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Review Article

Clinical Applications of Lasers in the Oral Cavity

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Abstract

The application of this light energy results in the modification or removal of tissue. Various parameters such as laser wavelength, energy level, mode of application and tissue characteristics will influence the effect of a particular laser on the tissue. With the advent of new technology lasers have taken the sheen away from scalpel particularly in most oral surgical procedures. The advantages of using the laser, however, are balanced by several significant disadvantages. However, if used safely and properly it can be a great tool to provide a modern and advanced oral health care. This article emphasizes on the principles of laser science, tissue interaction, types of lasers and their numerous clinical applications in the oral cavity.
Keywords: lasers, biostimulation, Photodynamic Therapy.

INTRODUCTION

A laser is a device with an active medium consisting of solid, liquid or gaseous substances which produces a light beam when excited by a source of energy [1, 2]. The radiation involved in generating laser light is nonionizing and does not produce the same effects attributed to X-radiation. The degree of light absorbed into the target tissue is based on the wavelength of the light [3]. The deeper the laser energy penetrates, the more it is scattered and distributed throughout the tissue. Once the light from lasers is absorbed, it is converted into heat. The thermal effects of heat generated depend on tissue composition and the duration the beam is focused on the target tissue [3, 4]. The duration of exposure determines the temperature change that causes the tissue alteration in terms of structure and composition. These changes may range from denaturation to vaporization and carbonization, and even melting followed by recrystallization in the case of hard tissue [3, 4]

Types of lasers

Lasers are categorized primarily into two types. High power lasers or surgical lasers have

photothermal effects with cutting, vaporization and hemostasis properties while low power lasers or therapeutic lasers have analgesic, anti-inflammatory and biostimulation properties [1, 2]. Lasers can also be categorized into hard lasers and soft laser (cold lasers). Hard lasers offer both hard tissue and soft tissue applications, but they are expensive and possess a potential for thermal injury. These include Carbon dioxide (CO_2), Neodymium Yttrium Aluminum Garnet (Nd: YAG), and Er: YAG laser. Soft lasers are predominantly used for applications. They are compact and economical. They are semiconductor diode devices which are broadly termed as low-level laser therapy (LLLT) or 'biostimulation [5, 6]. Depending upon the efficiency, specificity, comfort, and cost over the conventional modalities, lasers are indicated for a wide variety of procedures in the oral cavity.

Dental caries

While laser fluorescence has demonstrated good sensitivity and excellent reproducibility for detecting caries along with the removal of caries and cavity preparation without causing significant thermal effects. However, it is not able to quantify the extent of decay [7]. Er-based laser system can achieve effective ablation at temperatures well below the melting and vapourization temperatures of enamel [8].

Dentinal hypersensitivity

Dentinal hypersensitivity is one of the most common complaints in clinical dental practice. Comparison of the desensitizing effects of an Er: YAG laser with those of a conventional desensitizing system on cervically exposed hypersensitive dentine revealed that desensitizing of hypersensitive dentine with an Er: YAG laser is effective, and maintenance of a positive result is more prolonged than with other agents [9].

Recurrent aphthous stomatitis

Recurrent aphthous stomatitis (recurrent aphthous ulcers, canker sores) comprises a group of chronic, inflammatory, ulcerative diseases of the oral mucosa [10]. They present as three different clinical variants: Minor RAS, major RAS, and herpetiform ulcerations [11]. Treatment of RAS is symptomatic, the prime goal being to relieve pain and enhance the healing process. It may be accomplished by the usage of topical agents, systemic and topical steroids, cauterization, antibiotics, mouth rinses containing active enzymes, etc., but none of them have been proven to be efficacious [12]. When it is delivered in appropriate dosage, energy of the photons from the Low Level Laser Therapy (LLLT) is converted into photochemical, photophysical, and photobiological effects. These effects include lymphocyte stimulation, activation of mast cells, and also the proliferation of various types of cells such as fibroblasts and macrophages. All these factors synergistically promote anti-inflammatory effects and bio stimulatory effects, thus enhancing wound healing [1, 2]. Secondary clinical effects associated with LLLT are a decrease in the levels of histamine, bradykinins, and substance P, which reduces the inflammation [13]. This effect was clearly evident as the erythematous halo surrounding the ulcers had completely resolved by the 3rd day post LLLT [1]. In addition to its role in the management of RAS, it has a wide spectrum of clinical applications which include herpes labialis, angular cheilitis, trismus, paresthesia, dentine hypersensitivity, temporomandibular joint pain, and in the postoperative phase [14].

