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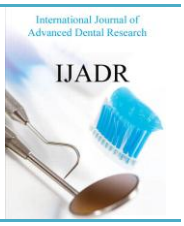

LASER IN ENDODONTICS

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ABSTRACT
Lasers were introduced into the field of clinical dentistry with the hope of overcoming some of the drawbacks posed by the conventional methods of dental procedures. Since its first experiment for dental application in the 1960s, the use of laser has increased rapidly in the last couple of decades. At present, wide varieties of procedures are carried out using lasers. 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 article reviews the applications of laser in endodontics and specifies the clinical importance of the lasers in each and every application.

INTRODUCTION

The word laser represents an elegant acronym as "Light Amplification by Stimulated Emission of Radiation". It was demonstrated for the first time by Theodore Maiman in 1960 with various laser types (Nd:YAG, Er, Cr:YSGG, Er YAG, CO2) having corresponding wavelengths (1064nm, 2780nm, 2940nm, 10600nm) becoming available to dentists to address their needs for hard and soft tissue treatment procedures [1,2].

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. Traditional endodontic techniques use mechanical instruments, as well as ultrasound and chemical irrigation to shape, clean and completely decontaminate the endodontic system [3].

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, techniques and technologies that can improve the cleaning and decontamination of this anatomical areas [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].

Laser Physics

Light is a form of electromagnetic energy that behaves like a particle and wave. Its basic unit is photon. LASER light energy has following characteristics

- Energy emitted is a light of one color (Monochromatic) thus of a single wavelength.
- Each wavelength is identical in physical size and shape (Coherent).
- Photons can be Collimated into an intensely focused energy beam which interacts with the target tissue.

APPLICATION OF LASER IN ENDODONTICS

- **Pulp diagnosis**

Laser Doppler flowmetry, which was developed to assess blood flow in microvascular systems also can be used for diagnosis of blood flow in the dental pulp. This technique uses helium-neon and diode lasers at a low power of 1 or 2 mW [6].

The laser beam is directed through the crown of the tooth to the blood vessels within the pulp. Moving red blood cells causes the frequency of the laser beam to be Doppler shifted and some of the light to be backscattered out of the tooth [7].

The main advantage of this technique, in comparison with electric pulp testing or other vitality tests, is that it does not rely on the occurrence of a painful sensation to determine the vitality of a tooth.

- **Pulp capping and Pulpotomy**

Pulp capping, as defined by the American Association of Endodontists, is a procedure in which "a dental material is placed over an exposed or nearly exposed pulp to encourage the formation of irritation dentin at the site of injury". Pulpotomy entails surgical removal of a small portion of vital pulp as a means of preserving the remaining coronal and radicular pulp tissues.

The traditionally used pulp-capping agent is calcium hydroxide; however, when it is applied to pulp tissue, a necrotic layer is produced and a dentin bridge is formed. A recently introduced material, mineral trioxide aggregate, shows favorable results when applied to exposed pulp. It produces more dentinal bridging in a shorter period of time, with significantly less inflammation; however, 3 to 4 hours are necessary for complete setting of the mineral trioxide aggregate [8].

Since the introduction of lasers to dentistry, several studies have shown the effect of different laser devices on dentin and pulpal tissue. Although ruby lasers caused pulpal damage, Melcer et al showed that the CO2 laser produced new mineralized dentin formation without cellular modification of pulpal tissue when tooth cavities were irradiated in beagles and primates [9].

LASERS IN ROOT CANAL TREATMENT

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

o Access cavity preparation and root canal orifice enlargement.
o Root canal wall preparation.
o Sweeping of Root canal and irrigation.
o Removal of pulp remnants and debris at the apical foramen.
o Sterilization or disinfection of infected canals.
o Obturation with gutta percha or resin.
o 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 used for root canal wall preparation [10].

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.

Along with lasers, 5.25% Sodium hypochlorite or 14% EDTA must be used along laser irradiation. Nd:YAG are widely used for Removal of pulp remnants and debris at the apical foramen.

