

LASERS IN PERIODONTAL THERAPY- WHAT GENERAL PRACTITIONERS HAVE TO KNOW?

Selvakumar.J, Rathika.J, Ranjini.R, Rambha.K

Department of Periodontology ,
Madha Dental College and Hospital, Kundrathur, Chennai, Tamilnadu, India

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Address of Correspondence:

Dr. J. Selvakumar, MDS.,
Professor & HOD,
Department of Periodontics ,
Madha Dental College & Hospital,
Kundrathur, Chennai – 69.
E-mail: dr.selvakumar@hotmail.com

ABSTRACT:

Lasers have emerged successful in the field of dentistry in the past decade; in future lasers will become indispensable in dentistry and every dentist must possess the knowledge about efficient and careful handling of lasers. Laser has proven its effect as an effective additional armamentarium along with conventional therapy and also for its antibacterial effect. But lasers as an exclusive treatment modality is yet to be proven and various studies are being done in this direction. The general dental practitioners before incorporating laser in their practice should understand the different types of lasers and its applications especially in the field of periodontics, laser physics, and laser settings as well as patient preparation for laser surgery and also to know about the disadvantages of lasers. This article will bring into limelight all these details.

KEYWORDS LASER, Diode Lasers, CO₂ Lasers, Periodontology,

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INTRODUCTION:

LASER is defined as Light Amplification by Stimulated Emission of Radiation. It denotes a device that emits light in spatially coherent and collimated pattern. A laser beam can endure in narrow fashion over a long distance and it can also be tightly focused. Dental laser is one of the most significant developments in modern dentistry. Lasers were introduced into the field of dentistry in 1960 with the hope of overcoming some of the drawbacks posed by the conventional method of dental procedures; to overcome various disadvantages of conventional method using low and high speed hand piece which includes noise and uncomfortable vibration, stress and pain for the patient. Now it's the era of painless, drugless, predictable evidence based dentistry and patients also prefer it. Laser is widely use in dentistry; however this article is concerned about its uses in Periodontics and also about the laser safety, laser physics, types of lasers, for the better knowledge in general practitioners.

HISTORY:

Albert Einstein in 1917 stipulated the idea over stimulated emission of radiation. Based on his theory, Maiman developed the first laser prototype in 1960 using a crystal of ruby as a medium that emitted a coherent radiation light, when stimulated by energy¹. In 1961, the first gas and continuously operating laser was described by Javan et al². The first application of laser to dental tissue was by Sognnaes in 1972. However, the current correlation of dentistry with laser takes its origins from an article published in 1985 by Myers and Myers relating to the in-

vivo excavation of dental caries using a modified ophthalmic Nd:YAG laser. Around 1989, Nd:YAG laser was found potent enough for oral soft tissue surgeries that undoubtedly headed to the current relationship between Laser and Periodontics. The first Er:YAG Laser system was introduced in 1997.

With the recent advances and development researchers suggest that lasers could be applied for the dental treatments including periodontal, restorative and surgical treatment.

LASER:

The word **LASER** is an acronym for
Light
Amplification by
Stimulated
Emission of
Radiation

TERMINOLOGIES:

LIGHT– Light is a form of electromagnetic energy that behaves as a particle and a wave. The basic unit of this energy is called photon. The wave of photons is defined by amplitude and wavelength.
AMPLIFICATION– Amplification is part of a process that occurs inside the laser.

STIMULATED EMISSION:

An atom absorbs a quantum of energy and goes to excited state. When it decays from excited state, the excess energy is released as a photon and goes into a lower energy state.

COMPARISON BETWEEN MANUAL SURGERY AND LASERS:

| | Laser surgery | Manual surgery |
|----------------------|----------------------|-----------------------|
| Operation time | Same | Same |
| Incision time | Longer | Shorter |
| Bleeding | Less | More |
| Suturing | Same | Same |
| Swelling | Less | More |
| Wound healing | Faster | Slower |
| Periodontal dressing | Recommended | Necessary |
| Pain | very little | Painful |

RADIATION:

Radiation refers to the light waves produced by the laser as a specific form of electromagnetic energy. All available dental laser devices have emission wavelengths of approximately $0.5\mu\text{m}$ (or 500nm) to $10.6\mu\text{m}$ (10.600nm).

