Review Article

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LOW LEVEL LASER THERAPY : AN UNTAPPED RESOURCE IN DENTISTRY

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ABSTRACT:

Imagine a tool that could reduce pain, improve wound healing, relieve muscle tension and regenerate nerves without the use of pharmaceuticals and the associated side effects. Although it may sound like magic, it's actually a therapeutic technology that has been used clinically for decades: low level laser therapy (LLLT). One of the first people to demonstrate the use of light as a therapeutic tool was Dr. Andre Mester in 1966. During an experiment investigating whether a low level laser could cause cancer, he shaved the bellies of two groups of rats and irradiated the skin. These were some of the first indications of the benefits of photobiomodulation.

Low level laser therapy (LLLT), also referred to as phototherapy or photobiomodulation, uses light energy from lasers or light emitting diodes to elicit cellular and biological responses in the body. Low Level Lasers are another subset of laser therapy that is a virtually untapped commodity in dentistry, yet which would be a huge asset to a dental practice and its patients. This review presents benefits of LLLT in the dental industry and a paradigm shift; instead of using drugs to treat the pain after it has started, a dentist now has the opportunity to treat the pain immediately in the dental office.

Key words: low level laser, photobiomodulation, phototherapy.

INTRODUCTION:

While the lasers already mentioned can be labelled *"High level lasers",* there is a less known type of lasers called *"Low level lasers"*. These lasers are generally smaller, less expensive and operate in the milli watt range, 1-500 milli watts. The therapy performed with such lasers is often called "Low Level Laser Therapy" (LLLT) and the lasers are called "therapeutic lasers". Several other names have been given to these lasers, such as "soft laser" and "low intensity level laser" whereas the therapy has been referred to as "biostimulation" and "biomodulation". The latter term is more appropriate, since the therapy can not only stimulate, but also suppress biological processes. Other terms often used for these lasers are 'cold lasers' & 'quantum healing lasers' [1].

The triage of dental treatment can be summarized as the control / eradication of disease, control/relief of pain and restoration of form/function. The

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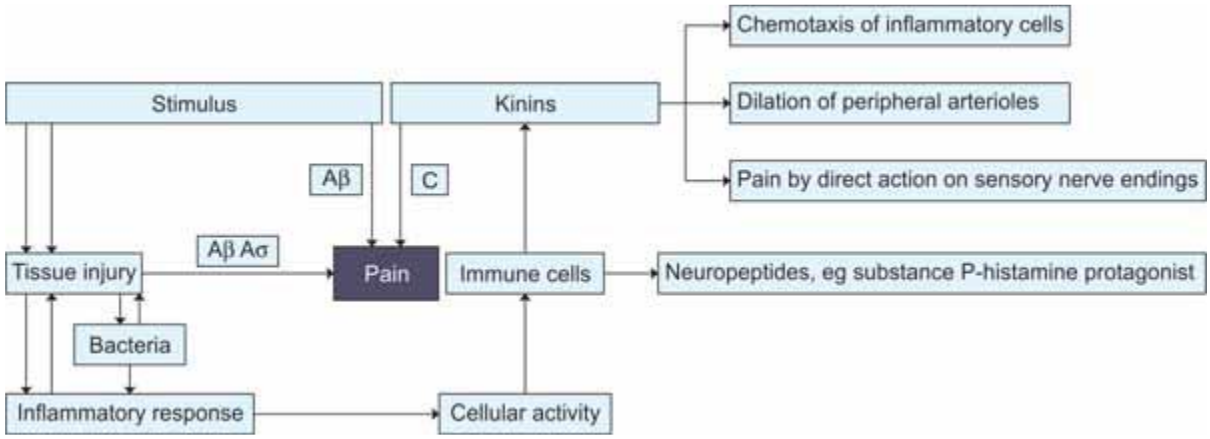
interrelationship of any stimulus with injury, cellular response and pain can be the product of nature & the potency of stimulus & the ability of the tissue to respond [2].



