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REVIEW ARTICLE

Lasers in Oral Medicine: An Update

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ABSTRACT

With the rapid development of technology, new lasers with a wide range of characteristics are now available and being used in various fields of dentistry. Soft tissue lasers are becoming popular among the clinicians due to their potential value in surgical procedures providing surface sterilization, dry surgical field and increased patient acceptance. In the past two decades, much experience and knowledge has been gained regarding this new venture. The purpose of this article is to provide an overview of the current and possible future clinical applications of lasers in oral medicine, including their use in treatment of oral mucosal lesions, orofacial pain, salivary gland pathologies, TMJ disorders and biopsies.

Keywords: Laser, Oral mucosal lesions, TMJ disorders, Biopsies.

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INTRODUCTION

LASER is an acronym for light amplification by stimulated emission of radiation. Lasers are heat producing devices converting electromagnetic energy into thermal energy. The characteristic of a laser depends on its wavelength (WL), and wavelength affects both the clinical applications and design of laser. The WL used in medicine and dentistry generally range from 193 to 10600 nm, representing a broad spectrum from ultraviolate to the far infra-red range. Earlier the most widely used lasers were the carbon dioxide, and neodymium-doped yttrium aluminum garnet (Nd:YAG). Since the beam of both lasers fall in the far infrared range on the spectrum, they are not visible, therefore these lasers often use quartz fiber incorporating a 630 nm coaxial helium-neon laser into the device to act as an aiming beam and facilitate use.[1] In the literature laser has been recommended for the treatment of benign oral lesions, e.g. fibromas, hemangiomas, papillomas, idiopathic gingival hyperplasias or gingival hyperplasia due to side effects of medications, aphthous ulcers, mucosal frenula or tongue ties (ankyloglossia), as well as premalignant lesions such as oral leukoplakias, erythroplakia, etc. Some reports on the use of the laser also support the possibility of treating malignant oral diseases in early stages (for example, T1N0 carcinomas) with excisional biopsies.[2]

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MECHANISM OF ACTION

If radiation energy (any amount) is absorbed by the tissue there are four basic types of responses that can occur like:

- Photochemical interaction
- Photothermal interaction
- Photomechanical interaction
- Photoelectrical interaction

Photochemical Interaction

This type of interaction includes the interaction of the beam with the chemical process of the tissue and can be further subdivided into as follows:

- *Biostimulation*: It describes the stimulatory effect of laser light on biochemical and molecular processes that normally occur in tissue like healing and repair.
- *Photodynamic therapy*: It is the therapeutic use of lasers for the treatment of pathological conditions. This could be beneficial in treating potentially premalignant lesions, such as oral leukoplakias and useful as an adjunct therapy in removal of areas of field cancerization adjacent to cancer sites.
- *Fluorescence*: This can be used to detect light reactive substances in the tissues.

Photothermal Interaction

It manifests basically the following:

- *Photoablation*: This is nothing but removal of the tissue by vaporization and superheating of the tissue fluids, coagulation or hemostasis.
- *Photopyrolysis*: It is burning away of the tissues.

Photomechanical Interaction

It includes the following:

- *Photodisruption or photodissociation*: Which is nothing but breaking apart of the structure by laser light.
- *Photoacoustic*: This involves removal of the tissues with shockwave therapy.

Photoelectrical Interaction

It includes the following:

- *Photoplasmolysis*: This describes how tissue is removed through the formation of electrically charged ions.[3]

TYPES OF LASER

Based on power, lasers can be classified into the following three categories:

High-power Lasers (Hard, Hot)

These lasers increase tissue kinetic energy and produce heat. As a result, they leave their therapeutic effects through thermal interactions. These effects include necrosis, carbonization, vaporization, coagulation and denaturation. These lasers usually have an output power of more than 500 mW.[4,5]

Intermediate-power Lasers

These lasers leave their therapeutic effects without producing significant heat. To shorten treatment period length and to accelerate the therapeutic effect in some cases, low-power lasers are replaced by intermediate lasers with output powers ranging from 250 to 500 mW.[4,5]

Low-power Lasers (Soft, Cold)

It is also known as low level laser. These lasers have no thermal effect on tissues and produce a reaction in cells through light, called photobiostimulation or photobiochemical reaction. Output power of these lasers is less than 250 mW. The critical point that differentiates low-power lasers from high-power ones is photochemical reactions with or without heat. The most important factor to achieve this feature in lasers is not their power but the power density per cm^2. If the density is lower than 670 mW/cm^2, it can mimic stimulatory effect of low-power lasers without any thermal effects.[4,5]

LASERS USED IN ORAL MEDICINE

Carbon Dioxide Lasers

This is most commonly used in soft tissue surgeries. It has a wavelength of 10,600 nm and is readily absorbed by water. Therefore it does not penetrate too deep into the tissues (0.1-0.23 mm) without repeated or prolonged use. This is used ideally for superficial lesions, resurfacing of the skin and removal of sialoliths.