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 [11,12].

Cleaning and Shaping the root canal system

Successful endodontic therapy, which mainly depends on the elimination of microorganisms from the root canal system, is accomplished by means of biomechanical instrumentation of the root canal. Complete removal of the smear layer would be consistent with the elimination of irritants from the root canal system [13]. Various laser systems used in dentistry, the emitted energy can be delivered into the root canal system by a thin optical fiber (Nd:YAG, erbium, chromium:yttrium-scandium-gallium-garnet [Er,Cr : YSGG], argon, diode) or by a hollow tube (CO2 and Er:YAG). Thus, the potential bactericidal effect of laser irradiation can be used effectively for additional cleansing of the root canal system following biomechanical instrumentation. This effect was studied extensively using lasers such as CO_2, Nd:YAG, excimer, diode, and Er:YAG [14].

There are several limitations that may be associated with the intracanal use of lasers that cannot be overlooked [15]. The emission of laser energy from the tip of the optical fiber or the laser guide is directed along the root canal and not necessary laterally to the root canal walls. Thus, it is almost impossible to obtain uniform

coverage of the canal surface using a laser [16]. Another limitation is the safety of such a procedure because thermal damage to the periapical tissues potentially is possible.

Stabholz and colleagues [16,17] recently reported the development of a new endodontic tip that can be used with an Er:YAG laser system. This new endodontic side-firing spiral tip (RCLase; Lumenis, Opus Dent, Israel) was designed to fit the shape and the volume of root canals prepared by nickel-titanium rotary instrumentation. It emits the Er:YAG laser irradiation laterally to the walls of the root canal through a spiral slit located all along the tip. The tip is sealed at its far end, preventing the transmission of irradiation to and through the apical foramen of the tooth.

Obturation

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. In fine and strongly curved canals, however, there were many cases in which laser tips perforated the canal wall.

DISCUSSION

The goal of laser dental surgery is to minimize post operative effects on soft tissues. Photo activated disinfection is one of the advantages of laser therapy. In 1960, with the efforts of Theodore Maiman, various laser types were being introduced which were available for hard and soft tissue procedures. In 1961, Weichman & Johnson put their efforts by using CO_2 for sealing of apical foramen which was thought to be minimal harming laser to use [18]. Sognnaes, in 1964 put forward his studies on laser effects like catering and fusion of enamel when subjected to specific wavelength of light [19]. In the same year, Stern and Sognnes looked for the possible use of ruby lasers in dental treatment. They found reduction in permeability of exposed enamel to acid demineralization and also explained about limitations of lasers that are to be used during the procedure. Goldman et al used laser for the first time on the vital tooth successfully, without producing any significant damage to the underlying bone [20]. In 1987 it was cited that Er;YAG is used for preparing cavities in enamel, dentine, and has advantage of reduced thermal effects. Study conducted in 1999 by Tokonabe et al revealed that cavity preparation with Er;YAG resulted in ablation craters [21]. Current research is actively being conducted for new wavelengths and clinical applications of laser; each device has its own features, advantages and disadvantages but they all provide useful contribution to dental armamentarium.

CONCLUSION

In past, dental treatment was quite troublesome for the patients, as patient was not aware about the necessity for treatment to be done as well as psychological factors such as fear of pain etc. Now-a-days, with introduction of lasers, dental treatment have become easy and less painful. The application of LASERs in endodontics will definitely alter the clinical practice with numerous uses in the nonsurgical as well as surgical aspects of therapy.

Apart from this, safety measures regarding use of laser should not be avoided. With the knowledge of necessary parameters for ideal treatment, lasers can be developed so that it can provide dentists the ability to care for patients with improved techniques and equipment.

