# Lasers introducing into the field of dentistry

Health & Medicine, Healthcare

## INTRODUCTION:

Light is an integral part of our life. The early 20th century saw one of the greatest inventions in science & technology, in that LASERS which later went on to became a gift to health sciences.

In this era of fast developing technologies and innovative ideas, the need for faster treatment has become a necessity. Treatment with lasers that is much less time consuming and painless is accepted and appreciated by the patient. Use of Lasers is not new; they have been in use for decades since their development by Maiman in 1960. Lasers have travelled a long way from ruby lasers to erbium lasers and are being fondly used in every aspect of dental treatment.

The term " LASER" originated as an acronym for " Light Amplification by Stimulated Emission of Radiation"[3] termed by GORDO GOULD in 1957.

## HISTORY OF LASERS:

The principle of the laser was the first known in 1917 when physicist Albert Einstein described the theory of stimulated emission. He was the first one to coin the term " Stimulated Emission" in his publication " Zur Quantentheorie der Strahlung" (On the Quantum Theory of Radiation) published in 1917 in the " Physikalische Zeitschrift" via a re-derivation of Max Planck's law of radiation, conceptually based upon probability coefficients (Einstein coefficients) for the absorption, spontaneous emission, and stimulated emission of electromagnetic radiation.[4]

Theodore Maiman became the first scientist who demonstrates the laser function and also developed a working laser device “ known as ruby laser,” made of aluminum oxide, that emitted a deep red-colored beam. After this invention, dental researchers started investigating the various potentials of lasers.

Though the credit for discovering the therapeutic use of lasers goes to Mainman et al (1960), lasers were brought to general dental practice in 1989 by Dr. William and Terry Myers after getting clearance by the US Food and Drug Administration (FDA); They modified an ophthalmic Nd: YAG laser for dental use.

## LASER PHYSICS:

It is important to understand the physics of lasers before using them. Laser light has three main properties that differentiate it from normal light. They are:-

- MONOCHROMATISM: The property of Laser light to have one specific color, which can be finely focused is called as monochromacity; in dental applications that color may be visible or invisible. Laser light possesses three additional characteristics: collimation, coherency, and efficiency.
- COLLIMATION: refers to the beam having specific spatial boundaries, which insures that there is a constant size and shape of the beam emitted from the laser cavity. A dental x-ray machine produces radiation with this property.

- COHERENCY: It is a unique property of lasers which means that the light waves produced in the instrument are all the same. They are all in phase with one another and have identical wave shapes; that is, all the peaks and valleys are equivalent1 (ie have identical frequency and identical wavelength).

## COMPONENTS OF A LASER SYSTEM:

The laser compartment consists of following major components which is important to understand for the production of light.

- ACTIVE MDEDIUM: It is an optical cavity at the center of the device. The core of the cavity is comprised of chemical elements, molecules, or compounds and is called the active medium. The material may be either a naturally occurring or man-made which when stimulated, emits laser light.
- ENERGY SOURCE/PUMPING MECHANISM: Surrounding the optical cavity is an excitation source, either a flash lamp strobe device, an electromagnetic coil, diode unit or an electrical coil, which provides the energy into the active medium. 1 Most energy sources for lasers are electrical[51] or a flashlight or arc-light[3]. A continuous-feed electrical discharge will result in a continuous feed of laser light emission. 3, 2
- OPTICAL RESONATOR: They are usually polished surfaces or two mirrors which are aligned at each end of the optical cavity; there is usually one (distal) high reflective mirror and one (proximal) partially reflective mirror. The function of the optical resonators is to perform amplification and collimation of the developing beam. The parallelism of the mirrors insures that the light is collimated.

- COOLING SYSTEM: Cooling system is used to lower the temperature of the compartments. Heat production is a by-product of laser light propagation. It increases with the power output of the laser and hence, with heavy-duty tissue cutting lasers, the cooling system represents the bulkiest component. Co-axial coolant systems may be air- or water-assisted.[3]
- CONTROL PANEL: Control panel is used to control variable parameters for the output of the laser. This allows variation in power output with time, pumping mechanism frequency, wavelength change (multi-laser instruments) and print-out of delivered laser energy during clinical use.[3]
- DELIVERY SYSTEM: It is a system through which laser reaches its targeted site. The coherent, collimated beam of laser light should be delivered to the target tissue in a manner that is ergonomic and precise.

## CLASSIFICATION OF LASERS:

- Lasers can be classified based on lasing (active) medium:
- Solid ; Eg. Nd: YAG lasers, Er: YAG lasers
- Liquid Eg. Dye lasers
- Gaseous; Eg CO
- According to tissue applicability and penetration
- Hard tissue lasers; Eg Erbium lasers
- Soft tissue lasers; Eg $CO_2$ laser

## COMMON LASER TYPES USED IN DENTISTRY8

- Sr. no Laser type Construction Wavelength(s) Delivery system(s)

- Argon Gas laser 488, 515nm Optical fibre
- KTP Solid state 532nm Optical fibre
- Helium-neon Gas laser 633nm Optical fibre
- Diode Semiconductor 635, 670, 810, 830, 980nm Optical fibre
- Nd: YAG Solid state 1064nm Optical fibre
- Er, Cr: YSGG Solid state 2780nm Optical fibre
- Er: YAG Solid state 2940nm Optical fibre, waveguide, articulated arm
- CO2 Gas laser 9600, 10600nm Waveguide, articulated arm

## LASER ENERGY AND TISSUE TEMPERATURE

Oral tissue is composite in nature, which can compromise the ideal interaction of a given laser wavelength with a target tissue site. Whenever laser energy is applied to oral tissue, it is incumbent on the dentist to understand the biologic rationale for its use. The principle effect of laser energy is photothermal (ie, the conversion of light energy into heat).