Nd:YAG Lasers

It has a wavelength of 1,064 nm. This is mostly used in soft tissue procedures. In addition, it is also used in removing tattoos and certain pigmented lesions.

Ho:YAG Lasers

This is used for arthroscopic surgery, soft tissue surgery. It has a wavelength of 2,100 nm.

Er:YAG Lasers

These lasers are most commonly used for the treatment of hard tissues and skin resurfacing. They have a wavelength of 2944 nm.

Argon Lasers

With a wavelength of 488,514 nm are readily absorbed by hemoglobin and melanin and are useful in the treatment of pigmented lesions and vascular anomalies.

Diode Lasers

They have a wavelength of 620 to 900 nm and are used to treat oral soft tissue lesions.

APPLICATIONS OF LASER IN ORAL MEDICINE

Oromucosal Pathologies

Leukoplakia

It is defined by WHO as 'a white patch or plaque that cannot be characterized clinically or pathologically as any other disease'. It is considered as a common precancerous lesion of the oral mucosa. There are different kinds of treatment for this lesion including scalpel excision, electro cautery, cryosurgery, laser surgery and medications. The lesions can be removed with laser and encourages regeneration of new, healthy epithelium. Small lesions can be removed with a carbon dioxide laser with a margin of 3 to 4 mm. The decision of whether excision or vaporization should be done is based on the texture and thickness of the lesion. Thickened hyperkeratotic lesions have less water content, therefore, vaporization cannot be done. Diffuse lesions cannot be managed by excision. In such lesions, carbon dioxide lasers can be used in a defocused mode to produce cross hatched pattern. The disadvantage of vaporization is that, a specimen cannot be taken and sent for pathological examination, so, the histology of the lesion cannot be determined.[6]

Oral Lichen Planus

It is a chronic inflammatory disease that causes bilateral white striations, papules, or plaques on buccal mucosa, tongue and gingiva. The oral lesions are exhibited in two forms: reticular and erosive. The reticular form is characterized by interlacing white lines called Wickham's striae. The erosive form appears as erythematous area with central ulceration. Erosive lichen planus can be

controlled by laser treatment. Carbon dioxide laser should be used along with selected local and systemic medications. The contact Nd:YAG laser with round probe can also be used.[7]

Oral Submucous Fibrosis

Oral submucous fibrosis (OSMF) is a chronic disease characterized by progressive inability to open the mouth. Various treatment modalities are available for its management, but these have largely been ineffective. In the modern era, the use of laser to release fibrotic bands leads to healing with minimal scarring, thereby decreasing the probability of procedure induced trismus. Diode laser is a portable device which delivers rays through a fiberoptic cable and, hence, can be delivered to relatively 'difficult-to-access' areas. Its cutting depth is less than 0.01 mm, and thus preserves tissues beyond this depth. It gives a precise line of controlled cutting without damaging the muscles and deeper structures. Hence, laser therapy eliminates the use of grafts, to close the defect in spite of extensive resection. It yields excellent functional results.[8]

Herpes Simplex Virus Infections

Herpes simplex virus types 1 and 2 are the main infectious agents associated with oral and genital ulcerations. Different methods of HSV identification and treatment of oral cavity lesions are available, including the use of oral, intravenous or topical antiviral medications. Low-level laser therapy (LLLT) can be used in association with conventional therapy. The choice of treatment method will depend on the number, location and size of the lesions.[9] LLLT presents both anti-inflammatory and analgesic effects, contributing to tissue repair and fibroblast proliferation and an increase in the interval between infections; moreover, it does not contribute in viral resistance.

Recurrent Aphthous Ulcers

It is the most common oral ulcerative lesion. The exact cause of these ulcers is unknown. Recently, LLLT has been used as the treatment modality. It helps in immediate pain relief and accelerates wound healing. According to De Souza et al, there is a significant pain relief in the same session after laser treatment and the lesion is totally regressed in 4 days. When steroids are used, it takes 5 to 7 days for regression.[10]

Walsh LJ has done a tremendous amount of research on the proposed mechanisms of the action of LLLT on both hard and soft tissues and has proposed that cold lasers (LLLT lasers) accelerate wound healing and reduce pain by perhaps 'stimulating oxidative phosphorylation in mitochondria and modulating inflammatory responses'.[11, 12]

Orofacial Pain

Trigeminal Neuralgic Pain

Trigeminal neuralgia is a neuropathic disorder of the trigeminal nerve that causes episodes of intense pain in the eyes, lips, nose, scalp, forehead, and jaw, with the majority of cases being unilateral (>95%).[13] This lancinating pain is typically in the distribution of the second and third divisions of the trigeminal nerve and can be triggered by facial movement, cold temperature, talking, and other common activities.[14] According to Eckerdal and Bastin, low-level laser of 830 nm wavelength was efficient in the treatment of 81% of patients, with 42% of them having no pain after a year.[15] In contrast, there was an improvement in 50% of patients who had been treated with injection of alcohol and only 20% remained pain-free after a year. It has also been shown that compared to placebo, low-level laser is significantly effective in pain relief.[16]