Interrelationship between response, stimulus and pain

Low level laser therapy involves the use of visible red and near-infrared light with tissue in order to stimulate and improve healing as well as reduce pain [2].

Lasers used in LLLT [3]

1. **Helium-Neon (He-Ne)** with a wavelength in the visible light spectrum (λ=632.8 nm) & a low power output of 1 to 5 mW.
2. **Gallium – Arsenide (Ga: As)** with a wavelength of 904 nm & a power output of 1-4 mW.
3. **GaAlAs (Gallium-Aluminium-Arsenide) laser** which emit in the near-infrared spectrum (780nm, 830nm & 900nm) with a power output of 10-30 mW.
4. **InGaAlP (Indium-Gallium-Aluminium-Phosphide) laser** which emit wavelengths in the red spectrum of visible light (630 to 700nm) with a power output of 25 to 50 mW.

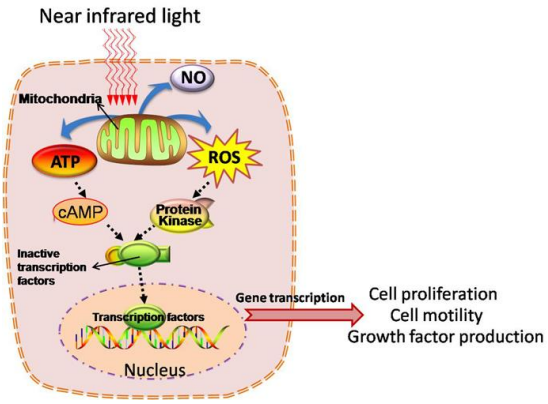
   Combination probes of two laser wavelengths or more laser diodes with LED's of various wavelengths may be made as *'cluster probes'* [4]

Mechanism of LLLT

The principle of using LLLT is to supply direct biostimulative light energy to the body's cells. Cellular photoreceptors (e.g.: cytochromophores) can absorb low-level laser light and pass it on to mitochondria which promptly produces the cell fuel: **ATP (Adenosine Tri Phosphate)** [4].

The most recognized theory to explain the effects and mechanisms of LLLT is the

photochemical theory. According to this theory, light is absorbed by certain molecules, followed by a cascade of biologic events suggested photoreceptors are endogenous porphyrins and molecules in the respiratory chain, such as cytochrome C-oxidase, leading to increased ATP production [4].



Mechanism of LLLT which takes place inside

How does it work?

The effect of low energy, Red and Infra-Red light are photochemical (not thermal). It triggers normal cellular function.

PHOTONS

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ABSORBED IN CYTOCHROMES & PORPHYRINS
WITHIN THE MITOCHONDRIA
AND AT THE CELL MEMBRANE
(Visible red light absorbed within mitochondria)
(Infra-red light at the cell membrane)

↓

SINGLET OXYGEN PRODUCTION
(Rate limiting mechanics operate to prevent excess singlet oxygen formation)

↓

FORMATION OF PROTON GRADIENTS ACROSS CELL MEMBRANE AND ACROSS MEMBRANE OF MITOCHONDRIA

↓

CHANGES IN CELL MEMBRANE | INCREASED ATP LEVELS | DNA PRODUCTION

↓

PHYSIOLOGICAL CHANGE

Low Level Laser Therapy Units

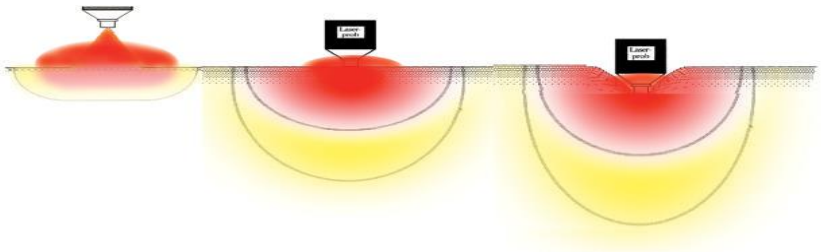
Low level laser units are much smaller, often self contained hand held devices which are either battery driven or charge via a pod in a bench top master unit [5].

