Review Article

LASER IN ENDODONTICS

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ABSTRACT:
With the rapid development of laser technology, new lasers with a wide range of characteristics are now available and being used in various fields of dentistry. Clinical studies clearly show advantages of laser treatments over currently-used conventional methods and techniques. The most important advantages are improved disinfection efficacy, more effective root canal cleaning, reduction of permeability, reduction of micro-leakage, and elimination of the need to use toxic solvents. The main aim of this review article is to give an update on lasers in endodontics.
Key words: Laser, endodontics, pulp, disinfection.

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INTRODUCTION

The word "LASER" is widely used in dentistry. It stands for Light amplification by stimulated emission of radiation. With the rapid development of laser technology, new lasers with a wide range of characteristics are now available and being used in various fields of dentistry. Studies continue to be conducted in order to make maximum use of properties of the existing lasers in the field of endodontics.[1]

LASER IN ENDODONTICS

The use of lasers in endodontics has been studied since the early 1970s, and lasers have been more widely used since the 1990s. A successful endodontic therapy is when there is complete and effective cleaning of root canal.[1] Tradi- tional endodontic techniques use mechanical instru-ments, as well as ultrasound and chemical irrigation to shape, clean and completely decontaminate the endodontic system. There is limitation of endodontic therapy such as lateral canals with various morphologies and dimensions.[2]

The usefulness of the debridement, cleaning and refining of the intra-radicular space is limited, because of anatomical complexity and the difficulty of common irrigants to penetrate into the lateral canals and the apical ramifications. Hence, there is need for new materials, tech- niques and technologies that can improve the clean- ing and decontamination of these anatomical areas.[3]

Dental lasers are named from chemical elements, molecules, or compounds that compose the core, or active medium, that is stimulated. This active medium can be a combination of gas, solid crystal rod, or a solid-state electronic device. Gas-active medium lasers are argon and carbon dioxide. Solid semiconductors are made with metals such as gallium, aluminum, and arsenide. Solid rods of garnet crystal are generally made from yttrium and aluminum, to which are added elements chromium, neodymium, holmium, or erbium.[4]

Different lasers considered for endodontic applications are the near infrared laser—diode (810, 940, 980 and 1,064 nm) and Nd:YAG(1,064 nm)—and the medium infrared lasers—Erbium,Chromium: YSGG (Er,Cr:YSGG; 2,780 nm) and Erbium:YAG (2,940 nm).[5]

Near infrared lasers such as Nd:YAG (from 803 nm to 1,340 nm) were the first to be used for root

decontamination delivers laser energy through an optical fibre.[5]

The medium infrared lasers, such as the Erbium (2,780 nm and 2,940 nm) laser family, with flexible, fine tips have also been used.

The far infrared laser CO^2 (10,600 nm) was the first to be used in endodontics for decontamination and apical dentine melting in retrograde surgery. It is no longer used in this field with the exception of vital pulp therapy (pulpotomy and pulp coagulation).

LASER- TISSUE INTERACTION[6]

Four type of interaction occur at tissue level.

1. Absorption is the phenomenon of the energy incident on tissue with affinity being absorbed and thereby exerting its biological effects.
2. Reflection is the phenomenon of a beam of laser light hitting a target and being reflected for lack of affinity.
3. Diffusion is the phenomenon of the incident light penetrating to a depth in a non-uniform manner with respect to the point of interaction, creating biological effects at a distance from the surface.
4. Transmission is the phenomenon of the laser beam being able to pass through tissue without affinity and having no effect

APPLICATION OF LASER

Laser in analgesia

The pulsed â Nd:YAG laser is widely used as a analgesia in endodontics. Its wavelengths interfere with the sodium pump mechanism, change cell membrane permeability, alter temporarily the endings of sensory neurons, and block depolarization of C and A fibers of the nerves. [7]

Pulp vitality and laser

A. Laser doppler flowmetry

This is one of the important application of LASER in endodontics. It is a noninvasive method of assessing and accurately measuring the rate of blood flow in the pulp which is a highly vascular tissue and cardiac blood flow in the supplying artery is transmitted through pulsations. [1] These pulsations are apparent on the laser doppler monitor of vital teeth and absent in the nonvital teeth. This method uses Helium Neon and diode lasers at a lower power of 1 or 2 mW. [7]

B. Thermal testing

To check the vitality of the pulp, Pulsed Nd:YAG laser has been used and it is better tolerated than hot gutta percha. [6]

LASER & DENTIN HYPERSENSITIVITY

The mechanism of laser for treatment of dentin hypersensitivity is not well explained, However Pashley suggests that it may occur through coagulation and protein precipitation of plasma in dentinal fluid or by alteration of nerve fiber activity. [8] Laser therapy has been recommended by Kimura et al. to treat dentin hypersensitivity with effectiveness between 5.2% and 100%, depending on the type of laser and parameters used. According to authors, lasers are more effective than other treatments, although effect diminishes in severe dentin hypersensitivity. Mckarthy et al indicates that the reduction in dentin hypersensitivity could be the result of alteration of root dentin surface, physically occluding the dentinal tubules.[9]

LASERS & PULP CAPPING

The role of LASER in direct and indirect pulp capping has proved to be useful in endodontics. Temperature increases during treatment is minimal, and may even sometime decrease while working with water spray cooling. During application of laser dentinal tubules may remain open allowing hybrid layer formation. No smear layer is produced. Another feature is very superficial thermal effect, therefore the necrotic zone is likely to be small. Examples are Er:YAG or Er,Cr:YSGG lasers which have bactericidal properties.[10]

LASERS IN ROOT CANAL TREATMENT [10]

The various uses of laser in root canal treatments are as follow

1. Access cavity preparation and root canal orifice enlargement.
2. Root canal wall preparation.
3. Sweeping of Root canal and irrigation.
4. Removal of pulp remnants and debris at the apical foramen.
5. Sterilization or disinfection of infected canals.
6. Obturation with gutta percha or resin.
7. Removal of temporary cavity sealing materials, root canal sealing materials, and fractured instruments in root canals.

