

# A Contemporary Apprise on LASERS and its Applications in Dentistry

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## ABSTRACT

Lasers are an important assistant to dental treatment regarding contamination control, wound recuperating control, draining control and vibration control in hard tissue expulsion. Accomplishment in clinical uses of dental lasers depend on a firm premise of laser material science. Distinctive laser wavelengths are caught up in changing degrees by the real oral tissue parts in particular; water, hydroxyapatite, hemoglobin, and melanin. From the most reduced vitality conveyance to the most elevated, lasers can be utilized for conclusion of caries and math, low-level laser treatment, teeth brightening, haemostasis and coagulation, tissue decontamination, melanin depigmentation, hard and delicate tissue removal. A mix of the above methodology will make up the greater part of the dental strategies in day by day dental practice. The laser tissue associations and systems will enable the administrator to convey the coveted treatment viably. Amid laser treatment, the clinician should remember the laser wavelength and emanation mode being utilized for the tissue communication wanted. It is basic that tissue collaboration is checked and proper modifications are made amid the method.

**KEYWORDS:** Laser, dentistry, various specialities

## INTRODUCTION

In 1960, Theodore Maiman<sup>1</sup>, a researcher with the Hughes Aircraft Corporation, built up the principal working laser gadget, which discharged a dark red-hued pillar from a ruby precious stone. Amid the following couple of years, dental scientists examined conceivable utilizations of this unmistakable laser vitality. Dr Leon Goldman<sup>2</sup>, a dermatologist who had been exploring different avenues regarding tattoo expulsion utilizing the ruby laser, centered two beats of that red light on a tooth of his dental practitioner sibling in 1965. The outcome was easy surface crazing of the finish.

Concentrates in the 1980s swung to different gadgets, for example, CO<sub>2</sub> and Neodymium YAG (Nd:YAG), which were thought to have better cooperation with dental hard tissues. The therapeutic group in the mid to late 1970s had started to consolidate lasers for delicate tissue systems, and oral specialists included the innovation in the mid 1980s. Edge<sup>3</sup>, Pecaro<sup>4</sup>, and Pick<sup>5</sup> referred to the advantages of CO<sub>2</sub> laser treatment of oral delicate tissue sores and periodontal systems. A versatile tabletop show was made accessible in 1987, and after 2 years Myers and Myers<sup>6</sup> got the US Food and Drug Administration's authorization to offer a committed dental laser, a Nd:YAG gadget. Since that time, various instruments have been influenced accessible for use in dental to practice, and more are being created. The clinician must be comfortable with the essentials of laser material

science and tissue cooperation so the best possible laser gadget is utilized to acquire the treatment objective securely and adequately. This article highlights points of laser science, machine qualities, and tissue communication that gives the establishment to the numerous utilizations of the utilization of lasers in dentistry.<sup>7</sup>

## BASIC LASER SCIENCE

The word LASER is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. A study of each of these words offers an understanding of the basic principles of how a laser operates.<sup>7-11</sup>

### Properties of LASER<sup>7-11</sup>

Velocity: The speed of light in a vacuum =  $2.99 \times 10^{10}$  cm/sec. Amplitude: The total height of the wave from peak to peak. Wave length: The distance between any two corresponding points on the wave. Frequency: A number of wave cycles per second.

### Comparison between ordinary visible light and LASER Light (Table 1).<sup>7-11</sup>

Visible Light	LASER Light
Multiple wave length= White light (Polychromatic)	Typically one colour-Monochromatic, specific wave length generated
Non-directional and Non-focused	Highly focused and directional-collimated beam
Unorganized	Organized and efficient
Incoherent	Coherent
Low intensity 0.1W/cm <sup>2</sup>	High intensity $10^8$ - $10^{16}$ W/cm <sup>2</sup>

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**Basic Laser Components<sup>7-11</sup>**

- Optical resonator / tube containing the active medium.
- Active medium(Lasing medium) solid, liquid or gas
- Pumping mechanism
- Controller
- LASER delivery system

**TYPES OF LASER LIGHT DELIVERY**

**1. Fiber optic delivery system:**Lasers in the visible (445 and 532 nm) and near infrared (from 810 to 1,064 nm) range use optic strands, by and large made of quartz, to convey the laser vitality to the tissue, specifically or by means of terminal hand piece, with straight and precise tips

Disadvantage: gets worn with time

**Why is Fiber optic important?**

- Light weight
- Easy to approach
- Easy sterilization
- Tactile sensation

**2. Hollow Fiber<sup>7-11</sup>:** Er: YAG and CO 2 lasers utilize a hollow tube with reflective internal walls which transmit laser energy along its internal axis.

Disadvantage: loss of energy over time with lack of control over variability of energy due to internal reflection.

**3. Articulated arm delivery system<sup>7-11</sup>:** This delivery system utilizes a progression of verbalized mirrors (generally 7) associated one to each other, prompting transmission of vitality.

Disadvantage: requires a precise system for alignment of mirrors.

