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REVIEW ARTICLE

Lasers in Dentistry

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ABSTRACT

Dental lasers function by producing waves of photons that are specific to each laser wavelength. This photonic absorption within the target tissue results in an intracellular or intercellular change to produce the desired result. This article will provide an overview of lasers for the practitioner who is considering adding such a device to his or her dental armamentarium.

Keywords: Laser, Low level laser, Photodynamic therapy.

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INTRODUCTION

Laser is an acronym for light amplification by stimulated emission of radiation described by Einstein in 1917.[1] Light is a form of electromagnetic energy that behaves as a particle and a wave. The basic unit of this energy is called a photon.[2] Laser light is monochromatic and has the characteristics of collimation and coherency.[3] All available dental laser devices have emission wavelengths of approximately 500 to 10600 nm. They are therefore within the visible or invisible infrared nonionizing portion of the electromagnetic spectrum and emit thermal radiation. Dental procedures performed today with the laser are so effective that they should set a new standard of care.

HISTORY OF LASERS

In 1954, Townes and Gordon built the first microwave laser or better known as "MASER," which is the acronym for "Microwave Amplification by Stimulated Emission of Radiation". In 1960, Theodore Maimen at Hughes Aircraft Company made the first laser. He used a ruby as the laser medium. In 1961, Snitzer published the prototype for the neodymium-doped yttrium-aluminum-garnet laser. In 1965, Goldman et al for the first time subjected a vital tooth to laser energy, the patient experienced no pain and had only minor, superficial damage to the crown. In 1985, Myers and Myers described the *in vivo* removal of dental caries using a modified ophthalmic Nd:YAG laser.

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CLASSIFICATION

- Based on the state of medium
  - Solid – Nd:YAG, diode
  - Liquid – Dye
  - Gas – CO_2, Argon, Er:YAG
- Based on output energy
  - Low output, soft or therapeutic – Stimulates cellular activity, Ex: He-Ne, diode
  - High output, hard or surgical – Utilized to cut, coagulate, vaporize, and carbonize, e.g., CO_2, Nd:YAG, Er:YAG
- Based on oscillation mode
  - Continuous wave
  - Pulsed wave.

LASER–TISSUE INTERACTIONS

Laser has four different interactions with the target tissue

1. Absorption – The amount of energy absorbed by the tissue depends on the pigmentation, water content, laser wavelength, and emission mode.
2. Transmission – Light can also travel beyond a given tissue boundary. This is known as transmission.
3. Reflection – Reflected light bounces off the tissue surface and is directed outward. Because the energy dissipates so effectively after reflection, there is little danger of damage to other parts of the mouth. It also limits the amount of energy that enters the tissue.
4. Scattering – Scattering occurs when the light energy bounces from molecule to molecule within the tissue. It distributes the energy over a larger volume of tissue, dissipating the thermal effects.

LASER ENERGY AND TISSUE TEMPERATURE

The principal effect of laser energy is photothermal.[4]

>175	Rapid cutting
>200	Carbonization
90–100	Vaporization
70–80	Welding
60	Coagulation
50	Hyperthermia
37	Normal

Advantages of Lasers over Conventional Surgical Procedures[5]

- Dry and bloodless surgery
- Less mechanical trauma
- Reduced bacteremia
- Instant sterilization of the surgical site
- Minimal postoperative pain and swelling
- Faster healing response
- Increased patient acceptance.

Disadvantages

- They are relatively high in cost
- Operations of lasers require specialized training
- No single wavelength will optimally treat all dental disease
- There is inability to remove metallic and cast-porcelain defective restorations by erbium family lasers
- Harmful to eyes and skin.

Laser Applications in Dentistry

- Diagnosis
  - Caries detection – It operates at a wavelength of 655 nm. At this wavelength, healthy tooth exhibits no fluorescence, resulting in very low-scale readings. However, carious tooth exhibits fluorescence with elevated scale readings on the display.[6]
  - Calculus detection and mobility – It operates at a wavelength of 655 nm. Calculus glows differently than the healthy tissue and also presents an audible signal representing the presence of calculus. Laser Doppler vibrometry is used to assess tooth mobility.
- Hypersensitivity
  - Low-level laser (diode laser) at a wavelength of 780 nm can be used for the treatment of hypersensitivity. They stimulate odontoblast to produce reparative dentin causing dentinal tubule occlusion. The sealing of dentinal tubules reduces pain.[7]
- Lasers in nonsurgical pocket therapy
  - Removal of calculus – Er:YAG lasers are found to be effective in removing subgingival calculus and leaves no craters on the root surface, thereby creating a surface favorable for fibroblast attachment.
  - Photodynamic therapy (PDT) – Photodynamics involves the application of dye to the treatment area. The dye is termed as photosensitizer, which gets activated in the presence of light at a wavelength of 630 and 700 nm to form free radicals, which destroys the unwanted microbes or tumor cells. Periowave is a photodynamic disinfection system that utilizes low-intensity Diode lasers to target and destroy microbial pathogens and reduce the symptoms of disease.[8] The adjunctive use of PDT along with scaling may result in greater bacterial reduction, clinical attachment level gain, as well as a reduction in bleeding on probing and pocket depths.
- Lasers in surgical therapies
  - Periodontal regeneration surgery – The most effective method is double-wavelength technique. It uses Er:YAG laser to debride the open surgical site, clean, and sterilize the root surface for the adhesion of fibroblast. The CO_2 laser would remove the epithelium, which will allow the fibroblast to adhere and create a new attachment.
  - Osseous Recontouring – Er:YAG lasers have the ability to ablate osseous tissue safely.[9]
- Lasers in implants

  For implant maintenance, Er:YAG laser has been suggested by taking benefit of its bactericidal effect. Matsuyama et al[10] demonstrated the debridement of implant abutment surface using Er:YAG laser and observed successful elimination of plaque and calculus with no damage to the implant surface. Kreisler et al[11] also reported nonexcessive heat generation on the implant surfaces and efficient sanitization using the Er:YAG laser.
- Lasers in root canal treatment

  Er,Cr:YSGG (2780 nm) and Er:YAG (2940 nm) can be used for access cavity preparation and root canal shaping and cleaning. Lasers, such as Er:YSGG (2780 nm), Er:YAG (2940 nm) and Nd:YAG (1064 nm) are used for root canal wall preparation.[12] The length of the root canal obtained through the X-ray is transferred to the fiber optical wave guide to ensure that the flexible 200 μm fiber reaches the apex. The laser is activated only after the fiber reaches the apex and the fiber is guided in an apical to coronal direction with rotary movements and in contact with the root canal wall. When the laser fiber is unable to be inserted into the canals, reamers and files are used, followed by lasers. Sweeping of root canal and irrigation are done in straight, slightly curved, and wide canals with lasers. Along with lasers, 5.25% sodium hypochlorite or

14% EDTA must be used along with laser irradiation. Neodymium-doped yttrium-aluminum-garnet lasers are used for the removal of pulp remnants at the apical foramen. Sterilization or disinfection of infected canals is done with pulsed Nd:YAG, argon, semiconductor diode, CO_2, and Er:YAG lasers.

CONCLUSION

Laser has become a ray of hope in dentistry. When used efficaciously and ethically, lasers are an exceptional modality of treatment for many clinical conditions that dentists treat on a daily basis. However, the future of dental laser is bright with some of the newest ongoing researches. Once our knowledge about optimal laser parameters for each treatment modality is complete, lasers can be developed that will provide dentists with the ability to care for patients with improved techniques.

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