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Research Article

LASERS IN ENDODONTICS

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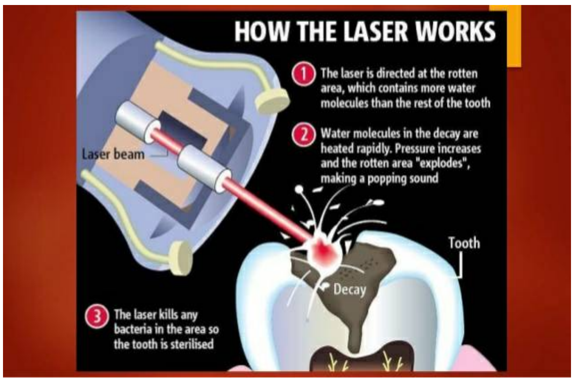
A B S T R A C T

With the rapid development of laser technology, new lasers with a wide range of characteristics are now available and are being used in various fields of dentistry. The search for new devices and technologies for endodontic procedures always has been challenging. Numerous researchers have investigated laser applications in dentistry in the past five decades. The purpose of this article is to provide an overview of the current and possible future clinical applications of lasers in endodontics, including their use in pulp diagnosis, pulp capping and pulpotomy, cleaning and shaping of the root canal system, and endodontic surgery.

INTRODUCTION

The foremost objective of an endodontic treatment is the effective cleaning of the root-canal system. The complexity of the root-canal system is well known. Numerous lateral canals, of various dimensions and with multiple morphologies, branch off from the principal canals. Therefore, the effectiveness of debridement, cleaning and decontamination of the intra-radicular space is limited, given the inability of common irrigants to penetrate into the lateral canals and the apical ramifications.The use of lasers in endodontics has been studied since the early 1970s, and the lasers have been more widely used since the 1990s. LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. Light is a form of electromagnetic energy that travels at a constant velocity in the form of waves.



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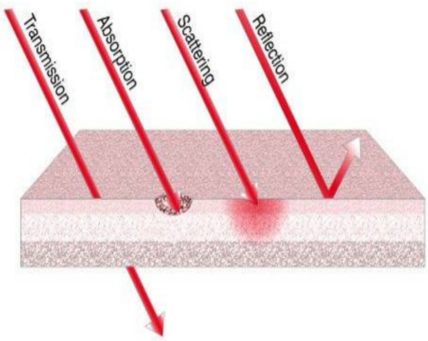
Different wavelengths have been shown to be effective in significantly reducing bacteria in infected canals and studies have confirmed these results in vitro.

Scientific basis for the use of lasers in endodontics

Laser-tissue interaction

The interaction of light on target follows the rules of optical physics. Light can be reflected, absorbed, diffused or transmitted. The interaction of the laser light and tissue occurs when there is optical affinity between them. This interaction is specific and selective based on absorption and diffusion. The less affinity, the more light will be reflected or transmitted.



Effects of laser light on tissue

The interaction of the laser beam on target tissue, via absorption or diffusion, creates biological effects responsible for therapeutic aspects that can be summarized as

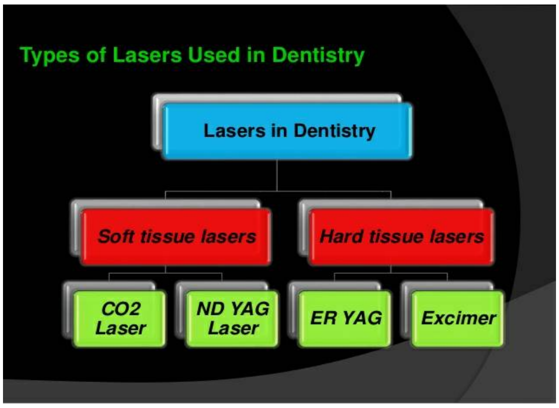
- photo-thermal effects

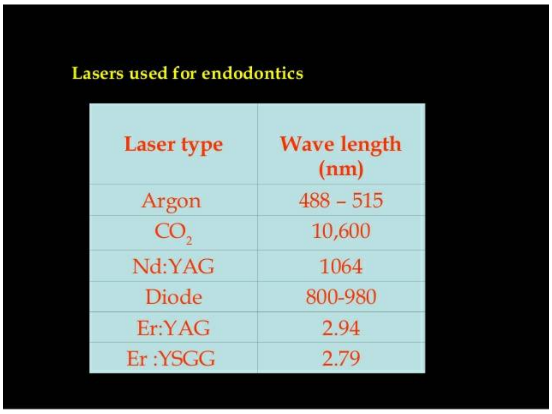
- photo-mechanical effects (this includes photo-acoustic effects)
- photochemical effects.

