IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

LASERS IN CONSERVATIVE DENTISTRY

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ABSTRACT

Lasers are without a doubt one of the most promising technologies in the field of dentistry . Numerous scientific publications have appeared in the literature over the last two decade s concerning laser equipment and its applications in the field of dental medicine. Laser equ ipment is now widely available on a large scale. The article examines laser applications in c onservative dentistry and specifies the clinical significance of lasers in each application.

KEYWORDS: Argon, CO2, Er: YAG, Nd: YAG, Laser, conservative, dentistry, patients.

INTRODUCTION

The acronym LASER stands for 'Light Amplification by Stimulated Emission of Radiation' [1]. In 1953, Hard Townes and Arthur L. Schawlow created a "MASER Optic" (Microwave Amplification by Stimulated Emission of Radiation). In 1961, W.R. Bennet and D.R. Herriot [2] developed the first laser using Helium-Neon. In 1964, C.K.N Patel created the first CO2 laser. In 1968, Romania produced the first CO2 and Nd laser. The first laser beam was created by Maimane using a ruby rod. In 1961, Javan et al. described the first gas and continuously operating laser. Goldman et al. introduced the first laser into the fields of medicine and dentistry in the 1960s, but the thermal damage was too great to consider this laser as a clinical instrument [2].

Light is a type of electromagnetic energy that exists as a particle and travels at a constant velocity in waves. The fundamental unit of this radiant energy is known as a photon; the wave of photons travels at the speed of light and is defined by two fundamental properties. The first is amplitude, which is defined as the wave oscillation's vertical height from the zero axis to its peak. This is related to the amount of energy in the wave: the greater the amplitude, the more energy that can do useful work. A joule is a unit of energy; a millijoule, which is one thousandth of a joule, is useful in dentistry. The wavelength of a wave is defined as the horizontal distance between any two corresponding points on the wave. This measurement is critical in terms of both how the laser light is delivered to the surgical site and how it interacts with the tissue. Wavelength is measured in metres, but dental lasers

have wavelengths that are much smaller, measured in nanometres (10- 9 metres) or microns (10-6 meters.) As the waves travel, they oscillate several times per second, which is known as frequency. The frequency is proportional to the wavelength: the shorter the wavelength, the higher the frequency [3].

A laser is a device that converts light of various frequencies into chromatic radiation in the visible, infrared, and ultraviolet regions, with all waves in the phase capable of mobilising enormous heat and power when focused at close range [4].

It emits light using a technique known as stimulated emission, which involves collimated (parallel) and coherent (temporally and spatially constant) electromagnetic radiation of a single wavelength. When laser light enters biological tissues, it can be reflected, scattered, absorbed, or transmitted to the surrounding tissues. Because wavelength emission primarily influences these modes of interaction in the target tissue, it must be chosen with caution for any diagnostic or therapeutic interventions [5].

Amplification is a process that takes place inside the laser. Understanding how light is produced can be aided by identifying the components of a laser instrument. At the heart of the device is an optical cavity. The active medium is made up of chemical elements, molecules, or compounds that make up the cavity's core. Lasers are named after the active medium material, which can be a gas container, a crystal, or a solid-state semi-conductor. An excitation source, such as a flash lamp strobe device, an electrical circuit, or an electrical coil, surrounds this core and pumps energy into the active medium. There are two parallel mirrors, one at each end of the optical cavity; or, in the case of a semi-conductor, there are two polished surfaces at each end. These mirrors serve as resonators, helping to collimate and amplify the developing beam. The mechanical components are completed by a cooling system, focusing lenses, and other controls [6].

Stimulated emission is a process that occurs within the active medium as a result of the pumping mechanism, and it was proposed by Albert Einstein in 1916.

The light waves produced by the laser are a type of radiation, or electromagnetic energy. The electromagnetic spectrum encompasses the entire range of wave energy, from gamma rays with wavelengths of 10-12 metres to radio waves with wavelengths of thousands of metres [7].

TYPES OF LASERS

The laser systems developed to date have been classified based on the active medium that is stimulated to emit photon energy. This categorises laser systems as solid state (Nd: YAG, Er: YAG, Er, Cr: YSGG), gas (CO2, Argon, Helium, Neon), diode, excimer, and dye. Laser systems are also classified based on their maximum output level, which can be low (soft) or high (hard) (hard). Lasers can also be classified based on their mode of oscillation (continuous or pulsed wave). The pulsed wave mode can be used to generate independent pulses (a free running pulse), as seen in the Nd: YAG, Er: YAG, and Er, Cr: YSGG lasers, or to

interrupt a continuous wave (gated or chopped pulse), as seen in the CO2 laser and the diode lasers [5].

CLINICAL APPLICATIONS

Applications of Laser in Restorative Dentistry

Prevention of caries

Using a CO2 laser, energy is absorbed and converted into heat in a few micrometres of the external enamel surface. Carbonate loss from the mineral and fusion of hydroxyapatite crystals occur, reducing interprismatic spaces and increasing acid resistance, providing a caries-preventive effect. [25]

Diagnosis

Lasers can detect pre-cancerous lesions that cannot be diagnosed clinically or radiographically. This is accomplished through the use of transillumination. Laser-induced fluorescence, or quantitative measurement of the fluorescence emission pattern, has been used in the assessment of caries. [26,27]

ETCHING AND BONDING

Er: YAG laser etching appears to be a viable alternative to acid etching, with similar effects on enamel and without the negative effects of phosphoric acid. 7 Irradiation with a diode laser increases the micro tensile bond strength of adhesive systems to dentin. [29]

