Review Article

Lasers in Dentistry

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ABSTRACT

Lasers are an up and coming technology in the field of dentistry. Various studies are being conducted *in vitro* as well as *in vivo* to study the effects and benefits of lasers for various dental procedures including endodontic disinfection, bleaching, apicocectomy, caries removal, and soft-tissue surgeries. This article highlights the working and mechanism of action of laser and its use in various fields of dentistry.

Key words: Cavity preparation, bleaching, non-carious cervical lesions

INTRODUCTION

The first lasers were developed in 1964 and, almost immediately, it became evident that it was a novel discovery. The evolution of the use of lasers in medicine occurred initially within the fields of ophthalmology, dermatology, and general surgery.[1] The presentation of lasers in endodontics has radically improved the viability and achievement pace of root waterway treatment. Lasers give more noteworthy availability to already inaccessible parts of the canal because of their better infiltration into dentinal tissues.[2]

The laser light, when decreased in its energy yield to a low level, can be utilized for mending of tissue and fix, cutting in a medical procedure, contracting tumors, unblocking impeded arteries, destroying contaminations, and other remedial purposes.[3]

Low-level laser may also be implemented for treating dentinal hypersensitivity. It works by biostimulation because of the increase in production of mitochondrial adenosine triphosphate (ATP), increasing the threshold of the free nerve endings, providing an analgesic effect.[3]

Hard tissue lasers were developed in the 1990s. These hard tissue erbium lasers can plane enamel, dentin, caries, cementum, and bone alongside cutting delicate tissue. The capacity of hard tissue lasers to diminish the vibrations, the perceptible cry of drills, microfractures, and the inconvenience that numerous patients dread is noteworthy when compared to airotors.[1]

Laser and physics behind it

Laser works by two fundamental cycles: Absorption and emission. At the point, when a particle retains a photon, this energy elevates an electron to a more lively state. While producing a photon, an atom ousts energy. A third and equally important process for atomic systems needs to be considered: The stimulated emission. If a molecule is in an excited state, it is not in a stable condition and the molecule will eventually return to its fundamental state. The amount of time that the system stays in the excited state is called the "lifetime" of the excited state. In invigorated emission, if a photon "passes close by" an energized atom, it can actuate an electrical irritation (this fills in as a "seed") that animates the framework to radiate an indistinguishable photon. The animated photon is known as the "twin" of the seed photon. The two of them have a similar energy; hence, their frequencies and wavelengths are indistinguishable and they leave the nuclear framework with a similar course and they move as one in space. In the event that the conditions are right, every one of the two coming about photons from the animated discharge will disturb other energized molecules, advancing more invigorated emissions. So then, there is a chain of invigorated emissions. These stimulated emissions are subsequently amplified, and this amplification of the stimulated emission is what results in laser light generation.[4]

HIGH-POWER LASERS AND THEIR INTERACTION WITH BIOLOGICAL TISSUES

High-power lasers are the ones that give rise to an intensity equal to or higher than 1 W/cm^2; these lasers increase tissue temperature by 1°C or more and cause coagulation, cutting, vaporization, or ablation of tissues.[4-6]

The interaction of laser light with biological tissues results in the either of these phenomenon's: Reflection, scattering, absorption, and transmission.[4-6]

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Effects on soft tissues

An increase of about 5°C is enough to cause changes in bonds and to alter the cell walls, and there is a linear relation between temperature and the tissue changes [Table 1].[4-6]

Effects on hard tissues

The tooth is made out of enamel, dentin, mash, and cementum, and the principle constituent is hydroxyapatite.[7,8] Dentin and cementum have a higher water and natural compound rate contrasted with enamel and are in this manner more helpless to heat retention than enamel.[9]

Because of the creation of hard tissues, lasers that emanate in the infrared area, such as CO2 (9600 nm), Er: YAG (2940 nm), and Er,Cr: YSGG (2780 nm), are the best contender for cutting enamel, dentin, and bone.[10,11]

Erbium lasers cut dental hard tissues by a process called thermal ablation. This mechanism is also called as explosive tissue removal that is water mediated. This occurs as the aftereffect of the quick warming of the sub-surface water present underneath the hard tissue framework that consequently assimilates infrared laser light. The warming of these water particles expands their sub-atomic vibration and therefore the sub-surface pressure. At last, a "blast" of tissue brings about the removal of tooth material.[10,11]

LOW-LEVEL LASER THERAPY

At the point, when lasers illuminate the tissues, energy is dispersed through the living framework and this energy should be consumed by the tissues to get wanted outcomes. The essential systems of low-level laser treatment are not actually known, considers recommend that it can keep away from death and increment cell expansion and motility.[12]

What's more, expanded use of ATP,[13] expanded cell membrane openness to Ca2+, regulation of development components and cytokines, incitement of cell separation and expansion, prompted blend and redesigning of collagen, expanded rigidity, angiogenesis, and help with discomfort, have been accounted for.

SAFE USE OF LASER TECHNOLOGY

ANVISA,[14] through resolution 2/2010, regulates "the management of health technologies used in the provision of health services, to ensure their traceability, quality, efficiency, effectiveness and security, and, where applicable, performance, from their entry into the healthcare facility to their final destination, including the planning of physical, human, and material resources, as well as professionals involved in these proceedings".