Frenectomy

A high labial frenal attachment would compromise the health of the gingiva by not permitting proper placement of a tooth brush resulting in poor oral hygiene practice and by muscle pull leading to opening of the gingival sulcus eventually leading to gingival recession and midline diastema, which may be of high esthetic concern and sometimes leading to speech difficulties [15, 16]. Few studies compared the mean VAS scores for discomfort associated with speaking and chewing, on the 1st, 3rd and the 7th day following frenectomy by conventional scalpel. These studies revealed a significant difference of the VAS scores of discomfort associated with chewing and speaking between both groups on the 1st, 3rd and the 7th days, with the laser group displaying significantly lower VAS scores [16]. The decreased pain and discomfort in the laser group might be attributed to the protein coagulum formed over the wound, which acts like a biological dressing, aids in sealing of the ends of sensory nerves.[17] In addition, absence of any sutures post the laser procedure might have contributed to lesser discomfort levels. Ankyloglossia is a rare congenital oral anomaly characterized by an abnormally short and thick lingual frenum that interferes with the normal movements of the tongue resulting in impairment of its physiological functions [18]. Suturing on the ventral surface of the tongue following a scalpel frenectomy may occasionally cause blockage of Wharton's duct. In addition to this, surgical manipulations on the ventral part of the tongue may also damage the lingual nerve and cause numbness of the tongue tip. These surgical challenges are better handled by the use of a diode laser [18]. The thermal effect of laser helps in sealing of capillaries by protein denaturation and stimulation of clotting factor VII production. This reduces the postoperative bleeding and edema [19, 20]. Few authors put forth the following advantages of laser over scalpel in performing frenectomy: (1) Efficient soft tissue cutting due to a clear operative field provided by achieving hemostasis; (2) eliminates the requirement of sutures; (3) less operating time; (4) brisk chance of postsurgical infection eliminating the need for postoperative antibiotics; (5) decreased wound contraction and scarring; we suggest laser as an ideal tool in the management of ankyloglossia [18-20].

Root canal treatment

The clinical application of lasers in aiding root canal disinfection is more promising than for root canal preparation. For disinfection, laser energy can be used directly or in combination with a photosensitive chemical that, when bound to microorganisms, may be activated by low-energy laser light to essentially kill the microorganism. The propagation of acoustic waves emanating from a pulsed-low energy laser may aid in distributing disinfecting solutions more effectively across the root canal system [21]. Root canal spaces are generally curved. Instruments used to clean the canal space throughout its length are flexible and follow the curvatures in a tooth root. In contrast, laser light will travel in a straight path [22]. Root canal preparation using laser light has not been proven to be more effective than mechanical shaping. Further, the interactions involved between laser energy and the tissue can cause a rise in temperature [23]. The increased temperature can char the canal space, damaging it to the point that the tooth may be lost. The increased temperatures may also be transmitted to the outer surfaces of the tooth, damaging the periradicular tissues [24].

Laser assisted curettage

Both the Nd:YAG and gallium-arsenide (or diode) lasers are very frequently used for curettage [3]. However, literature is replete with articles emphasizing that there is no added benefit to the patient when this procedure is performed after traditional mechanical scaling and root planning [25]. Second school of thought justify the use of laser assisted curettage with the thought that lasers kill the micro-organisms. With no demonstrable benefit and with a significant risk of collateral damage to the periodontium, laser curettage appears to be neither scientifically nor ethically justified [3].