**4. Hand pieces<sup>7-11</sup> (Table 2)**

Close contact	Non-Contact hand piece
<ul style="list-style-type: none"> <li>• Works by way of tips of diverse size, shape, length, and angle.</li> </ul>	<ul style="list-style-type: none"> <li>• These are also called tip-less, uses a sapphire lens, located in the final part of the hand piece.</li> <li>• Specific distance from the target (usually from 5 to 10 mm depending on the type).</li> </ul>
<ul style="list-style-type: none"> <li>• Intended for specific interaction with improved kinds of tissues.</li> </ul>	
<ul style="list-style-type: none"> <li>• The radiation of the laser beam close to or in direct contact with the target tissue.</li> <li>• Expands precision of work.</li> </ul>	

**EMISSION MODES**

- **Continuous wave:-** The beam transmitted at one power level continuously as long device is active.
- **Gated pulse mode:-** A periodic alteration of laser energy being on or off, similar to blinking of an eye. Mode achieved by an opening closing of the shutter in front of the beam path.
- **Free running pulsed mode (Donat wave mode):-** large peak energy of laser light are emitted for a short time (microsecond) followed by a long time when the laser is off.

**LASER & TISSUE INTERACTIONS**

The light energy from a laser can have four different interactions with the target tissue, and these interactions depend on the optical properties of that tissue and wave length used.<sup>10-15</sup>

**Transmission<sup>10-15</sup>**

- Transmission of laser vitality specifically through the tissue, with no impact on an objective tissue.
- Water is generally straightforward to Nd:YAG while tissue liquids promptly retain carbon di-oxide

**Absorption<sup>10-15</sup>**

This impact is the typical alluring impact, and the measure of vitality that is consumed by the tissue relies upon the tissue qualities, for example, pigmentation and water content, and on the laser wavelength and discharge mode.

- Diode and Nd : YAG has a high fondness for melanin and less communication with hemoglobin.
- Longer wavelength is more intelligent with water and hydroxyapatite – Erbium, carbon dioxide laser.
- Short wave lengths, from around 500-1000nm are consumed promptly in pigmented tissue.

**Diffusion or Scattering<sup>10-15</sup>**

- Scattering of the laser light causes debilitating the vitality and conceivably delivering no helpful biologic impact.

**Reflection<sup>10-15</sup>**

- Laser beam becomes more divergent as the distance from hand-piece increases.
- Can be dangerous

**TYPES OF TISSUE INTERACTIONS**

**1. Photochemical-** effects that lasers make to arouse chemical reactions, such as curing of the composite resin. They can also origin a breakdown in chemical bonds, such as in the process of photodynamic therapy.

**2. Photo ablation-** When a laser is absorbed, it elevates the temperature and produces photochemical effects depending on the water content of the tissues. When a temperature of 100°C is extended, vaporization of the water within the tissue occurs, a process called Ablation. Removal of tissue by vaporization and super heating of tissue fluids, coagulation, and hemostasis.

**3. Tissue fluorescence-** used as a diagnostic method to detect the light reactive substance in tissue. Eg. Diagnodent for caries detection

**4. Vaporization & Carbonization-** At temperatures below 100°C, but above almost 60°C, proteins begin to denature, without vaporization of the underlying tissue. On the other hand, at temperatures above 200°C, the tissue is dehydrated and then burned, resulting in an undesirable effect called Carbonization.

## CLASSIFICATION OF LASERS

1. Based on active medium<sup>7-16</sup>
  - A. Solid
  - B. Liquid
  - C. Gas
2. Based on Application
  - A. Soft tissue lasers
  - B. Hard Tissue lasers
3. Based on wavelength
  - A. Excimer 195-350nm
  - B. Alexandrite 337nm
  - C. Argon 455-515nm
  - D. He-Ne 637nm
  - E. Diode 655-980nm
  - F. Nd:YAG 1064nm
  - G. Ho:YAG 2100nm
  - H. Er, Cr:YSGG 2780nm
  - I. Er:YSGG 2790nm
  - J. Er:YAG 2940nm
  - K. CO<sub>2</sub> 10600nm

## HOW THE LASER WORKS ON THE TOOTH?

The laser is directed on the rotten area, which contains more water molecules than rest of the tooth



Water molecules in the decay are heated rapidly. Pressure increases and the rotten area “explodes” making a popping sound



The laser kills bacteria in the area leaving the tooth surface sterile

## COMMONLY USED LASERS IN DENTISTRY

1. **Carbon dioxide Lasers**<sup>3&4,10-19</sup>: Gas Lasers

### Advantages

- Have high affinity for water, rapid soft tissue removal.
- Rapid hemostasis with shallow penetration.
- Generally used in surgical procedures both major and minor.
- Improves mechanical retention of sealant

### Disadvantages

- Have the highest absorbance of any laser
- Large size, high cost
- Greater hard tissue destruction

2. **Neodymium- Yttrium Aluminum Garnet Laser (Ne: YAG)**<sup>11-19</sup>: Solid state Lasers

### Advantages

- Highly absorbed by pigmented tissues.

