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Application of LASER in Periodontics: An Insight

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Abstract

The use of LASERs becomes getting more common in dentistry due to the availability of different systems. However, application of LASERs within the field of periodontics has created confusion regarding the use of LASERs. Hence the aim of this study is to review concept of application, advantages, disadvantages and clinical applications of LASERs within the field periodontics. *Methods:* A narrative review was undertaken by the author on LASERs in periodontics by searching Google scholar, Saudi digital library and PubMed data bases for publications on LASERs in periodontics. After reviewing the full text articles information on LASERs was reported. *Results:* A LASER device consists of several components and acts by different mechanisms such as Photothermal ablation, photomechanical ablation and photochemical effect. LASER application has many advantages when all the safety precautions were followed carefully. LASER technology has wide spread clinical application within the field of periodontics. *Conclusion:* There is a need to develop an evidence based method for the application of LASERs in the field of Periodontics. With continuously developing LASER technologies in the field of periodontics may require comprehensive information about the Lasers, and special expertise in the field.

Keywords: Implants; LASER; Periodontics; Photothermal; Photomechanical; Photochemical.

Introduction

At the last three decades, there has been a continuous development of dental devices using LASER "Light Amplification by Stimulated Emission of Radiation". The etiology of gingivitis and periodontitis and the modalities of treatment have shown major changes [1]. Periodontal disease includes host microbial interaction and other risk factors that contribute to the progression and severity of these diseases. Soft tissue LASERs are the first choice for microbial reduction and coagulation [2]. These properties enable them as an excellent choice to be used in advanced periodontitis casesthat has severely inflamed tissue and mixed bacterial infection [3].

LASER light is monochromatic (specific wavelength), directional (low divergence), and coherent (all waves are in a certain phase relationship to each other). These highly directional and monochromatic LASER lights can be delivered onto target tissue as a less continuous wave, gated-pulse mode, or free running pulse mode [4]. *Continuous waves:* The beam is emitted at one power level continuously as long as the foot switch is pressed. *Gated-pulse mode:* The LASER is in an on and off mode at periods. The duration of the on and off timer is in microseconds. *Free running pulse mode:* Very large LASER energy is emitted for an extremely short span in microseconds, followed by a relatively long time at which the LASER is off [5].

The scope of LASERs within the field of periodontics has widened as witnessed by rapidly increasing number of publications. Many different LASERs, such as diode, CO2, Nd: YAG, Er: YAG,

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and Er, Cr:YSGG have been developed and utilized in dental practice. On the other hand, dilemma regarding the use of LASERs within the field of periodontics prevails among the practitioners due to the presence of hard and soft tissues. Hence there is a need to address this issue by reviewing the basic concept and use of LASERs within the field of periodontics. Hence the aim of this study is to review concept of application, advantages, disadvantages and clinical applications of LASERs within the field periodontics.

Methodology

Study proposal was submitted and formal Approval for the study was obtained from the Research center of Riyadh Elm University (FRP/2018/195).

A narrative review was undertaken by theauthor on LASERs in periodontics by searching google scholar, Saudi digital library and pubmed data bases for publications on LASERs in periodontics. After reviewing the full text articles information on LASERs was reported.

Components of LASER devices

Components of LASER devices consisted of firstly LASER medium, which can be a solid, liquid or gas. Second LASERtube (medium) having two mirrors, one fully reflective and the other one partially transmissive, which are located at either end of the optical cavity. Thirdly the power sourcesatom in the LASER medium to higher energy levels.

The main action of LASERs on teethand bacteria depends on the absorption of LASER by tissue chromophore (water, apatite minerals, and various pigmented substances) within the target tissue.

The mechanisms of LASER action include

1. Photothermal ablation: when using high-powered LASERs, which used to vaporize or coagulate tissue through absorption in the tissue.
2. Photomechanical ablation: tissue destruction due to a range of phenomena, including shock wave formation, cavitation.
3. Photochemical effects: Using light sensitive substances to treat conditions such as cancer [6].

Advantages of LASER *[7]*

1. Minimal post-operative bleeding
2. Coagulate, vaporize, or cut tissue
3. Wound tissue sterilization
4. Swelling and scarring are minimal
5. No need for sutures
6. Minimal trauma
7. Less surgical time and post-surgical pain
8. High patient acceptance.

LASER safety

General safety requirements include LASER warning sign outside the clinic, use of barriers within the operatory, and the use of eyewear to protect against reflected LASER light or accidental direct exposure. High volume suction must be used to evacuate the plume from tissue ablation. Several authors have studied the thermal effect of LASERs on the periodontal ligament and surrounding bone. Hence, periodontal tissues are not damaged if the temperature increase is kept below 5°C. A threshold temperature increase of 7°C is commonly considered as the highest thermal change, which is biologically acceptable to avoid periodontal damage [8].