Myofacial Pain

Myofacial pain dysfunction syndrome (MPDS) is the most common reason for pain and limited function of the masticatory system. The effects of LLLs for controlling the discomfort of patients are investigated frequently. Several studies have shown that use of 830 nm wavelength laser in several appointments can reduce or eliminate myofacial pain.[17,18] Shirani et al evaluated the efficacy of a LLLT producing 660 and 890 nm wavelengths and concluded LLLT was an effective treatment for pain reduction in MPDS patients.[19]

Temporomandibular Joint Disorder Pain

Temporomandibular joint (TMJ) pain is recognized as an important source of disability that leads to considerable socioeconomic costs as a result of medical treatments, surgical interventions, and frequent absences from work.[20,21] A potential noninvasive treatment for TMJ pain is LLLT. The relative clinical efficacy of LLLT for the treatment of temporomandibular disorders (TMD) is controversial.

Some authors reported the efficacy of LLLT to be superior to placebo therapy.[22] while others found no significant differences between LLLT and placebo for measures of TMJ pain.[23]

Mucositis Pain

Pathologic evaluation of mucositis reveals mucosal thinning leading to a shallow ulcer thought to be caused by inflammation and depletion of the epithelial basal layer with subsequent denudation and bacterial infection.

'Low' or 'low and middle' energy (output power ranged from 5 to 200 mW) irradiation with helium/neon laser (wavelength 632.8 nm) has been reported to be a simple atraumatic technique (with no known toxicity in clinical setting), useful in the treatment of mucositis of various origins.

Salivary Gland Pathologies

Sialolithiasis

Sialolithiasis is the most common disease of the salivary glands. It is characterized by the development of calcifications (sialoliths) that accumulate within the salivary gland parenchyma and associated ductal systems. Most of the sialoliths are found in the submandibular gland.[24] Various types of lasers have been employed to treat sialolithiasis, including carbon dioxide, diode, Ho:Yag and Nd:YAG lasers. Among these diode laser has been reported to have more advantages. It has a greater absorption by hemoglobin, oxyhemoglobin and melanin, thereby making its penetration depth smaller than Nd-YAG laser. Owing to the smaller penetration in blood rich tissues diode laser is accepted to be safe in the adjacent tissues.[25] Due to its excellent cutting and coagulation ability, diode laser is an alternative option for the soft-tissue surgery.

Mucocele

Mucocele is a common lesion of the oral mucosa that results from an alteration of minor salivary glands due to a mucous accumulation. Mucocele involves mucin accumulation causing limited swelling. CO_2 laser has a high water absorption rate and is well absorbed by all soft tissues with high water content. In addition its effects on adjacent tissues are minimal. These properties make CO_2 laser the perfect surgical treatment for oral soft tissues.[26] The cut is precise and does not affect the muscle layer, causes minimal hemorrhage and almost no acute inflammatory reaction. The operation time is short (3 to 5 minutes) making it a convenient treatment for children and patients who cannot withstand long treatment.[27]

Biopsy

With regard to the technique used, we can distinguish biopsy as incisional and excisional. The excisional biopsy is the removal of the lesion in total, allowing, at the same time, to carry both a diagnostic and therapeutic procedure. The incisional biopsy involves the removal of one or more fragments representative of the lesion, together with the adjacent tissues, deep and surrounding it, and only after the histological examination, it is possible to establish the treatment of residual lesion.[28] It is possible to make withdrawals of histological samples using two different procedures, which is used respectively, the scalpel and the laser. The laser biopsies present some advantages compared those made with the scalpel: generally these interventions do not require anesthesia or sutures and the healing of the donor site, at least in the initial stages, it is more rapid. The laser most commonly used for this purpose are the diode laser, KTP laser, CO_2 laser, Nd: YAG laser, Er:YAG laser.[29]

Advantages

One of the main benefits for using dental lasers is dry surgical field and better visualization. It also provides tissue surface sterilization and reduction in bacteremia**.** There is decreased pain, swelling, edema and scarring. The tissues treated with laser show minimal mechanical trauma with faster healing response and is widely accepted by the patients. When laser is used, the operating time is reduced, patients require a shorter hospital stay, thus is cost-effective.

Disadvantages

There are some disadvantages to the current instruments, they are relatively high in cost and operations of lasers require specialized training. Dental instruments mainly used are both side and end cutting, thus, a modification of clinical technique is required. No single wavelength will optimally treat all dental disease. Moreover, they are harmful to eyes and skin.

CONCLUSION

Dental lasers are now well-established instruments. Ongoing research is showing the many benefits of laser therapy. The ability to perform less invasive procedures with greater patient comfort makes laser dentistry something the modern practitioner should consider. Over the past few decades, the use of lasers among oral and maxillofacial lesions has grown dramatically. Lasers offer many useful clinical applications for dentists in the diagnosis and treatment of patients with different type of oral mucosal lesions and maxillofacial disorders, as long as the clinician receives the proper training to use this technology safely and effectively. Laser may seem to have a much greater role in the future than is now realized.

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