Power outputs are typically in the order of 10-50 mW, when measured at the level of the diode laser itself. It is important to note that the final useable output (from the hand piece) will be less because of losses in the internal optical path or in the delivery system [5].

Low Level laser device with different tips

The beam profile from a typical diode laser is rectangular, with a high divergence on the long axis (20 degrees from the centre axis), and a low divergence on the short axis (2 degrees). This gives a highly divergent oval or 'sweep' profile. Diode lasers may have integrated optics which produce collimated and focused light beams. To obtain a more useful beam, a series of lenses or a self-focusing graded index fiber can be used in front of the device to either deliver the treatment beam itself or to direct the laser output into a small diameter flexible optical fibre or a solid light guide (similar to the light tip on a curing light) [5].

Contact mode is needed for all applications, when contacting dental structures (enamel, dentin) some fluid might be needed to ensure full contact b/w the probe and surface to minimize loss of energy [4].



Non contact (Deep) | Contact (Deeper) | Contact with pressure (Deepest)

Whatever the delivery system used, it is important that the components which come into direct contact with patients are able to be protected adequately with a laser-transmissive disposable barrier, can be autoclaved, or are disposable. Similarly, it should be possible for the clinician to activate the laser into treatment mode without breaching asepsis. Some units employ footswitches or light-operated switches to allow hands-free operation [4].

Glasses are available which provide protection against common LLLT wavelengths in both the visible and near infrared spectrum [4].

Dosimetry:

The dosimetry of low level laser light is crucial to the infra-surgical effects of wavelengths used. This is based on Arndt-Schultz law [6]. This is summarized as "small doses stimulate living systems, medium doses impede and large doses destroy". The **energy** used is indicated in *Joule (J)*, which is the number of milliwatts x the number of seconds of irradiation. Thus, 50 mW x 60 seconds produces energy of 3000 millijoules, equals 3 J. Suitable therapeutic energies range from 1-10 J per point. The **dose** is expressed in J/cm2. To calculate the dose, the irradiated area must be known. 1 J over an area of 1 cm2 = 1 J/cm2. 1 J over an area of 0.1 cm2 = 10 J/cm2. There is generally no heat sensation or tissue heating involved in this therapy [8]. The incident fluence increasing through a range of infra-ablative values gave rise to cellular effects as follows:

a. < 60 mJ/cm^2 : zero bioactivation
b. 120-240 mJ/cm^2 : biostimulation
c. 240-300 mJ/cm^2 : zero bioactivation
d. 300-600 mJ/cm^2 : bioinhibition

In clinical practise, low level laser therapy, effective through stimulatory rather than ablative mechanisms delivers fluences of 2-10 mJ/cm^2 depending on the target tissues as follows [6]:

- Oral epithelium and gingival tissue: 2-3 J/cm^2
- Transosseous irradiation (periapical tissue): 2-4 mJ/cm^2
- Extraoral muscle groups/TMJ: 6-10 J/cm^2

CLINICAL APPLICATIONS IN DENTISTRY:

- Dentin hypersensitivity [8]
- Post extraction socket/post trauma sites [9]
- Post herpetic neuralgia [7]
- Wound healing in dentoalveolar abscess, gingivitis and periapical granuloma [7]
- Temporomandibular joint disorders [7]
- Post oncology- mucositis , dermatitis, post surgery healing [7]

How Does Low Level Laser Therapy (LLLT) Benefit patients?

* Relieves acute and chronic pain
* Increases the speed, quality and tensile strength of tissue repair
*Increases blood supply
* Stimulates the immune system
*Stimulates nerve function
*Develops collagen and muscle tissue

*Helps generate new and healthy cells and tissue
*Promotes faster wound healing and clot formation
* Reduces inflammation

Is low level laser therapy more effective than high energy irradiation?

Studies have shown that LLLT produces a biological effect in increasing the potential of action of pulp tissue & low-energy wavelengths produced are safer to the pulp because they stimulate circulation and cellular activity. Since low-level irradiation is mostly related to bio-stimulation and analgesia, such effects are temporary. The role of 'soft laser' as a therapeutic tool is thus a contentious issue.