CURING OF COMPOSITES

Curing composites can also be done with a laser, which has a greater depth of curing than halogen light. The argon laser has been demonstrated to be effective in the polymerization of dental resins. [29]

BLEACHING

Lasers are also used to bleach both vital and non-vital teeth. The laser is used to boost the bleaching material's effectiveness. [30]

APPLICATIONS OF LASER IN ENDODONTICS

PULP DIAGNOSIS

LDF was developed to assess blood flow in microvascular systems, but it can also be used to diagnose blood flow in the dental pulp. This novel technique made use of a light beam generated by a He-Ne laser and a diode laser at a low power of 1 or 2 Mw. [31]

DENTINAL HYPERSENSITIVITY

A low output laser can be used to irradiate the electric activity of nerve fibres within the dental pulp to treat dentinal hypersensitivity, whereas a high-power laser can be used to melt and fuse the dentinal tubules. [32]

PULP CAPPING AND PULPOTOMY

After irradiation at 2 W for 2 seconds, lasers aid in pulpal healing. In human patients, CO2 laser was found to be a valuable aid in direct pulp capping. [31]

CLEANING AND SHAPING THE ROOT CANAL SYSTEM

When compared to conventional techniques, the Nd: YAG laser improved canal wall cleanliness. The Er: YAG laser is used to clean the canal in photoinduced photoacoustic streaming (PIPS). [31]

ROOT CANAL OBTURATION

The Argon, CO2, and Nd: YAG lasers have all been used to soften gutta-percha, and the results show that the Argon laser can be used to produce a good apical seal. [32]

ENDODONTIC PERIAPICAL SURGERY

The use of laser in endodontic periapical surgery has several advantages, including improved haemostasis and concurrent visualisation of the operative field, potential sterilisation of the contaminated root apex, potential reduction of root surface dentin permeability, and a reduction in postoperative pain. [31]

ADVANTAGES AND DISADVANTAGES OF LASERS

ADVANTAGES

• They are frequently less painful, which reduces the need for anaesthesia.

• Some people are afraid of the standard drill. They feel more at ease around lasers.

• When dealing with soft tissue, lasers reduce swelling and bleeding.

• Lasers aid in the retention of more of the intact tooth during cavity treatment.

DISADVANTAGES

• It is not possible to use a laser on a tooth that has already had a filling, and the treatments for which lasers can be used are extremely limited.

• They cannot be manoeuvred around cavities between two teeth or around larger cavities that require the placement of a crown.

• They also cannot be used to remove old fillings, silver fillings, or damaged crowns. Laser technology is also ineffective in preparing teeth for bridge placement.

• Even when a laser is used, a conventional drill is still required for bite adjustment as well as shaping and polishing the filling.

• While laser can reduce the need for anaesthesia, it cannot completely eliminate it.

Other uses of Lasers in Dentistry

Lasers have been used as an adjuvant treatment in endodontics, both in low-intensity laser therapy and in high-intensity laser treatment, to improve the outcome of clinical procedures. The clinical use of a low-intensity laser in endodontic therapy has been thought to be useful in post-pulpotomy (with the laser beam being applied directly to the remaining pulp and on the mucosa towards the root canal pulp); post-pulpectomy (with apical irradiation); and periapical surgery (irradiating the mucosa of the area which corresponds to the apical lesion and the sutures).High-intensity lasers such as Nd: YAG (neodymium: yttrium, aluminium, garnet), Ho: YAG (holmium: yttrium, aluminium, garnet), Er: YAG (erbium: yttrium, aluminium, garnet), Excimer, CO2 (carbon dioxide) and diode have been recommended successfully as adjuvant methods in the endodontic treatment of contaminated canals, to remove bacteria from the root dentinal surfaces as well as from the deep dentinal layers. High-intensity lasers such as Nd: YAG (neodymium: yttrium, aluminium, garnet), Ho: YAG (holmium: yttrium, aluminium, garnet), Er: YAG (erbium: yttrium, aluminium, garnet), Excimer, CO2 (carbon dioxide) and diode have been recommended successfully as adjuvant methods in the endodontic treatment of contaminated canals, to remove bacteria from the root dentinal surfaces as well as from the deep dentinal layers. In addition, using lasers to replace aerosol-producing handpieces in periapical surgery can reduce the risk of blood-borne pathogen contamination of the surgical environment. The following are the unique properties of laser light as they relate to endodontic surgery: precision; coagulation; decreased postoperative pain, oedema, and scarring; sterilisation; and selective absorption. [21-24]

Laser scanning, holography, and soft and hard tissue applications are the most common uses of lasers in orthodontics. Laser therapy can help with plaque gingivitis, which is caused by the retention of bacterial plaque in orthodontic patients. The CO2 and Nd: YAG lasers have been reported as having been tested in this regard, and have proven their ability to destroy bacterial plaque. [20-24]

Conclusion

New methods of performing certain dental procedures will continue to replace those that were once thought to be the pinnacle as dental technology evolves. While some practitioners are aware of this new technology, others continue to advocate for traditional instruments. In the past, there were many reasons for a patient to avoid dental treatment: not understanding the necessity of a treatment, psychological discomfort, and economic and social factors; however, the fact that the most significant issue was "fear of pain" was rarely discussed. When the knowledge of the parameters required for an ideal treatment

becomes a reality, lasers can be developed, allowing dentists to care for their patients with improved techniques and equipment.

"Any advancement in technology should be for the benefit of humanity, and I fear the day when technology surpasses humanity," Albert Einstein said. To provide the best therapeutic effect to our patients, we as dental practitioners must be well-versed in the principles of laser application.

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