Review Article

THE ROLE OF LASER IN MODERN DENTISTRY: LITERATURE REVIEW

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https://doi.org/10.51847/GHfzVsoiAa

ABSTRACT

Light Amplification by Stimulated Emission of Radiation is referred to as "LASER." The laser has been applied to a wide variety of hard and soft tissue procedures since Miaman used it for the first time in dentistry in 1960. The use of lasers in contemporary dental practice, where they can be used as an addition to or substitute for traditional techniques, is becoming better understood. Lasers were once thought to be an advanced technology with few practical uses in clinical dentistry. Albert Einstein predicted in 1917 that photoelectric amplification might result in a single frequency, or stimulated emission, which served as the impetus for the creation of the laser and its predecessor. For studies of patients with non-alcoholic fatty liver disease, the Medline, Pubmed, Embase, NCBI, and Cochrane databases were searched. Incidence, etiology, and management options were analyzed. With decades of development, laser technology for soft tissue surgery, resin curing, cavity preparation, and caries detection is highly developed. This does not rule out the possibility of further important developments. In fact, similar to laser abrasion, the blending of ideas from various technologies may open the door to new procedures and therapies.

Key words: Dental application, Lasers, Photostimulation, Photosensitization, Resin curing

Introduction

During the past ten years, the clinical uses of lasers in dentistry have been widely researched [1, 2]. At the same time, organizations supporting laser dentistry with a global focus have also emerged. The use of lasers in contemporary dental practice, where they can be used as an addition to or substitute for traditional techniques, is becoming better understood. Lasers were once thought to be an advanced technology with few practical uses in clinical dentistry. Albert Einstein predicted in 1917 that photoelectric amplification might result in a single frequency, or stimulated emission, which served as the impetus for the creation of the laser and its predecessor, "the Maser." [3].

The first time LASER, also known as "light amplification by stimulated emission of radiation,"was used in public was in a 1959 article by Gordon Gould, a graduate student at Columbia University [4]. Theodore Maiman developed the first practical laser at the Hughes Research Laboratories in Malibu, California, by combining helium and neon [5]. In 1961, a laser was developed using yttrium-aluminum-garnet crystals that had been treated with 1-3% neodymium (Nd: YAG) [4]. The ruby laser was developed in 1963, but the argon laser was first used to coagulate retinal lesions in medicine in 1962 [4]. Patel created the CO2 laser at Bell Laboratories in 1964 [4]. Diode lasers are now frequently utilized in dentistry. Research into the various uses of lasers in dental practice has continued since Miaman's [5] introduction of lasers in dentistry in the 1960s.

Hard lasers like carbon dioxide (CO2), neodymium yttrium aluminum garnet (Nd: YAG), and erbium yttrium aluminum garnet (Er: YAG), which have applications for both hard and soft tissues but have limits due to their high costs and risk for thermal harm to the tooth pulp, are one option. While "low-level laser therapy" (LLLT) or "biostimulation" are the two terms used to describe applications of cold and soft lasers, semiconductor diode devices, which are small and inexpensive, are the basis for these technologies [6].

Due to their ease, efficiency, specificity, comfort, and lower cost when compared to conventional modalities, lasers are recommended for a variety of procedures [7] in dental practice. This review focuses on both hard and soft tissue applications in dentistry.

Types of laser

There are several ways to categorize lasers used in dentistry, including the type of laser used (gas or solid), the type of tissue they can be applied to (hard tissue and soft tissue lasers), and the wavelength range. A laser application's risk must also be taken into consideration.

Carbon dioxide laser

Due to the high affinity of the CO2 laser wavelength for water, it can quickly remove soft tissue and cause hemostasis with a very shallow penetration depth. The CO2 laser's drawbacks include its relatively large size, high price, and interactions that can damage hard tissue despite having the highest [8] absorbance of any laser.

Neodymium yttrium aluminum garnet laser

Due to its excellent hemostasis and high absorption by pigmented tissue, the Nd:YAG surgical laser is superior for cutting and coagulating dental soft tissues. In addition to its surgical uses, the Nd:YAG laser has also been researched for non-surgical sulcular debridement in the management of periodontal disease and the Laser Assisted New Attachment Procedure [9].

Erbium laser

Erbium lasers can be categorized into two types based on their wavelength: lasers made of yttrium aluminum garnet (Er: YAG) and yttrium scandium gallium garnet (Er: Cr: YSGG) are also available. Erbium wavelengths in dental lasers have the most water absorption and the largest affinity for hydroxyapatite. It is therefore the preferred laser for treating dental hard tissues. Erbium lasers can be utilized for both hard tissue and soft tissue operations since dental soft tissue contains a lot of water [10].

Mechanism of laser action

Laser light has a single wavelength and is monochromatic in nature. An energy source, an active lasing medium, and two or more mirrors that collectively make up an optical cavity, or resonator, make up its three primary parts. An electrical current, an electrical coil, or another pumping mechanism provides energy for the laser system to be amplified. An active material in an optical resonator absorbs this energy, which results in the spontaneous emission of photons. After photons have been bounced back and forth across the medium by the optical resonator's highly reflective surfaces and before they leave the cavity through the output coupler, stimulated emission is utilized to boost them. In dental lasers, laser light is transmitted from the laser to the target tissue using a fiber optic cable, hollow waveguide, or articulated arm. A cooling system, focusing lenses, and other controls round out the system [11]. The active medium, which can be a gas, crystal, or solid-state semiconductor, determines the laser's wavelength and other features primarily through its composition.

