

Low Intensity Laser Therapy

Basics and clinical applications

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INTRODUCTION

Light in its various forms has been used for healing from the time of the ancient Egyptian and Greek civilizations.^(1,2) With recent advances in the engineering of devices and the development of appropriate protocols for effective therapeutic application of light, dramatic benefits and treatment of many complex medical conditions are now achievable.⁽³⁻⁵⁾

The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. A laser produces photons of light with specific characteristics.⁽¹⁾ These include: Monochromaticity: In laser light, all electromagnetic waves have the same wavelength and color. Coherence: All the photons in laser light oscillate in the same phase. Directionality: Due to the coherence factor light is also highly directional. Intensity: the high intensity produced in a small area.^(1,4,5)

High power or thermal lasers can produce a substantial amount of heat. This destructive potential makes high power laser a key component in industrial applications such as cutting and welding.^(2,3) Because thermal laser combines power and precision, it also has many beneficial uses in medical applications.⁽¹⁾

Unlike thermal lasers, the low intensity laser beam is "soft power" and does not produce heat.

Low intensity laser energy initiates and stimulates

many beneficial physiological processes within the cell.⁽⁶⁻⁸⁾ In essence it promotes the healing of damaged cells which makes it applicable in the therapy of many pathologies. Moreover, it is non-destructive with regard to the target tissue.^(8,9)

Many terminologies are used to characterize Low Intensity Laser Therapy. Many synonyms commonly used, particularly in the literature include photo bio-stimulation, light therapy, phototherapy, laser therapy, soft laser therapy, cold laser therapy, laser light therapy, low level or energy laser, low energy photon therapy, soft tissue laser therapy, low reactive laser therapy and therapeutic laser.^(1,9)

Laser therapy is the use of monochromatic light emission from a low intensity laser diode (250 milliwatts or less) or an array of high intensity super luminous diodes (providing total optical power up to the 2000 milliwatt range).^(9,10) Based on experience, it is clear that laser therapy above 250 milliwatts, even if used for milliseconds, can result in tissue damage, but below 250 milliwatts, using proper frequencies, duty cycles and controlling a number of other parameters, tissue stimulation can be advanced in a cumulative pattern, rather than produce inhibition of healing, which may occur at higher power settings.⁽¹⁰⁾ The light source is placed in contact with the skin allowing the photon energy to penetrate tissue, where it interacts with various intracellular biomolecules resulting in the normalization of cellular components. There are

two types of diodes used in low intensity laser therapy^(11,12):

- 1) Superluminescent Diodes (SLD) are designed for the treatment of a large surface area.
- 2) Laser Diodes (LD) have higher power output and narrow beams, making them ideally suitable as "laser probes" for deeper penetration.^(9,10,12)

The particles of energy are absorbed by a variety of micro-molecules within the cell, a process which initiates a number of positive physiological responses. In essence, light energy is converted into biochemical energy. In result, normal cell morphology and function are restored. The process is curative.^(8,10)

A wave length bandwidth that starts at approximately 600nm and ends at approximately 900nm (red-to-NIR region) has been identified as containing the wavelengths appropriate for laser therapy. No adverse effects have been documented for any wavelengths over this range.^(7,9)

The Physiological Effects Of Low Intensity Laser therapy

They can be categorized into short term and long term effects: Short Term effects includes: production of beta-endorphins and cortisol, which enables the body to combat the stress associated with the disease process.⁽¹³⁾ The short-term effect is significant in 5-10% of cases during or after the initial treatment, but is not as important as the long term or cumulative effect. Long Term Or Cumulative Effect are as follows: DNA and ATP production is increased resulting in improved cellular metabolism.⁽¹³⁻¹⁵⁾ Neurotransmission is facilitated due to elevated levels of serotonin and acetylcholine. Mitochondrial activity is stimulated, macrophages, fibroblasts and other cells functions are modulated. Angiogenesis improves. Cell membrane potential is regulated, essentially in Na, Cl and K ion transfer (electrolyte balance). Cytokines are released.^(16,17,18)

Furthermore; LASER can stimulate immune response and alter positively histamine response, improve lymphatic drainage, increase Production of growth hormone. Finally, the body's natural healing processes are enhanced. Some other positive activities are modulated including the humoral and cerebral spinal fluid effects which are highly significant and are currently under investigation

in research laboratories.^(12,15)

The monochromatic coherent and polarized characteristics of the therapeutic light beam permit penetration of deep tissues without affecting normal cells. It should be noted that the end result is curative with regard to the pathology, rather than symptom modulation, the conventional approach for the management of pain.^(14,16,17)

LASER Application in clinic

As always in medicine the placebo effect is at work. In addition to the positive effort of nature, light invariably contributes a healing component no matter how minute, therefore a number of patients will improve with the psychological boost of laser therapy even though it may be of minimal value per se. Indeed, this is inevitable in simple easy to treat cases which would return to normal function without any treatment. As we all know many types of pathology are relieved by rest and nature alone.⁽¹⁸⁻²¹⁾

Clinical experience reveals that different medical problems respond better to certain protocols than others; in addition, each individual is genetically different, therefore the ability to customize protocols is required for proper treatment.^(1,19) This process, referred to as "customization", accommodates a variety of factors, some of which may be unknown. The settings need to be available over an infinite range with customization for each individual cellular genetic make-up in order to achieve a suitable response.^(20,21)

Treatment must be applied in a therapeutically effective manner through control of frequency, duty cycle, wavelength, waveform, energy density, duration, etc. Power is not the only factor for effective treatment using laser therapy.^(18,19) Other important parameters mentioned above, also treatment duration and of course energy density (J/cm²) should be considered.⁽²⁰⁾

