LASERS in DENTISTRY

Lasers have significantly contributed to dental clinical practice with precise and effective way. LASER is an acronym of "Light Amplification by Stimulated Emission of Radiation".It has been discovered that lasers have increased the efficiency, specificity, ease, cost, and comfort of dental treatment.

History :

In 1917, Albert Einstein set the foundation for the invention of the laser by explaining the photoelectric amplification, and it was introduced to the public in 1959.

Einstein identified that a laser is promoted by the emission of radiation as a natural process.

Lasers are capable of increasing light intensity to synthesize beams of an effective wavelength, which are directional and of a high intensity.

Introduction of laser in dentistry, in the 1960s, by Miaman, led to a continuous research in the various applications of lasers in dental practice.

Leon Goldman, *a pioneer in laser medicine,* have reported the biomedical aspects of lasers and have also recorded findings in laser dentistry, mainly on the effects of lasers on dental caries, teeth and other tissues since 1963.

Dental Lasers: 1993- Nd YAG, 1994- CO2 Laser, 1996- Laser welder, 1998- Er-YAG Laser.

Types of LASER:

There are two scenarios, on the one hand there are *hard lasers,* such as, Carbon dioxide (CO2), Neodymium Yttrium Aluminum Garnet (Nd: YAG), and Er:YAG, which offer both hard tissue and soft tissue applications, but have limitations due to high costs and a potential for thermal injury to tooth pulp, whereas, on the other hand in *cold or soft lasers,* based on the semiconductor diode devices, which are compact, low-cost devices used predominantly for applications, are broadly termed as *low-level laser therapy (LLLT) or 'biostimulation'.*

The mixture of some noble gases such as argon, krypton, and xenon with reactive gases produce a special type of gas discharge which is called the excimer laser.

LLLT has established itself well in clinical dentistry, attributed to the therapeutic effects like bio stimulation, regenerative capacity and anti-inflammatory effects seen at the lower heat.

Wavelength:

The characteristic of a laser depends on its wavelength (WL), and wavelength affects both the clinical applications and design of LASER.

The WL used in medicine and dentistry generally range from 193 to 10600 nm, representing a broad spectrum from ultraviolate to the far infra-red range.

The diode laser has a wavelength range of 635 to 950 nm utilizing flexible quartz fibre and it is absorbed by the pigmentation of the soft tissue and has good haemostatic agent, with the power output of 2 to 10 W.

Characteristics of LASER:

Each of the processes of laser interaction with biological tissues depends on the characteristics of the laser system, such as:

Wavelength, pulse duration, pulse energy, repetition rate, beam spot size, delivery method, laser beam characteristics, and optical properties of tissue, such as the refractive index, scattering coefficient (μs), absorption coefficient (μa), and anisotropy factor.

Mechanism of action:

The laser can damage biological tissues through four different mechanisms.

Thermal mechanisms - Most of the damage caused by laser irradiation is due to tissue absorption and consequent heating. Heat may dissipate beyond the boundaries of the irradiated target area. Cells within this area show characteristic burns and tissue is damaged by protein denaturation.

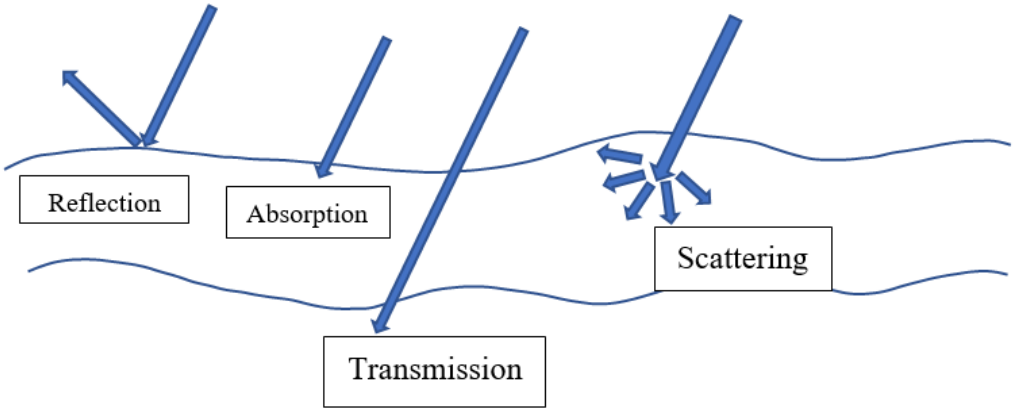
Chemical mechanisms - The absorbed radiation can initiate chemical reactions that often result in oxidation and cell death. Usually the damage threshold is low and chemical reactions continue after irradiation ceases.