HLLT, on the other hand, is also a better option for management of hypersensitive teeth, if appropriate parameters are maintained to prevent irreversible damage to the pulp. Since, an increased number of tubules per unit area are observed in sensitive dentin & tubule diameters are twice as wide when compared with non-sensitive teeth, lasers act by blocking dentinal tubules are more likely to provide long-term pain relief. HLLT produces rapid & lasting pain relief [10] .

Additionally, the placebo effect must be taken into account where immediate relief is obtained with laser therapy. This effect consists of a complex mixture of physiological and psychological interactions, depending considerably on the doctor-patient relationship. This is thought to vary from 20-60% in dentin hypersensitivity clinical trials [10] .

The most important issue concerning the effectiveness of treatment is the elimination of causes related to cervical pain and control of primary causes of dental erosion and dentin exposure. Modification of dietary habits is essential since dietary acids contribute to Dentinal hypersensitivity & influence its treatment. Therefore, patients should be counseled about the quantity & frequency of acid intake and cautioned against brushing too soon after acid ingestion. Elimination of gastric regurgitation problems and establishment of proper oral hygiene techniques are important as well to promote therapy. [10]

With the development of thinner, more flexible and durable laser fibres, laser application in dentistry will increase. Ideally, the laser of the future will have the ability to produce a multitude of wavelengths and pulse widths, each specific to a particular application.

NEWER LOW LEVEL LASER DEVICES AVAILABLE:

1. **TERRA-DENT**

   TerraDent laser works by increasing circulation in the micro cells affected by dental procedures. This results in cell growth and reduced inflammation. Treatments with TerraDent may also help to prevent complications, which often arise during the post-procedure period due to infection [11] .

Mechanism behind Terra-Dent

Terra Dent laser involves the use of Multi Radiance Technology (MRT). **MRT** was engineered to allow one laser emitter device to produce the power and range of spectrum from superficial to the deepest bone and hard tissue. It combines superficial 660 nm red Light with medium penetration 875 nm infrared, and deep penetrating 905 nm super pulsed Infrared laser, plus magnetic induction for enhancing microcirculation. Multi Radiance Technology (MRT) uses multiple therapeutic radiances (four healing energies) working together for the absolute best biologic cellular response from skin to bones and everything in between. MRT has a unique combination of four radiances, which is perfect for optimal pain relief and quickened healing.

Working together, these multiple radiances induce biology conducive to healing and pain relief. When used at preset frequencies, you can control the depth of the therapeutic energy from the surface up to 13 cm (5 inches) deep [11] .

Terra-Dent laser with dental probes or accessories

Benefits-

- Reduces Pain by increase of serotonin level
- Increases circulation in tiny cells
- Stimulates fibroblasts and osteoblasts
- Effective for nerve injuries and TMJ
- Reduces Swelling and hyper sensitivity

- Increases Healing of soft tissue and bone
- Increases release of B-endorphins

2. DR. M LASER TOOTH BRUSH

It is the world's first semiconductor tooth brush that utilizes low level laser therapy. This tooth brush treats dentin hypersensitivity & alleviates tooth ache. The laser beam is emitted only when main body is hold and tooth brush sensor is contacted after mode switch is pressed [12].

All the functions in Dr. M tooth brush is controlled by a built-in micro computer (micom). Its laser technology also prevents dental caries thus allowing maintenance oral hygiene and healthy oral cavity [12].

Laser tooth brush kit

CONCLUSION:

Low level laser therapy has been found to accelerate wound healing and reduce pain, possibly by stimulating oxidative phosphorylation in mitochondria and modulating inflammatory responses. By influencing the biological function of a variety of cell types, it is able to exert a range of several beneficial effects upon inflammation and healing.

Future trials of new LLLT applications in dentistry should make use of standardized, validated outcomes, and should explore how the effectiveness of the LLLT protocol used may be influenced by wavelength, treatment duration, dosage, and the site of application.

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