- The laser must only be used within a controlled environment
- Care ought to be taken to keep away from unexpected specular reflections
- The laser bar optical way should end in the objective region, utilizing a diffuse material
- Eye assurance is required if there is any likelihood that the beam could be seen, straightforwardly or in a roundabout way, from a distance of under 13 cm
- A normalized cautioning sign ought to be fixed at the passageways to the controlled region instructing the presence with respect to laser light
- The beam directions should be protected at whatever point doable
- If potential lasers should be worked by controller
- Ambient lighting ought to be expanded when eye security weakens apparent light, utilizing light hued divider surfaces and diffuse lighting, and staying away from specular reflection
- If plausible, the bar and target region ought to be encased in a material obscure to the frequency of the laser
- Wherever potential screens ought to be utilized to lessen the beam reflection directions.

Table 1: Effect of temperature on soft tissues

Temperature	Primary effect	Secondary effect
37	None	None
42	Tissue heating	Destruction of some chemical bonds; changes in cellular membranes; necrosis of small areas
50	Reduction of enzymatic activity	Ablation of cells
60	Tissue denaturation	Coagulation, necrosis, bleaching of tissue
80	Changes in permeability of membranes	Destruction of chemical bond
100	Cutting, vaporization	Thermal decomposition
150	Carbonization	Darkening of the tissue (this can be avoided by the use of a coolant)
400	Melting	Fast incision

LASERS IN CONSERVATIVE DENTISTRY

The erbium lasers (Er: YAG and Er,Cr: YSGG) eliminate finish and dentin through a cycle called thermomechanical removal.[15,16] In this cycle, the laser energy is consumed by the water beneath the surface that is ensured by the hard tissue lattice, and this rapidly prompts "miniature blasts" that eliminate the mineralized tissue. The best piece of the energy is consumed by the removal cycle and just a little division may warm the nearby tissues.[17,18]

The impacts of laser illumination on mineralized tissues differ as per the synthesis of the tissue and the amount of water. The high amount of water inside the carious tissues builds the connection of the laser with the objective tissue, prompting a specific evacuation of carious tissue which brings about a more moderate cavity that follows the standards of minimal intervention dentistry.[18]

There are many benefits of using laser irradiation for cavity preparation instead of a high-speed drill.

The benefits are:

- Viability in selective caries removal and pit preparation[19,20]
- Great acknowledgment by the patients because of the shortfall of clamor and vibration, adding to a less agonizing/more agreeable treatment[19]
- In a few cases, there is no requirement for sedation[21]
- Bacterial reduction[22]
- Effects can be produced in the tissue fundamental the tissue being illuminated: These impacts are like those instigated by low force lasers – biomodulation and analgesia.[23]

MANAGEMENT OF NON-CARIOUS CERVICAL LESIONS

According to Eccles in 1982, tooth surface loss or tooth wear refers to the pathological loss of tooth tissue by a disease process other than dental caries. It is a term used to explain the combined processes of erosion, attrition, and abrasion.[24]

Various studies evaluating the impact of CO2 laser irradiation on their effect on enamel resistance to erosion elicited positive results.[25]

Desensitization with laser innovation relies on the kind of hardware utilized. Low-power lasers, which act by biomodulating cell reactions, will advance a decrease in torment levels by depolarizing nerve strands and the arrangement of tertiary dentin.[26]

DENTAL BLEACHING WITH LEDS AND LASERS

H_2O_2 is the bleaching agent used in all different types of bleaching methods and diffuses through the organic matrix of the enamel. During this cycle, the oxidizing agent responds with the natural material in the spaces between the crystals of the enamel and follows-up on the organic matrix of the dentin.[27] LEDs create least temperature increment that does not harm the pulpal tissue, as they just actuate the bleaching gel and not the dental structure.[28] Bleaching separates the larger particles of the shade that retains light and subsequently obscure teeth. During this cycle, more modest atoms are framed, which mirror light and have a bleaching effect, and consequently lessening the darkness of the shading.[29]

LASERS IN ENDODONTICS

The main goal of a successful endodontic therapy is to achieve complete disinfection of the root canal and periapical region.

The amalgamation of endodontic treatment and antimicrobial photodynamic therapy is a novel technique which includes a non-toxic photosensitizer (PS) and a harmless visible light source.[30]

These energized PSs react with the nascent oxygen to produce a species of reactive oxygen, which cause the death and injury of organisms.[31]

LASERS FOR APICOECTOMY

Various examinations have utilized various frequencies and power settings in root canal sanitization: The CO2 laser, Nd: YAG laser (1064 nm), high-power diode laser (810 nm), Er: YAG laser (2940 nm), and Nd: YAP laser (1340 nm), all show stamped bactericidal effect.[32,33]. High-power lasers, if utilized properly and at right setting for the objective tissue, lessen dentin porousness, permit preparation of cavity without vibration, and help with cleaning canal during instrumentation.[34,35]

TREATMENT OF THE PULP CHAMBER FLOOR

The furcation area has shown a higher pervasiveness of furcal channels in molars that prompt a correspondence of infectious by products of the pulp with the radicular area and periodontal tissues.[36] Irradiation of the pulp chamber floor and resulting use of cyanoacrylate *in vitro* tests showed a huge decrease in dentin permeability. This ended up being an exceptionally helpful methodology for keeping up sterilization around here.[37]

CONCLUSION

With the new developments in the field of dentistry happening almost every day, it is very important to know the mechanism, the advantages, disadvantages, and effects of the new technologies coming up.

Even though laser is a promising technology, it is not time tested. It may come up with unforeseen consequences. The available literature and clinical studies clearly suggest that there is still a long way to go to achieve mastery over the procedures and techniques. Most of the studies and experiments carried out are *in vitro* studies and their effects on human tissues are still not known. Hence, it is imperative to understand the pathophysiology of various clinical situations and their biological response and consequences of laser therapy on different tissues.

The ultimate success may also depend on easy availability and affordability by population at large as well as the available clinical expertise.

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