LASER PHYSICS:

LASER COMPONENTS

1. Optical cavity / resonator
2. Parallel mirrors placed on either side of the laser medium
3. Pump energy source
4. Cooling system

LASER ENERGY IS MEASURED BY:

Joules: a measure of energy

Watt: unit of power

One watt = one joule per second

Power density : watts/cm²

Smaller the focal spot higher the power density

LASER DELIVERY SYSTEMS:

- The coherent, collimated beam of laser light should be delivered to the target tissue in a manner that is ergonomic and precise

1. ARTICULATED ARMS – Hollow tubes, 450 mirrors
2. HOLLOW WAVEGUIDE – Semi rigid tube, reflective pathway
3. OPTIC FIBRE / ADDITIONAL RIGID TIP – Quartz silica flexible fibre, Quartz, Sapphire tips
4. HAND HELD UNIT – Low level lasers

- There are two mode of laser contact – contact mode and non contact mode.

EMISSION MODES:

Laser radiant energy can be generated from a laser device in a

1. Continuous wave (CW) [Continuous form]
2. Pulsed modes [Discrete or single pulses or multiple timed pulses]
 - Super pulse
 - Chopped (gated) continuous wave

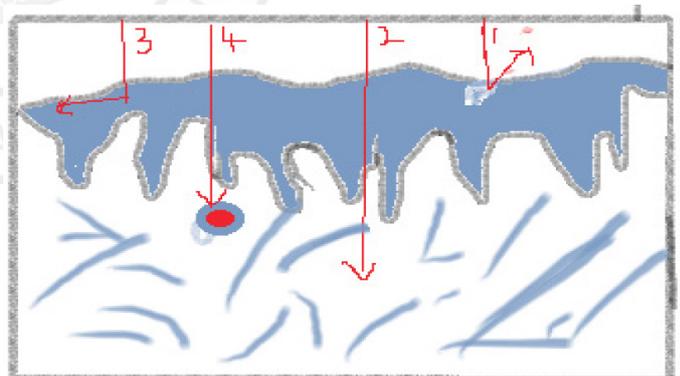
In the continuous wave form, the beam is emitted at only one power level for as long as the operator depresses the foot switch. In pulsed mode form, there is an alternate period of beam emission and resting period.

LASER-TISSUE INTERACTION:

Laser light can have four different interactions such as reflection, transmission, scattering and absorption with the target tissue, depending on the optical properties of that tissue. Dental structures have complex composition and these four phenomena occur together in some degree relative to each other.

Given the diversity of available wavelengths, the prudent clinician should first determine the specific clinical treatment goals and then select the technology (laser or otherwise) best suited to achieve the desired endpoint(s).

Reflection occurs when the laser beam is simply redirected from the tissue surface, whereas transmission refers to the passage of laser through the tissue. Scattering is the dispersion of laser beam and absorption occurs when laser light is absorbed by pigments, free water molecules, proteins and other macromolecules.



1. Reflection
2. Transmission
3. Scattering
4. Absorption

ABSORPTION RATES:

Different lasers are absorbed at varying rates into specific tissue types. Main targets of the Er:YAG hard tissue laser is water and hydroxyapatite. Main target of diode laser (810nm , 940nm , or 980nm) is melanin and hemoglobin and to a lesser extent water.

TYPES OF LASERS^{3,4,5,6,7}

| LASER TYPE | | WAVELENGTH | COLOR |
|--------------------|--|-------------------|--------------------|
| Excimer lasers | Argon Fluoride (ArF) | 193 nm | Ultraviolet |
| | Xenon Chloride (XeCl) | 308 nm | Ultraviolet |
| Gas lasers | Argon | 488 nm, 514 nm | Blue, Blue - green |
| | Helium Neon (HeNe) | 637 nm | Red |
| | Carbon Dioxide (CO ₂) | 10,600 nm | Infrared |
| Diode lasers | Indium Gallium Arsenide Phosphorus (InGaAsP) | 655 nm | Red |
| | Gallium Aluminum Arsenide (GaAlAs) | 670 – 830 nm | Red – Infrared |
| | Gallium Arsenide (GaAs) | 840 nm | Infrared |
| | Indium Gallium Arsenide (InGaAs) | 980 nm | Infrared |
| Solid state lasers | Frequency-doubled Alexandrite | 337 nm | Ultraviolet |
| | Potassium Titanyl Phosphate (KTP) | 532 nm | Green |
| | Neodymium:YAG (Nd:YAG) | 1064 nm | Infrared |
| | Holmium:YAG (Ho:YAG) | 2100 nm | Infrared |
| | Erbium, Chromium:YSGG (Er,Cr:YSGG) | 2780 nm | Infrared |
| | Erbium:YSGG (Er:YSGG) | 2790 nm | Infrared |
| | Erbium:YAG (Er:YAG) | 2940 nm | Infrared |

Absorption is dependent on pigmentation, water content of the tissue and laser wavelength. Erbium and CO₂ are absorbed from few to several microns depth. But diode and Nd:YAG lasers can reach deeper depths and even cause thermal necrosis.

