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Lasers in Endodontic: A review

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Abstract

Since the development of ruby laser by Maiman in 1960 & application of laser for endodontics by Weichman in 1971, a variety of papers on potential applications for lasers in endodontics have been published. Lasers have been a significant advancement in the field of endodontics. Be it effective cleaning, root canal treatment, surgery etc. The lateral accessory canals and anatomical complexities have been a restraint in root canal procedure, for such cases lasers have been introduced to simplify the process & have good clinical results. As there has been a boon in the improvement of laser techniques, many latest lasers having a broad array of characteristics is accessible and can also be helpful in several areas related to dentistry. When compared with conventional techniques, laser treatments has been proven to be more advantageous. The purpose of this article is to summarize laser applications in endodontics, including their use in pulp diagnosis, dentinal hypersensitivity, pulp capping and pulpotomy, sterilization of root canals, root canal shaping & obturation & apicectomy. This article reviews the role of lasers in endodontics since the early 1970s & summarizes what future may hold for endodontics. With the potential availability of many new laser wavelengths and modes, much interest is developing in this promising field.

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INTRODUCTION

Effective cleaning of canals of the root is the aim for performing root canal procedure. Conventionally manual instrumentation and chemical irrigation for cleaning and shaping of root canal have been used (Olivi *et al.*, 2011) Presence of lateral canals with varying morphologies and dimensions, anatomical complexities and intricacy of irrigants penetrating in canals present laterally as well as complex branching of canals near apex, causes a restraint of endodontic therapy. Hence, Laser technology was introduced in endodontics to improve the conclusions gathered by the use of standard techniques by using light energy to increase the ability to clean and helps in removal of debris along with smear layer within the canals and hence leading to improvisation in the cleansing of the canal (Kimura *et al.*, 2000). In 1971, Weichman & Johnson became the first to use the laser in endodontics in an attempt to close the apical opening of foramen via Co2 laser. As there has been a boon in the improvement of laser techniques, many latest lasers having a broad array of characteristics has been accessible and can also be helpful in several areas related to dentistry. When compared with standard techniques, laser

treatments has been proven to be more advantageous. According to results, it has been suggested that laser was proven effective for removing debris, smear layer, & also been a useful disinfection tool.

History

1917- Albert Einstein gave the theory of stimulated emission on which principle of the laser was based.

1960- Theodore Maiman developed "ruby laser" (Aoki *et al.*, 2004).

1964- Patel invented the co2 laser. It was the only laser which can be applied to hard as well as soft tissue (Karlovic *et al.*, 2005).

1964- Nd: Geusic developed YAG.

1965- Stern and Sognnaes were the first to report that ruby laser was responsible for vaporization of enamel (Sognnaes and Stern, 1965).

1971-Weichman and Johnson reported the effectiveness of laser during root canal treatment for the first time (Yamamoto and Sato, 1980).

1990-Diode lasers emerged which were semiconductor-based (Adrian *et al.*, 1971).

1997- FDA gave clearance to Er:YAG laser and the Er,Cr:YSGG after 12 months.

Mechanism Of Action

An active medium produces a beam of laser that leads to the production of specific wavelength photons on stimulation via light/electricity. Some of the characteristic features being, monochromatic(beam composed of a single wavelength), unidirectional, coherent, which are being released via a medium which is active and stimulated. On production of the laser beam, it travels in a single path, although the different types of laser and the related conduction hardware may diverge the beam. Active media being a solid-state, gaseous state, or in a semiconductor state. Erbium laced yttrium, Er: YAG and aluminium are some of the solid active media which are crystal medium host drug in company with atoms which are capable of producing light and are excitable."CO2" being an accepted laser wherein the active medium remains preserved in a vacuum chamber. On stimulation by an electrical source, semiconductor present in diode laser emits the light(laser), [7] by a process called optical pumping. On absorption of a photon by erbium atom, the electrons get raised to a superior energy level. On returning to lower energy state, two similar electromagnetic waves are released, which can further excite a large number of atoms in the reaction, which results in a magnification of the produced light. The active medium is surrounded by a mirror called resonator, which will further increase the light energy. The output coupler is one of the mirrors is less than 100% reflective from where the light leaks and these photons from a beam of a laser. After the formation of the beam, with the help of beam transfer hardware, the beam is passed on towards the target tissue Table 1 (Lin *et al.*, 2010).