Effects of laser light on bacteria and dentinal walls

Using different outputs, all the wavelengths destroy the cell wall due to their photo-thermal effect. Gram-negative bacteria are more easily destroyed with less energy and radiation than gram-positive bacteria due to the structural characteristics of the different cell walls. The near infrared lasers are not absorbed by hard dentinal tissues and have no ablative effects on dentinal surfaces. 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.

Laser wavelengths used in dentistry





Lasers used for endodontics

Laser type	Wave length (nm)
Argon	488 – 515
CO_2	10,600
Nd:YAG	1064
Diode	800-980
Er:YAG	2.94
Er :YSGG	2.79

Nd:YAG

- solid active medium containing a crystal of yttrium-aluminium-garnet doped in neodymium
- wavelength- 1064nm
- first laser designed exclusively for dentistry

Diode

- solid-state semiconductor laser that uses a combination of aluminium, gallium and arsenide that converts electric energy into light energy
- wavelength- 800-980nm
- poorly absorbed by tooth structure, hence soft tissue surgery can be safely performed in close proximity to dental hard tissues.
- Advantage of being compact, portable and economical

CO2 Laser

- gas-active medium laser
- wavelength- 10600nm
- highly absorbed by both hard and soft tisses and has a shallow depth of penetration
- not suitable for hard tissues due to deleterious thermal absorptive effect on the pulp

Er:YAG and Er,Cr:YSGG

- Er:YAG is a solid active medium crystal containing yttrium-aluminium-garnet that is doped with erbium
- Wavelength:
- Er:YAG: 2940 nm
- Er,Cr:YSGG: 2790 nm
- They have the highest absorption in water and have a high affinity to hydroxyl-appatite.

Argon

- active gas medium containing argon
- two emisiion wavelengths:
- 488nm : blue in color
- 515nm: blue-green in color

Applications of lasers in endodontics

Vascular Vitality Assessment of Pulp

Traditional vitality assessment methods such as heat, cold and electric pulp testers assess neural vitality and often cause false-positive errors. Laser Doppler Flowmetry (LDF) is an accurate method to assess the blood flow in a microvascular system.

Pulp Capping and Pulpotomy

Pulp capping and pulpotomy constitute a more conservative form of pulp therapy as compared to pulpectomy. Pulp capping is recommended when the exposure is 1.0mm or less, especially in a young patient. Pulpotomy is recommended in immature permanent teeth, where pulpectomy cannot be done. The most commonly used agents for both the procedures are calcium hydroxide and MTA (mineral trioxide aggregate). The use of lasers in these procedures leads to a potentially bloodless field since the laser has the ability to coagulate and seal small blood vessels. The laser-tissue interactions make the treated wound surface sterile, besides improving the prognosis.

Disinfection of Root Canals

Laser technology was introduced to endodontics with the goal of improving the results obtained with traditional procedures through the use of light energy by enhancing the cleaning ability and the removal of debris and smear layer from the root canals and also improving the decontamination of the root canal system. Studies have assessed the role of CO2, Nd:YAG, Er:YSGG, Er:YAG, diode lasers in root canals and found evidence of dentinal tubule disinfection. The laser is delivered into the root canal system with the help of thin fiberoptics as in the case of Nd:YAG, Er:YSGG, argon and diode lasers.Some limitations with the intracanal use of lasers have been concluded by Goodis *et al*. The laser beam which is emitted from the tip of the fiberoptic is directed vertically downward into the root canal and not laterally into the dentinal tubules, which is further compromised by the inherent curvature in the root canals. Therefore, it is not possible to laser-irradiate all the dimensions of the canal system thoroughly.Another drawback put forth was the inadequate transmission of the laser into the periradicular region while irradiating the apical third of the root canal system. It is potentially dangerous in the areas around the apices of teeth close to the mental and mandibular foramen. The development of the side-firing tip with an Er:YAG laser is an effort to overcome this hazard.

Apical Surgery

Apical surgery including apical resection is indicated when the previously performed root canal therapy fails and nonsurgical means are inadequate to ensure in toto removal of the concerned pathology.

The potential for using lasers is on the following basis

- Their ability to seal and coagulate small blood vessels, thus enabling a bloodless surgical field.
- Sterilization of the surgical site.
- Potential of lasers (Er:YAG) to cut hard dental tissues, without causing significant thermal damage to the tissues in the immediate vicinity.

CONCLUSION

Although numerous studies have time and again proved the efficacy of lasers in endodontics, the acceptance of this technology by the clinicians is still limited. This could be attributed to the high cost of technology and the need for more than one laser frequency to cover all endodontic applications.But, the future of lasers in endodontics seems to be promising, with the rapid advancement of thinner and more flexible fiberoptic delivery systems and also with an improvement in our knowledge of optimal laser parameters.

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