LASER hazards

Primary hazards: caused directly by LASER beam which affect the eyes leading to damage to retina, cornea, lens and slight carelessness can destroy vision permanently.

Secondary hazards: it is related to the operation of the LASER and are independent of radiation characteristics [9].

Operating room safety

Patient safety

1. Use of non-inflammable materials
2. Use of eye shields for the patients
3. Use of LASER resistant shielding materials for surgical field and for protecting anesthesia equipment
4. Certain anesthesia technique may also decrease potential hazard

Personal safety

1. Post signs that LASER being used
2. Eye shield to be worn by all personnel in operating room

3. Safety shields must be used
4. A LASER safety officer should be stationed at the LASER unite
5. Use only wet cloth in operative field
6. Use only non-combustible anesthetic agent
7. Avoid alcohol based topical anesthesia and gauze
8. Protect tissues adjacent to surgical site [10]

Clinical Applications of LASERs in Periodontal Therapy *[11-16]*

1. Abscess treatment
2. Aphthous ulcers and herpetic lesion
3. Crown lengthening
4. Biopsy removal
5. Frenectomy and frenotomy
6. Gingival incision and excision
7. Hemostasis
8. Sulcular debridement
9. Tissue retraction (Troughing)
10. Subgingival scaling

Capability of LASER to remove calculus from periodontally involved root surfaces, although the effectiveness did not reach that achieved by hand instrumentation. The lack of cementum removal in contrast to SRP may qualify the LASER as an alternative approach during supportive periodontal therapy.

LASER and Photodynamic therapy

The newest therapeutic approach to eradicatethe bacterial pathogens in periodontal infection is photodynamic therapy. Killing of bacteria using photodynamic therapy has been defined as either antimicrobial photodynamic therapy (aPDT), photodynamic antimicrobial chemotherapy (PACT) or photodynamic disinfection [17].

Using aPDT requires a photosensitizer material, light and oxygen. The photosensitizer reacts to targeted microorganism and stimulated by light LASER in the presence of oxygen. Photoinactivation of microbes is limited to the localization of the photosensitizer, ensuring the protection of distant cells from side-effects. Because of the fact that traditionalperiodontal therapies such as scaling and root planning does not eliminate periodontal microfloracompletely, especially in deep pockets, a PDT may be considered to be an alternative therapeutic modalities [18].

Mechanism of action

It is based on the principle that the photosensitizer (or photo-activatable substance) binds to the targeted cells and then can be activated by light of the appropriate wavelength in the presence of oxygen. This results in the generation of singlet oxygen and free radicals, which are extremely toxic to certain bacteria [19].

Disadvantages [20].

1. Probable toxicity of the photosensitizer to periodontal tissues.
2. Most of the dyes used in aPDT adhere strongly to the soft tissue surface of the periodontium, causing retention of the dyes in the pocket which has negative effect on healing.
3. Temporary pigmentation of the periodontal tissue

Advantages [21]

1. This new strategy of using PDT is less traumatic & quicker in the treatment of inflammatory periodontal diseases.
2. Photodynamic therapy in vitro studies have shown greater (> 95%) reduction in micro-organisms.
3. PDT offers numerous advantages, particularly in avoiding emergence of antibiotic resistance species, requiring less technical skills & reducing operating time in comparison to manual scaling and root planning.
4. Well-designed clinical trials are needed for proper evaluation of this therapy. Multi discipline clinical trials should be designed to establish the clinical evidence based effectiveness of PDT in periodontal, endodontics and even orthodontic treatment.

Application of LASERs in implant dentistry

Erbium-doped yttrium-aluminium-garnet lasers showed adequate capability of bacterial decontamination from the surface of titanium implants in invitro studies. Whereas carbon dioxide and gallium-aluminium-arsenide diode lasers showed varied ability to produce bacterial decontamination, the bacterial sensitivity based on the species involved [22]. With the increasing number of edentulous patients undergoing implant treatment occurrence of peri-implantitis has been increasing continuously. Recent advances in the LASERs (Er:YAG and Er, Cr:YSGG) have shown more advantageous in removing calcified deposits on the surface of titanium implants without causing

any damage, compared to mechanical therapy or titanium curette [23].

Conclusion

There is a need to develop an evidence based method for the application of LASERs in the field of Periodontics. With continuously developing LASER technologies in the field of periodontics may require comprehensive information about the LASER, and special expertise in utilizing LASER in periodontics. In addition further studies are needed to evaluate clinical parametersof success between manual and LASER treatments.

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