Er,Cr:YSGG (2780nm) and Er:YAG (2940nm) can be used for access cavity preparation, root canal shaping and cleaning. Lasers such as Er:YSGG

(2780nm), Er:YAG(2940nm) and Nd:YAG(1064 nm) are use3d for root canal wall preperation. [11] The length of the root canal, obtained through the X-ray, is transferred to the fiberoptical wave guide to ensure that the flexible 200µm 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 to be used, followed by lasers. Smear layer is completely removed and dentinal tubuli are for the most part closed if pulsed Nd:YAG laser is applied at 15 Hz / 1.5 W settings. 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 laser irradiation.[12]

Nd:YAG are widely used for Removal of pulp remnants and debris at the apical foramen. removal of pulp remnants, control of hemorrhage, and stimulation of cells surrounding the root apex as well as debridement on the surface.

Sterilization or disinfection of infected canals are done with Pulsed Nd:YAG, argon, semiconductor diode, CO, Er:YAG lasers. Because of laser energy and wavelength characteristic, they are useful in killing microorganism. In Photoactivated disinfection, tolonium dye is applied to the infected area and light is transmitted into the root canals at the tip of a small flexible optical fiber that is attached to a disposable hand piece. Laser emits 100mW and does not generate sufficient 8 heat to harm the adjacent tissues.[12,13]

In endodontics, lasers use the photo-thermal and photomechanical effects resulting from the interaction of different wavelengths and different parameters on the target tissues. These are dentine, the smear layer, debris, residual pulp and bacteria in all their various aggregate forms. Using different outputs, all the wavelengths destroy the cell wall due to their photo-thermal effect. Because of the structural characteristics of the different cell walls, gram-negative bacteria are more easily destroyed with less energy and radiation than gram-positive bacteria.[14] The near infrared lasers are not absorbed by hard dentinal tissues and have no ablative effect on dentinal surfaces. The thermal effect of the radiation penetrates up to 1mm into the dentinal walls, allowing for a decontaminating effect on deeper dentine layers. The medium infrared lasers are well absorbed by the water content of the dentinal walls and consequently have a superficial ablative and decontaminating effect on the root canal surface.

With vertical condensation method, obturation of canals can be done with Lasers. Anic and Matsumoto attempted to investigate whether it is possible to perform the root canal filling using sectioned gutta-percha segments and a pulsed Nd:YAG laser. With the lasers, Removal of temporary cavity sealing materials, root canal sealing materials, and fractured instruments in root canals became possible.[15] In fine and strongly curved canals, however, there were many cases in which laser tips perforated the canal wall.

LASER TREATMENT OF PERIAPICAL LESIONS OF SINUS TRACT

Laser therapy is recommended for cases for which apicoectomy or periapical curettage cannot be performed, or for which standard endodontic treatment cannot be performed, because of deep post in the root canal. This treatment can be performed to accelerate wound healing in combination with endodontic or surgical treatment. Pulsed Nd:YAG and CO 2 lasers are recommended for these treatments. [16] This treatment generally is performed three or four times during one visit. When using the CO laser, the exit of drainage 2 must be ablated as deeply as possible at 1 or 2 W and under air cooling or local anesthesia. The aforementioned laser treatments are performed once or twice a week until the sinus tract disappears. For the pulsed Nd:YAG laser, 2 W and 20pps are the recommended parameters and the fiber tip must be inserted into the tract and drawn slowly from the root apex to the exit through the sinus tract.[17]

LASER IN PERIAPICAL CURETTAGE, APICOECTOMY AND RETROGRADE CAVITY PREPARATION

Because of relatively bloodless and post surgical course, coagulation, minimal cutting, sterile surgical area, swelling and scarring, vaporization and minimal or no suturing and much less or no post surgical pain, lasers proved to be effective. [18] Permeability of dentin exposed by apicoectomy is one of the causes of endodontic surgery failure because microleakage and bacterial contamination trigger inflammation. The use of lasers resulted in smoother surfaces and more homogenous dentin fusion and

recrystallization, which occluded tubules and decreased permeability. [19]

INDICATION AND CONTRAINDICATION OF LASERS IN ENDODONTICS [20,21]

Indications-

a. Teeth with lateral canal leading to periodontal involment.
b. Teeth with pulp necrosis and purulent pulpitis.
c. Teeth with gangarenous changes.
d. Teeth with periapical lesions upto 5mm or more.
e. Teeth that has been treated atleast 3 months with no success.

Contraindications-

a. In advanced periodontitis cases.
b. A deep crown and root fracture.
c. Obliterated root canals in endodontic treated teeth.

LASER PROTECTION

The operator should be well trained to use a laser device. The surgical environment must have a warning sign and limited access. The operator, patient and the surgical team should wear protective eyewear so that any reflected energy does no damage. High volume suction must be used to evacuate the plume formed by tissue ablation, and normal infection protocol should be followed. The laser should be in good working condition.[22,23]

CONCLUSION

Author concludes that with the advent of Lasers in dentistry, the complex procedures have become easier and time saving. Thus the patient care has improved.

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