Classification

According to Light Active Medium

Gas lasers

Argon

CO2

Liquid

Dyes

Solid

Nd YAG

(Er: YAG)

Diode

Semiconductor

Hybrid silicon laser

Excimers

Argon-fluoride

Krypton-fluoride

Xenon-fluoride

Applications Of Lasers In Dentistry

1. For Cutting of Enamel and Dentin.

2. For Root canal procedure.

3. Bone cutting and lengthening of crown.

4. Apicectomy& Endodontic Surgery

5. For procedures in periodontics.

6. For Soft Tissue treatment (Frehtzen and Koor, 1990).

Applications Of Lasers In Endodontics

1. Laser application can be used in patients showing any of the below mentioned clinical findings. Tooth with purulent pulpitis, lateral canals, teeth showing gangrenous changes in coronal portion and pulp of root, teeth showing peri-apical lesions and abscess, root resorption because of trauma or infection. Also for tooth which has undergone three months of treatment without any success.

2. Analgesia

3. Dentin Hypersensitivity

4. Pulpotomy, pulp capping(direct and indirect)and amputation of pulp

5. Canal disinfection and irrigation-

Table 1: Based On Light Spectrum

Ultraviolet Light	100 nm - 400 nm	Not used in dentistry
Visible light	400 nm to 750 nm	Frequently used in dentistry (Argon & Diagnodent Lasers)
Infrared light	750 nm to 10000 nm	Maximum lasers used in dentistry come under this.

a. Preparation of access cavity and magnification of orifice.

b. Preparation of the canal wall

c. Sweeping of Root canal and irrigation.

d. Sterilizing the canals which are contaminated

e. Obturate by gutta percha

f. removing temporary restoration and instruments which are fractured

6. Diagnosis of fracture of root(vertical)

7. Surgical part in endodontics-

a. Prepare a flap

b. To gain access to apex of root bone is cut.

c. Root end amputation

d. For Retro fill composite, preparation of root end is done.

e. Removing the hyperplastic as well as pathological tissues from near the apices.

8. Pulp vitality diagnosis

9. Modification of root canal wall.

Thermal Consideration

When treatment was carried out of 45 seconds duration at 15Hz, it was observed that a temperature of 38 degree celcius was measured on surface of the root, this resultant parameter lied within the physiological limits.

The flow of blood around the root surface keeps the dental tissue more expeditiously cooled, this was considered that in an in-vivo situation. On treatment with fibre-optical waveguide in coronal direction the temperature on root canal wall decreases which assures that only marginal tissue is affected and hence no damage is expected.

Morphological Changes

On applying Nd:YAG with 15Hz/1.5W, the maximum part of dentinal tubuli closes because of inorganic melting. Smear layer removal occurs & (Gutknecht, 2007) by using 810nm laser diode comparable results can be expected. On application of Er:YAG laser, entire smear layer removal occurs while the tubuli of dentin remains open.

Disinfection Effect

Conventional alternate rinse in root canal preparation by sodium hypochlorite or hydrogen peroxide have been successfully proven to have a bactericidal effect (Suryavanshi *et al.*, 2017). The only one to examine an 80% of reduction in bacterial count following 5 treatment sessions were BYSTROM et al. but only in root canals of upto ISO30 while the curve roots remained an exception.

Gutknecht et al (Gutknecht *et al.*, 1996) was successful in achieving 99.92% decrease in bacterial count in the canal by using Nd:YAG laser. Nd:YAG lasers when tried in various combinations with bacteria and various designs of experiment, 99% of decrease in bacterial count as studied by Rooney et al & Hardee et al in 1994. Further studies have been carried out to determine the depth upto which the laser can peneterate through dentin. When Nd:YAG laser was used deep of about 1000 micrometer, it showed bactericidal effect, as proven in 1997 in a study by Klinke et al. When compared with rinsing solution, sodium hypochlorite was the only one to show successful reduction in bacterial count at a depth of 100 micrometer.

CONCLUSIONS

In todays dental treatment procedures lasers are playing very important role, if used efficaciously and ethically. As the advancement of much thin, elastic & long lasting fibres, application of lasers in root canal treatment is soon going to increase. Since laser technology came in the areas of dental treatment, the complicated techniques is becoming simpler with less consumption of time and hence improving ability to concern for patients. Due to relatively high cost laser devices are have limited access. Evaluation of studies on laser showed that Nd:YAG laser treatment was effective in replacing the customary procedures.

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Conflict of Interest

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