Photoacoustic mechanisms - When radiation is absorbed and transformed into heat over a short time interval, there can be rapid expansion of the heated volume, generating an acoustic wave that propagates through the tissue and interacts with other tissues in remote regions.

Photoelectric mechanisms - Lasers operating with high power densities, usually with biological tissue.

Interaction of Lasers on Tissue:

When we aim the laser towards the tissue to execute a specific task, the interaction with biological interference will occur as reflection, transmission, scattering or absorption.



Lasers target the different chromophores in the tissue which selectively absorbs the laser as heat and yields a desirable response with the principle of selective photothermolysis.

LASERS in different field of Dentistry:

Type of LASER	**WAVE LENGTH**	**USED IN**
Carbon Dioxide Lasers	10,600 nm	Superficial lesions, resurfacing of the skin and removal of sialoliths, Apthous ulcers, Herpetic lesions, Coagulation of bleeding areas, Removal of granulation tissues, Excision of epulis, Inflammatory hyperplasias, Mucoceles and ranulas and Pigmented lesions, Premalignant lesions

		like leukoplakia, sublingual keratosis,
Nd:YAG Lasers	1,064 nm	Pigmented lesions, Sialoliths and verrucous carcinoma.
Ho:YAG	2,100 nm	Excisional biopsy
Er:YAG	2944 nm	Hard tissues and skin resurfacing
Argon Lasers	488,514 nm	treatment of pigmented lesions and vascular anomalies
Diode Lasers	620 to 900 nm	oral soft tissue lesions.

Recently, lasers have also been used for sinus grafting procedures, as reported in a study performed with an Er,Cr:YSGG laser. The advantages of using the erbium laser include straight clean cuts and precise hard tissue cuts by virtue of the laser's energy interaction with water at the tissue interface.

Argon Lasers with a wavelength of 488,514 nm are readily absorbed by hemoglobin and melanin and are useful in the treatment of pigmented lesions and vascular anomalies. It seems to be the perfect instrument for dental bleaching when used with 35% H2O2 and a dye whose absorption coefficient is appropriate for the light–H2O2 interaction, as heat production is minimal.

He-Ne laser can be used for Radiation Mucositis.

Low level laser can be used for Herpes lesions, apthous ulcers and denture sores.

Helium Cadmium Lasers can be used for Fluorescence examination.

Photodynamic therapy (PDT) is a component of two aspects of the minimal intervention protocol for dental caries treatment (i.e. prevention and cure) because the interaction of a

specific wavelengths of light with a non-toxic compound (the photosensitizer [PS]) and oxygen can result in the production of reactive species, which are capable of inducing the death of bacterial cells in dental biofilms.

Based on the use of the diode laser and the principles, the first commercially available device based on laser fluorescence was developed, DIAGNOdent (LF; KaVo, Biberach, Germany). More recently, a new version of this device has become available – the DIAGNOdent pen (LFpen; KaVo). This new version uses similar principles to the original in differentiating fluorescence between sound and caries tissues.

The dosage parameters for dental lasers are pre-set for most situations and only the advanced operator will feel a need to adjust these settings.

If the laser power (P), the area to be irradiated (A), and the optimum dose (D) for a determined condition are known, the exposure time (t), that is the time the light is turned on during treatment, can be determined: t (s) = D (J/cm^2) x A (cm^2) / P (W)

Commonly, laser equipment displays power and dose on its screen. Once these parameters have been established, exposure time is automatically calculated by the equipment.

Precausions While Performing the procedure :

Doors should be closed during the procedure

To wear safety goggle : by patient, operator , assistant

Not to look direct into laser beam

Laser hand piece should be pointed only towards the area treated.

Not to bend fibre optic cable.

Laser machine should not be moved during the procedure.

Advantages and disadvantages of LASER :

Advantages of using lasers include less pain, less need for anesthetics, no risk of bacteremia, excellent wound healing; no scar tissue formation, bleeding control (dependent on the wavelength and power settings), usually no need for sutures, use of fewer instruments and materials and no need for autoclaving and ability to remove both hard and soft tissues. Lasers can be used in combination with scalpels (however, the laser is a tool and not a panacea).

Disadvantages of using lasers include relatively high cost of the devices, need for additional education (especially in basic physics), every wavelength has different properties and the need for implementation of safety measures (i.e. goggle use, etc.).

In conclusion, Laser system has far been the latest addition among technologies that clearly have made an exceptional impact because of its minimal side effects, high precision level, and biocompatibility. The application of laser treatment in maxillofacial medicine has potential implications for quicker treatment and faster healing. Although lasers have many advantages, it is important to determine the effective laser type and wavelength to meet all requirements in both soft and hard tissues.

Lasers have significantly contributed to dental clinical practice in the 21st century and they will play a very important role in the dental practice in the coming future.

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