## TARGET TISSUE EFFECTS IN RELATION TO TEMPERATURE

- Sr. No. Tissue temperature (°C) Observed effect
- 37–50 Hyperthermia
- 60–70 Coagulation, protein denaturation
- 70–80 Welding
- 100–150 Vaporization, ablation
- 200 Carbonization

## LASER TISSUE INTERACTION

The photothermal effects of laser energy with tissue, can be divided into – primary and secondary effects. Primary interaction effects include-

- absorption,
- transmission,
- scattering, and
- transmission.

Secondary effects include laser wavelength, tissue (composition), tissue thickness, surface wetness, incident angle of beam, incident energy of beam, emission mode, and exposure time. It is essential for the clinician to choose the laser wavelength that will be absorbed maximally by the target tissue and to regulate the power parameters to create maximal surgical effect while not producing any unwanted collateral damage.

## LASER EMISSION MODE1:

The dental laser device can emit the light energy in two modalities as a function of time, constant on or pulsed on and off. The pulsed lasers can be further divided into two distinctive ways in which the energy is delivered to the target tissue. Thus, three different emission modes are described-

- Continuous wave.
- Gated pulse mode.
- Free running pulse mode.

## CURRENT AND POTENTIAL APPLICATION OF LASERS IN DENTISTRY

Describing the use of lasers in a general practice setting is a daunting task. General practitioners should be jacks-of-all-trades. Consequently, a discussion of the use of lasers in a general practice setting must include the following disciplines: surgical and nonsurgical periodontal therapy; fixed, removable, and implant prosthetics; endodontics; cosmetics; oral medicine,

surgery, and pathology; pedodontics and orthodontics; and operative dentistry.

Laser use in dentistry5, 10, 11, 12, 13

**Fixed prosthetics/cosmetics**

- Crown lengthening/soft tissue management around abutments
- Osseous crown lengthening
- Troughing
- Formation of ovate pontic sites
- Altered passive eruption management
- Modification of soft tissue around laminates
- Bleaching

**Implantology**

- Second-stage recovery
- Peri-implantitis
- Decontamination of implant surfaces

**Removable prosthetics. Treatment of –**

- **Epulis fissurata**
- **Denture stomatitis**
- **Residual ridge modification**
- **Tuberosity reduction**
- **Torus reduction**
- **Soft tissue modification**

**Periodontics**

- Frenectomy
- Gingivectomy

- Graft Periodontal regeneration surgery
- De-epithelialization
- Removal of granulomatous tissue
- Osseous recontouring
- Gingivoplasty
- Removal of calculus deposits and root surface detoxification.

**Pediatrics**

- Diagnosis and treatment of high frenal attachments.
- Exposure of teeth for orthodontic care.
- Gingival recontouring and gingivectomies in orthodontic patients; Dilantin hyperplasia and crown lengthening in caries preparations.
- Pulp therapy in primary teeth.
- Removal of amalgam and other direct restorations.
- Sealant placement.
- Caries removal and tooth preparation.
- Treatment of ankyloglossia

**Oralsurgery/oral medicine/oral pathology**

- Biopsy
- Operculectomy
- Apicoectomy
- Oral soft tissue pathologies

**Operative dentistry and endodontics**

- Pulp diagnosis
- Pulp capping and pulpotomy
- Cleaning and shaping of the root canal system

- Endodontic surgery
- Dentinal hypersensitivity

**Orthodontics**

- Frenectomies
- Operculectomy
- Treatment of Gingival hyperplasia

**ADVANTAGES & DISADVANTAGES OF LASER DENTISTRY:**

The lasers can provide the following advantages when properly used by well-trained clinicians (who understand physics in laser usage) –

- Needle-free or ‘‘ no anesthesia’’ or “ Painless” dentistry.
- Reduced anxiety and fear of drills.
- Creating a more bloodless field because of the ability of producing excellent haemostasis, and sealing of blood vessels, which further leads to superior visualization of the surgical site.
- Decreased bacterial contamination of the surgical site.
- Decreasing postoperative swelling.
- Decreased need for sutures.
- Reduced overall treatment time.
- Less mechanical trauma.
- Better patient compliance.
- Less inavasive.

**DISADVANTAGES:**

- Compulsory use of glasses for eye protection (patient, operator, and assistants).
- Inadvertent exposure to irradiation (action in noncontact mode).

- Risk of excessive tissue destruction by direct ablation and thermal side-effects.
- High cost of laser apparatus.

## CONCLUSION:

Lasers were introduced into the field of dentistry as they are a precise and effective way to perform many dental procedures. Treatment with lasers provides a hope of overcoming the disadvantages of conventional dental procedures. As the applications for dental lasers expand, greater numbers of dentists will use the technology to provide patients with precision treatment that may minimize pain and recovery time. Every discipline of dentistry has been positively affected with the use of laser technology including oral medicine, oral surgery, pediatric and operative dentistry, periodontics and implantology, prosthetic dentistry. The ability of the lasers to perform less invasive procedures without any discomfort to the patients had made a tremendous impact on the delivery of dental care. This will continue as this technology will continue to improve and evolve.