APPLICATIONS OF LASER IN DENTISTRY:

LASERS USED IN VARIOUS DENTAL SPECIALITIES^{8,9,10}

ORAL SURGERY

In Oral surgery, lasers have been vastly used since 2000 for its bloodless field and low post-operative pain. It is used for removal of impacted tooth, incision of soft tissue, pregnancy epulis, mucocele, removal of hard tissue and for all minor surgical procedures.

ORTHODONTICS

In Orthodontics laser is used for efficacy of the treatment in bracket curing, and post-orthodontic removal of residual cement and for exposure of impacted tooth.

PEDODONTICS:

In Pedodontics it is used in contrary to rotary instruments in the removal of caries in deciduous teeth, pulpotomy and pulpectomy procedures and for surgical removal of tongue tie.

CONSERVATIVE AND ENDODONTICS

In Endodontics, lasers are used for simple and effective treatment of bleaching, caries removal, canal irrigation, curing of restorative material, removal of fractured restorations, etching of the tooth, root resection and for smile designing.

PROSTHODONTICS

In Prosthodontics, lasers are used for sulcus deepening, vestibuloplasty, crown contouring, crown lengthening and for smile designing.

APPLICATION IN PERIODONTICS^{11,12,13,14,15,16,17}

Laser has been used in Periodontics for

various procedures such as flap surgery, frenectomy, frenotomy, gingival contouring / gingivectomy, disinfection of periodontal pocket, depigmentation, for bacterial reduction, curettage, pocket reduction, operculectomy, soft tissue crown lengthening, open flap debridement, periimplantitis, gingivoplasty, for removal of granulation tissue, for management of periodontal abscess, deepithelialization of inner and outer flap, cleaning of tooth and bone surfaces.

WHY USE A CO₂ LASER?^{18,19,20,21,22}

CO₂ has a wavelength of 10600nm, it has strong hemostatic and bactericidal effect. It has been approved by FDA for soft tissue surgeries. It emits coherent beam that is near a major spectroscopic absorption peak of water. Target is chromophore and Water, since all tissues contain water, interaction becomes greater. It has unique application in evaporative ablation and functions as precise thermal knife.

ADVANTAGES^{23,24,25,26,27,28}

The various advantages are rapid incision and ablation, there is minimal damage to the normal tissues adjacent to the area of operation, good intra-operative hemostasis. 'No touch' technique permits surgery in locations difficult to reach, improved patient benefits, minimal post-operative swelling, very low infection rate, minimal scar formation, elimination of need for skin grafting in floor of mouth. Healed tissue is supple and maintains normal healing capacity. Healing is rapid in comparison to other thermal instruments.

DISADVANTAGES

Some of the disadvantages are loss of tactile sensations, additional safety requirements, high cost, special attention required to avoid contact with the endotracheal tube.

Nd:YAG LASER^{29,30,31,32}

It is used in contact and non contact modes for cutting and ablating tissues. Advantage is the fiber optic tip which can be used in narrow area of periodontal pocket, cleaning of tip intermittently is very important, has got affinity for pigmentation. Gingival troughing is excellent and painless with this

laser. Thus no need for retraction cords while making impressions. Pulse duration is 150ms which is lesser than the level of nerve action potential, thus the anesthetic effect.

ADVANTAGES^{33,34,35,36,37}

Gingivectomies are carried out with ease. It provides excellent haemostasis and minimal tissue rebound. The amount of anaesthesia required is minimal and there is less post-operative discomfort. It can be used in treating operculectomies, hyperplastic tissue under denture, in crown lengthening in which osseous reduction is not required, excision of aberrant frenal attachments and removal of post-operative granulation tissue during flap surgeries.

Er,Cr:YSGG & Er:YAG LASERS

ADVANTAGES

They are extremely effective in caries removal, tooth preparation and caries close to gingiva can be treated and soft tissue recontouring can be done with the same instrument

DISADVANTAGES

These Lasers are contraindicated for amalgam restoration removal and their haemostatic ability is limited.

DIODE LASER^{38,39,40}

Diode lasers have wavelengths of different categories like 810nm, 940nm, 980nm. Active medium is a solid semiconductor. Electromagnetic spectrum is near infrared and invisible. Absorption characteristic is melanin, hemoglobin, water. Diode lasers are effective against melanin and haemoglobin. They can be safely used on tooth, bone and implants. It has optic fiber delivery system and operates on continuous-wave and pulse mode. The pulsed beam is used for laser decontamination, continuous beam is used to remove the diseased epithelial pocket wall.. Contact mode is continuous-wave at low power. It has affinity for anaerobic bacteria with advantage especially for decontaminating failing implants in peri-implantitis.