Aesthetic gingival re-contouring and crown lengthening:

With the advent of the diode laser, many clinicians include optimization of gingival aesthetics as part of the comprehensive orthodontic treatment since conventional gingivectomy is associated with pain, discomfort, and bleeding [26].

In orthodontics

An impacted or partially erupted tooth that requires exposure for bonding by conservative tissue removal can be facilitated by a laser. The procedure with laser is painless, in addition to having no bleeding thereby facilitating an attachment to be placed immediately [27]. Isolated areas of transient tissue hypertrophy can easily be excised with the diode laser. It can be easily used to remove tissue that has overgrown mini-screws and appliances as well as for replacing a tissue punch if needed when placing mini-screws in the unattached gingiva [28].

Vestibuloplasty

Vestibuloplasty is a mucogingival procedure that aims at the surgical modification of the gingiva-mucous membrane relationships including deepening of the vestibular trough, altering the position of the frenulum or muscle attachments, and widening of the zone of attached gingiva [29]. Studies reported that the use of low level laser therapy enhances phagocytic activity by macrophages and also results in mast cell degranulation. These put together result in an effective wound debridement with reduction in the slough at the surgical area [29, 30]. Laser treated wound exhibits less scar formation due to a few number of myofibroblasts resulting in a minimal wound contraction compared with the scalpel wound [31]. Hence, it was observed that patient treated with lasers had a good vestibular depth due to less tissue rebound, whereas the patients treated with scalpel exhibited a poor outcome owing to more tissue rebound resulting in a poor vestibular depth post the surgical procedure.

Soft tissue excisions

Lasers can be used effectively for the surgical management of soft tissues growths in the oral cavity. Peripheral giant cell granulomas are generally treated surgical by wide local excision down to the underlying bone with the aid of conventional scalpel, electrocautery, radiosurgery or lasers. Though electrocautery and radiosurgery cause less bleeding and increase the visibility in addition to being less invasive than the conventional scalpel, lasers avoid the needle infiltrated anesthesia which is generally appreciated by many patients [32, 33]. CO2, Nd:YAG, Helium-neon and excimer are the various soft tissue lasers that can be used for soft tissue excision. They showed deleterious effects on the irradiated tissue by causing compositional changes. However, Er, Cr:YSGG laser keeps the tissue healthy with minimal carbonization and charring than the other laser groups [34].

Malignancies

Photodynamic therapy (PDT), is employed in the treatment of malignancies of the oral mucosa. It damages the cells and the associated blood vascular network, triggering both necrosis and apoptosis. This activates the host immune response, and promotes anti-tumor immunity through the activation of macrophages and T lymphocytes [35]. There is direct evidence of the photodynamic activation of production of the TNF alpha, a key cytokine in host anti-tumor immune responses [36].

Laser safety

Lasers are relatively simple to use. However, certain precautions should be taken to ensure lasers are a safe and effective tool. Primarily protective eyewear should be used by everyone in the vicinity of the laser, while it is in use. Secondly, accidental exposure to the non-target tissue should be prevented. It can be accomplished by limiting the access to the surgical environment and minimizing the reflective surfaces [37].

Conclusion

Since its inception, Laser technology for hard tissue application and soft tissue surgery has undergone high state of refinement. Taking into consideration the admirable clinical outcome that is revealed in the literature, the lasers prove to be a dependable alternative as it is an efficient, secure, and satisfactory option for soft tissue surgeries. Considering the wide spectrum of clinical conditions that prevail in the oral cavity and the numerous treatment options available for tackling them, lasers definitely gain an edge over the other existing treatment modalities due to its localized effects resulting in no harm to the adjacent tissues and no systemic toxicity. It is noninvasive with good patient compliance having no mutagenic effects and can be used repeatedly without risk

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