REFERENCES

1. Miserendino LJ, Pick RM. (1995) Lasers in Dentistry, Chicago: Quintessence Publishing Co. Inc.
2. Colojoara C, Miron M, Leretter M. (1998) Laseri in Stomatologie. Actualitati si perspective, Timisoara: DA&F Spirit.
3. Giovanni Olivi, Rolando Crippa, Giuseppe Iaria, Vasilios Kaitsas, Enrico DiVito & Stefano Benedicenti. (2011) Lasers in endodontics (Part I). *Roots*, 1-4.
4. Karlovic Z, Pezelj-Ribaric S, Miletic I, Jukic S, Grgurevic J, Anic I. Erbium. (2005) YAG laser versus ultrasonic in preparation of root-end cavities. *J Endod*, 31, 821-3.
5. Shekhar Bhatia, Shivani Kohli. (2013) Lasers in root canal sterlisation- A review. International journal of scientific study. 1 (3), 107-111.
6. Kimura Y, Wilder-Smith P, Matsumoto K. (2000) Lasers in endodontics: a review. *Int Endod J*, 33, 173-85.
7. Cohen S, Liewehr F. (2002) Diagnostic procedures. In: Cohen S, Burns RC, editors. Pathways of the pulp. 8th edition. St. Louis (MO): Mosby; p. 3-30.
8. Torabinejad M, Chivian N. (1999) Clinical applications of mineral trioxide aggregate. *J Endod*, 25, 197-205.
9. Melcer J, Chaumate MT, Melcer F, Zeboulon S, Hasson R, Merard R, et al. (1985) Preliminary report of the effect ofCO2 laser beam on the dental pulp of the Macaca Mulatta primate and the beagle dog. *J Endod*, 11, 1-5.
10. Kathari A, Ujariya M. (2014) Lasers in endodontics- A review. *J Res Adv Dent*, 3(1), 209-211.
11. Anic I, Matsumoto K. (1995) Comparison of the sealing ability of laser softened, laterally condensed and low temperature thermoplasticized gutta percha. *J Endod*, 21, 464-469.
12. K Gorkhay et al. (1999) Effects of oral soft tissue produced by a diode laser in vitro. *Lasers in Surgery and medicine*, 25, 401-406.

13. Drake DR, Wiemann AH, Rivera EM, Walton RE. (1994) Bacterial retention in canal walls in vitro: effect of smear layer. J Endod 20, 78-82.
14. Mehl A, Folwaczny M, Haffner C, Hickel R. (1999) Bactericidal effects of 2.94 l Er:YAG laser irradiation in dental root canals. *J Endod*, 25, 490-3.
15. Goodis HE, Pashley D, Stabholz A. (2002) Pulpal effects of thermal and mechanical irritants. In: Hargreaves KM, Goodis HE, editors. Seltzer and Bender's dental pulp. Quintessence Publishing, Inc; p. 371-410.
16. Stabholz A, Zeltzser R, Sela M, Peretz B, Moshonov J, Ziskind D. (2003) The use of lasers in dentistry: principles of operation and clinical applications. *Compendium*, 24, 811-24.
17. Stabholz A. (2003) The role of laser technology in modern endodontics. In: Ishikawa I, Frame JW, Aoki A, editors. Lasers in dentistry, revolution of dental treatment in the new millennium. *Elsevier Science BV Int Congr Series*, 1248, 21-7.
18. Weichman JA, Johnson FM. (1971) Laser use in endodontics. A preliminary investigation. *Oral Surg Oral Med Oral Pathol*, 31(3),416-420.
19. Stern RH, Sognnaes RF. (1964) Laser beam effect on dental hard tissues. *J Dent Res*, 43, 873.
20. Goldman L, Gray JA, Goldman J. (1965) Effect of laser beam impacts on teeth. *J Am Dent Assoc*, 70, 601-606 B,
21. Tokonabe H, Kouji R, Watanabe H, Nakamura Y, Matsumoto K. (1999) Morphological changes of human teeth with Er:YAG laser irradiation. *J Clin Laser Med Surg*, 17, 7-12.