformation conducted by compensatory alternative routes created around the lesion, between the central and peripheral nervous tissue. The effect of some visible and near-infrared lasers on progenitor neuronal cells in colture was definitively demonstrated in the year 2006, when Anders et al.[5] obtained a patent on this process.

After 5 years of experimentation (2000–2005) with 18 different types of lasers and different combinations of dosage parameters, following our protocol, we obtained a range of wavelengths and dosages capable of increasing migration, maturation, differentiation, and proliferation of progenitor cells. This mechanism could be increased also *in vivo*, and it could be responsible for the positive results that we have managed to obtain. In another hypothesis, glia could transform into functional neurons, under laser stimulation. All these hypotheses could be connected together in reality. Last but not least, we have the energetic hypothesis: lasers could influence the human energetic field, envisaged as a field of bioradiation around the body, called bioplasma, with a waveband approximately from 200 to 2000 nm, with seven principal windows of major energy exchange and different wavelengths.

These were termed chakra under the previous understanding, but now are called coherence domains in modern physics. Light energy from the laser could influence selectively each coherence domain. This energy hypothesis could justify the results obtained in patients with traumatic BIs, when we irradiate only the coherence domain, and we obtain dramatic improvement of the electrocardiogram and clinical features.

Regarding peripheral nerves, nonsurgical laser treatment (NSLT), also known as LLLT, is very useful in the treatment of trigeminal neuralgias, essential and secondary, in congenital and secondary facial paralysis, in postherpetic neuropathies, and dental neuralgias after extractions. Regarding cranial nerve lesions, the results are measurable with clinical and diagnostic tools, such as evoked potentials and EMG. Regarding dental neuralgias, the anti-inflammatory effect is quite immediate and measurable with clinical evaluation, and pain evaluation using internationally recognized scales (the visual analogue scale and similar). Rockhind[6] has shown the benefit of laser-assisted transplantation of stem cells in the surgical reconstruction of the totally transected sciatic nerve in the rat model. The laser-treated rats regained ambulation in a much shorter time than the untreated animals.

In conclusion, multi-wavelength nonsurgical laser therapy (NSLT) has a viable role in the treatment of CNS pathologies, in addition to lesions of the peripheral nervous system. Detailed data have demonstrated that laser therapy for traumatic BIs and SCIs has had very good results, demonstrated with clinical evaluations and objective instrumentation.

Laser therapy results controlled with the diagnostic procedure of evaluation and coupled with specific physical therapy for each patient can dramatically and extensively improve his or her quality of life. Great benefits are also obtainable in the treatment of peripheral nerves; however, they are in addition treatable with other medical and surgical therapeutic approaches. Results are also possible for degenerative CNS lesions, but unfortunately the good results obtained initially until today have always been transitory with a maximum duration of some months, followed by a return to the same condition as before the treatment. While we wait to elucidate and understand the causes of degenerative CNS diseases, perhaps we could develop a much smaller type of hand-held and better operated laser system for the use in this type of patients in their own homes. The future of laser therapy for injuries and pathologies of the CNS and peripheral nervous system is very bright and is getting brighter.

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