- Effective for cutting and coagulating dental soft tissues
- Good hemostasis
- Used in non-surgical sulcular debridement

### Disadvantages

- High cost and size.

3. **Erbium Laser**<sup>11,20-22</sup>: Solid state Lasers

### Advantages

- Erbium wavelengths have a high affinity for hydroxyapatite and the highest absorption of water.
- Used for both soft and hard tissues

### Disadvantages

- High cost.
- Marginally prolonged treatment time but better results.

4. **Diode Lasers**<sup>11-19</sup>: Solid state Lasers

### Advantages

- Engrossed primarily by tissue pigment (melanin) and hemoglobin.
- Used for soft tissue applications

### Disadvantages

- Poorly absorbed by the hydroxyapatite and water present in the enamel

5. **Argon Laser**<sup>11-19</sup>

- Yield high intensity visible blue light
- Curing of dental restorations
- It also changes the surface chemistry of both enamel and root surfaces dentine, which reduces the probability of recurrent caries.
- Removes extrinsic and intrinsic stains
- Bleaching of teeth.

6. **Erbium: Chromium: Yttrium Scandium Gallium Garnet Laser (Er:Cr:YSGG)**<sup>11,20-22</sup>

- Etches enamel surface
- Removal smear layer

7. **Erbium: Yttrium Aluminium Garnet Laser (Er:YAG)**<sup>11,20-22</sup>

- Remove caries in enamel and dentin
- Removes dislodged GIC and Composite
- Desensitize the hypersensitivity dentine

## LASERS USES IN VARIOUS DENTAL SPECIALITIES

- A. **Oral Surgery**<sup>4,11,23-25</sup>

1. Surgery (major & minor)
2. Treatment of abscess
3. Aphthous ulcer
4. Hemostasis
5. Curettage
6. Epulis
7. Irritation fibroma

8. Frenectomy
9. Gingivectomy prior to impression
10. Granuloma
11. Haemangioma
12. Removal of hyper plastic tissue
13. Bacterial reduction
14. Operculectomy
15. Flap surgery
16. Excisional biopsy
17. Retention cyst
18. Exposure of impacted teeth
19. Seeping haemorrhage
20. Sulcus preparation
21. Vestibuloplasty
22. Root end resection
23. Ankyloglossia

**B. Periodontics**<sup>5, 11, 26</sup>

1. Flap surgery
2. Frenectomy
3. Gingival contouring/ Gingivectomy
4. Pocket treatment
5. Bacterial reduction
6. Curettage
7. Pocket reduction
8. Operculectomy
9. Decontaminate membrane
10. Internal bevel incision

**C. Orthodontics**<sup>11</sup>

1. Bracket curing
2. Post orthodontic removal of residual cement
3. Exposure of impacted tooth

**D. Paedodontics**<sup>11</sup>

1. Removal of caries in deciduous teeth
2. Pulpotomy and Pulpectomy procedure

**E. Endodontics**<sup>11, 26-31</sup>

1. Bleaching
2. Caries removal
3. Canal irrigation
4. Curing of cement
5. Removal of fractured restorations
6. Etching of the tooth
7. Root resection (Apexectomy)
8. Smile design

**F. Prosthodontics**<sup>11, 32-34</sup>

1. Sulcus deepening
2. Vestibuloplasty
3. Crown contouring
4. Crown lengthening
5. Smile design

**ADVANTAGES OF LASER**<sup>6-11</sup>

- No anesthesia, no drill
- Less blood loss, less pain hemostatic, analgesic effect.
- Reduce post-operative edema
- Less post-op scarring.

- Initial healing, rapid regeneration, reduce post sensitivity in restorations
- Dressing & suturing is not required for wound closer.
- Less chances of metastasis
- Sterilization of treatment site.
- Laser exposure to tooth enamel causes a reduction in caries activity.
- The patient becomes free of fear & anxiety.
- Advantageous for medically compromised patients
- The patient becomes free of fear & anxiety.

**DISADVANTAGES OF LASER**<sup>6-11</sup>

- Laser beam could harm the patient or operator by direct beam or reflected light, causing retinal burns
- Laser - more expensive
- Need qualified personal
- Lasers can't be used
  - ✓ fill cavities located between teeth
  - ✓ remove defective crowns or silver fillings
  - ✓ prepare teeth for bridges

**LASER HAZARD CONTROL MEASURES**<sup>6-11</sup>

- The small flexible fiber optic, hand pieces or tip must be steam sterilized in sterilizing pouches
- Practice of protective wear
- Use of screen & curtains should be promoted
- Use of proper clothing
- Use of anti-fire explosive
- Proper training and courses
- Use of laser filtration masks prevents air borne contamination
- Foot pedal control switch with protective hood prevents accidental depression by surgical staff.

**CONCLUSION**

Although lasers cannot replace all the conventional procedures in dentistry, its use enables some procedures to be performed differently than the conventional procedure and its development in the field of dentistry continues to expand further enabling greater patient care.. Lasers are a "new and different scalpel" (optical knife, light scalpel)

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