ADVANTAGES OF LASER IN DENTISTRY^{41,42,43}

Most of the lasers maintain dry surgical field, reduction in the thermal damage to non-target tissue, there is less post-operative pain and tissue edema, selective tissue absorption, there is decrease in wound contraction thus leading to scarring, immediate sterilization of the surgical site, accelerated wound healing and consumes less time.

DISADVANTAGES⁴⁴

Laser treatment tends to be more expensive. Since the cost of the laser is much higher than a dental drill. Lasers cannot be used on teeth with existing restorations as well as removal of defective crowns or silver fillings. Laser beam is very delicate to handle in cutting process. The slight mistake in adjusting distance and temperature may lead to burning or discolouring.

PREPARATION OF PATIENTS PRIOR TO LASER PERIODONTAL THERAPY

- Clean patient's skin and remove make up and cream residue, as they act as physical barriers to the absorption of laser light.
- The surface to be irradiated should be clean and dry and relative insulation is always necessary
- The extension of the lesion is to be measured with a ruler to calculate the dosimetry accurately.
- Laser therapy can be an isolated treatment or used in addition to conventional treatment. The laser should be as perpendicular as possible to the tissue to minimize refraction . Metal instruments should not be used to avoid beam reflection.
- The total maximum energy to be applied in each session should be calculated taking into account the patient's age group, nutrition and hydration status, and type of tissue to be irradiated .
- Respect the safety norms determined by ANSI: wear safety glasses with the colour and optical density determined by the equipment manufacturer. This protection to be used by everybody present in the room during the procedure.

- Question the patient about the use of photo sensitive substances such as medication (tetracycline, griseofulvine, sulfamine and furocumarine) and dermatological creams.
- The patient's individual response should be analysed in every treatment session to evaluate the methodology, which may be altered according to the results. Before changing the therapeutic dose it is advisable to increase the frequency of application and analyse the results again.
- Upon beginning of the treatment, it is advisable to use the lower total therapeutic dose per session, and gradually increase it whenever necessary.
- Literature reports that wavelength that are visible within the electromagnetic spectrum have a better performance on superficial lesion (aphthae, traumatic ulcer, dentine hypersensitivity).
- In many cases, laser therapy allows the professional to reduce or even substitute the chemical treatment.
- An average, response to treatment are generally absorbed after the third therapeutic session.
- Thorough but gentle cleaning is essential to the healing process. In treated areas, use an extra soft tooth brush for 1 to 2 days, and floss gently. Regular brushing and flossing may be done in all other areas.
- Oral irrigation may begin after 24 hours. Use a medium to low power setting, directing the water stream at a 90 degree angle to the tooth – not into the pocket. Subgingival irrigation is contraindicated until further evaluation.

CONCLUSION:

In past, dental treatment was quite troublesome for the patients, as patient were not aware about the necessity for treatment to be done as well as psychological factors such as fear of pain were a hindrance to treatment. Now-a-days, with the introduction of lasers, dental treatment has become easy and less painful. However none of the laser systems guarantees total analgesia but it has taken an important step in the direction to reduce pain. Laser used for soft tissue procedure allows decreased scarring, less bleeding to the site and post-operative wound management.

With the knowledge of necessary parameters for ideal treatment, lasers can be developed so that it can provide the dentist the ability to care for patient with advanced techniques and equipment.

Thus, lasers are no doubt very effective for selective dental procedures especially minor surgical procedures and as an adjunct to conventional treatment but many times they are either hyped or missed.

Before investing in laser, dentist should fully understand the differences between the various types, applications and its financial feasibility.

FINANCIAL SUPPORT AND SPONSORSHIP:

Nil

CONFLICT OF INTEREST:

There is no conflict of interest

INSTRUCTIONS TO THE PATIENTS AFTER LASER PERIODONTAL THERAPY:

- Patients are asked not to eat until numbness wears off.
- Smoking compromises the healing process; hence smokers are advised to refrain from smoking for as long as possible (or preferably, take opportunity to stop smoking).
- Avoid spicy, sharp, crunchy foods for 24 hours.
- Avoid alcohol-containing products for 24 hours.
- Avoid seeds or husks for 3 to 5 days.
- Rinse with salt water three times daily until tissues are comfortable.
- Any NSAID may be taken as directed to manage mild discomfort.
- More severe pain should be evaluated by the dentist.

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