A laser's light energy can interact with a target tissue in four ways [11]—transmission, Absorption, Scattering, and Reflection. Depending on the amount of water in the tissues, when a laser is absorbed, it raises the temperature and creates photochemical effects. Ablation vaporizes the tissue's water when a temperature of 100°C is attained. Proteins start to denature at temperatures above about 60°C, below 100°C but above about 60°C without vaporizing the underlying tissue. On the other hand, at temperatures higher than 200°C, the tissue gets dried up before burning, which causes a negative side effect known as carbonization [11]. Chromophores—light absorbers with a specified affinity for particular light wavelengths—are necessary for absorption. Water and Hydroxyapatite are the main chromophores in dental hard tissues, whereas Melanin, Hemoglobin, and Water are the main chromophores in intraoral soft tissue. Because different laser wavelengths have varying absorption coefficients regarding these fundamental tissue elements, the laser selection technique relies on this [12].

Treatments of laser in dentistry

Soft tissue laser procedures

Lasers can be used for a variety of soft tissue procedures, including wound healing, the treatment of aphthous ulcers and post-herpetic neuralgia, photodynamic therapy for cancer, aesthetic gingival re-contouring and crown lengthening, exposing immature and partially erupted teeth, removing inflamed, hypertrophic tissue, and removing various tissues [13].

Compared to conventional procedures like electrosurgery, these have two important advantages: less intraoperative bleeding and postoperative pain. The extent of tissue absorption determines the laser's effect on soft tissues. In this regard, water and hemoglobin in oral tissues are crucial for effectively absorbing many widely used dental lasers [14]. Specific procedures in individuals with bleeding disorders are more effectively performed using lasers with better hemostasis properties.

Hard tissue laser procedures

Photochemical effects

High-intensity visible blue light (488 nm) produced by the argon laser can start photopolymerizing materials used in light-cured dental restorations that use camphorquinone as the photoinitiator. Additionally, root surface dentine and enamel's surface chemistry can both be changed by argon laser radiation, which lowers the likelihood of recurrent caries [15].

Cavity preparation, caries, and restorative removal

According to various studies, Er: YAG has been used since 1988 to remove caries in the enamel and dentine by ablation without negatively affecting the pulp's temperature and even without water cooling. These devices are similar to air-rotor devices except that the cavity's floor is not as smooth [16]. Glass ionomer, composite resin, and cement can all be removed with the Er: YAG laser.

Treatment of dentinal hypersensitivity

Dental hypersensitivity is among the most often reported problems in clinical dentistry. The effectiveness of desensitizing hypersensitive dentine using an Er:YAG laser and the longer duration of a good response in comparison to other treatments are demonstrated by comparing the desensitizing effects of an Er:YAG laser to those of a traditional desensitizing device on cervically exposed, hypersensitive dentine [17].

Etching

Laser etching has been compared to acid etching of enamel and dentine. Surfaces of enamel and dentine etched with the (Er, Cr: YSGG) laser show minute flaws and lack a smear layer [18]. After Er:YAG laser etching, dental hard tissues adhere less effectively than after traditional acid etching.

Nerve repair and regeneration

Low-level laser therapy has been proven to speed up neuronal maturation and regeneration after injury and decrease the amount of inflammatory mediators from the arachidonic acid family produced by the injured nerves [19]. Daily radiation is typically administered during LLLT operations for extended periods of time, such as 10 days at 4.5 J each day [19]. In terms of fostering the regeneration of inferior dental nerve (IDN) tissue that has been harmed during surgical operations, results from the direct use of this technology in dentistry have proven promising.

The safety of laser

Despite the fact that the majority of dental lasers are quite simple to use, several safety precautions should be followed to ensure their efficient and secure use [20]. Everyone who is close to the laser while it is active must first put on safety glasses. This comprises the patient, the doctor, any assistant on the patient's side, and any onlookers like relatives or friends. Every piece of protective eyewear worn must be wavelength-specific. Additional measures to prevent unintentional exposure to non-target tissue include restricting access to the operating room, removing reflective surfaces, placing warning signs outside the nominal hazard zone, and checking that the laser is in good working order with all manufacturer safeguards in place. Any vapor plume produced during tissue ablation should be removed with high-volume suction, and standard infection measures should be adhered to in order to prevent exposure to harmful bacteria. A specialized laser safety officer should be assigned to each office to oversee the proper use of the laser, organize staff training, monitor the donning of safety goggles, and be educated about any relevant laws.

Conclusion

After decades of research up to this point, the state of laser technology for use in hard and soft tissue surgery is highly developed, and additional developments are still feasible. Additional uses for laser-based photochemical processes are pretty promising, especially for focusing on specific cells, pathogens, or chemicals. The use of both diagnostic and therapeutic laser treatments is anticipated to rise further in the future. In the coming ten years, particular laser technologies will be expected to become indispensable parts of modern dental practice.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: None

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