The wavelength of the light is one factor that controls the depth of penetration. This myth is the result of confusion between the rate of repetition (frequency) of the applied waveform and the wavelength of the light (frequency of light equals the inverse of wavelength). The power of the light source also affects the penetration depth.^(19,20,22)

There is an overdose range at which too much power inhibits recovery of the cell and therefore

the cure of the pathology being treated. One cannot concentrate power into too short a time interval in order to reduce treatment times. Moreover higher power settings can denature intracellular proteins or cause burns.^(16,19,20)

Treatments are typically 15 minutes to one hour in length and a treatment program statistically requires an average of 10 treatments. The number of treatments will vary with regard to the individual problem. Just as every medical condition varies, so will the individual response to therapy. The onset of pain relief as a result of treatment varies depending on each patient's response to Low Intensity Laser Therapy.^(15,17,22)

The Advantages of Low Intensity Laser Therapy

For many years, rehabilitation therapies - including ultrasound, interferential current, TENS, etc. - have been used extensively throughout the world to treat pain and stimulate the healing process. However, the healing effects of these treatments have been disappointing as they only modulate symptoms.⁽¹⁵⁾ In contrast, low energy laser is able to influence the pathology directly at the cellular level, resulting in therapeutic benefits that are more profound and generally curative. At best, alternative therapies act as counter-irritants, creating a transient increase in circulation and the release of endorphins, providing only temporary symptomatic relief.^(16,19,20)

However, Laser is non-invasive, non-toxic, easily applied, highly effective with cure rate > 95% and it has no known negative side effects. The process of "customization: that individualize therapy for each patient permits a balanced therapeutic approach, particularly when the standard therapy is less than effective or plateaus. In contrast, today's pharmacological practice prescribes the same dose of medication to an adult male and female.^(17,23) It should be evident to anyone that this is inappropriate, yet most prescriptions are dispensed in this fashion. By comparing the rationale and elegance of the laser approach, one can easily comprehend the logic for individualization of therapeutic protocol.^(13,18)

Laser Side effects

Low Intensity Laser Therapy does produce

radiation, in the form of photon energy, both in the visible and near-infra-red regions of the electromagnetic spectrum.^(5,17) Worldwide research, conducted over the past thirty years indicates that normally functioning cells are not adversely affected by this type of irradiation.^(9,19)

Conditions Treated With Laser Therapy

Different research programs have explored the potential of laser in the treatment of challenging medical conditions where conventional therapies are inadequate. These include:

- I) General conditions include repetitive stress injury; Carpal tunnel syndrome; Rotator cuff tear; Epicondylitis; Fibromyalgia; Reflex sympathetic dystrophy; Dupuytren's contracture; Temporomandibular joint dysfunction⁽¹⁸⁻²³⁾
- II) Injuries including: Ligament and tendon tears; Fractures with associated soft tissue injuries; Facet joint syndrome; Bulging and herniated discs and contusions⁽¹⁹⁻²²⁾
- III) Inflammatory conditions including: tendonitis, myositis, synovitis, bursitis, plantar fasciitis, rheumatoid arthritis
- IV) Degenerative diseases such as osteoarthritis, chondromalacia patella, discogenic and vertebrogenic radiculopathy, spinal stenosis and calcifications (e.g. bone spurs)
- V) Other Applications fields include: Wound healing; Dermal ulcers (venous stasis, atherosclerotic, contact, diabetic or traumatic ulcers); Burns (thermal or chemical). Lymphedema (acute & chronic). Dermatology (herpes zoster (shingles), eczemas and psoriasis). Gout / arthritis and neuropathies (diabetic, etc)⁽¹⁷⁻²³⁾

CONCLUSION AND DISCUSSION

In this article we have demonstrated the definition of Low Energy Laser, its physiologic effect on cellular level and its wide clinical application in treating a broad range of musculoskeletal pathologies.

In conclusion, more studies are expected to provide information regarding its therapeutic effectiveness and therapy protocols. Future research can enhance the understanding of Laser technology and its wider application.

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LASER THERAPY [Low Intensity Laser Therapy " LILT : Low Level Laser Therapy " LLLT]. The term LASER is an acronym for the Light Amplification by Stimulated Emission of Radiation. In simple yet realistic terms, the laser can be considered to be a form of light amplifier - it provides enhancement of particular properties of light energy. Laser light will behave according to the basic laws of light, in that it travels in straight lines at a constant velocity in space. It can be transmitted, reflected, refracted and absorbed. The recent research, both laboratory based & clinical trials, is found to concentrate on a few key areas. Most dominant amongst these are wound healing, inflammatory arthropathies, soft tissue injury and the relief of pain. Keywords. Low intensity Laser, applications, side effects. References. Turner, J. and L. Hode. Laser therapy clinical background and scientific practice, 13.3, Prima Books AB, Grangesberg, 2002. Proc. Young S, Bolton P, Dyson M, Harvey W, Diamantopoulos C. Macrophage responsiveness to light therapy. Lasers Surg Med, 1989;9(5):497-505. A randomised, placebo controlled trial of low level laser therapy for activated Achilles tendinitis with microdialysis measurement of peritendinous prostaglandin E2 concentrations. Br J Sports Med, 2006;40(1):76-80. Low-level laser therapy has been used to stimulate the orthodontic tooth movements (OTM). Low level laser therapy has biostimulatory effects. In the last decade, researchers have attempted to determine the affect of Low level laser therapy on the pathways and cells directly associated with orthodontic tooth movement. The results of studies on the rate of tooth movement are controversial. While the majority of published research outcomes indicate an increase in the rate of tooth movement after laser therapy compared to controls, but others reported no difference or even indicated the inhibitory