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Laser application in Oral Medicine

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Abstract

Lasers in dentistry began to gain popularity in the 1990s. Lasers in dentistry are used as a treatment tool or as an adjunct tool. By using the laser in the field of dentistry, the main goal is to overcome the disadvantages, which are currently being experienced in conventional dental treatment procedures. Many specialties in dentistry including oral surgery, implants, oral medicine, periodontics, pediatrics, and operative use the current new laser technology. The ability of lasers to provide minimally invasive procedures with less discomfort to the patient has been useful in the patient delivery system in dental practice. This article describes in brief on the uses of lasers in the branch of Oral Medicine.

Introduction

The word Laser stands for "Light Amplification by Stimulated Emission of Radiation". The invention of the laser was not intended but was the result of many ideas and discoveries, each building upon the ones that came before it in the past century. One such idea is the optical MASER (Microwave Amplification by Stimulated Emission of Radiation) designed by Charles Townes in September 1957 which is the predecessor of laser technology. The term laser was first coined by Gordon Gould, a graduate of Columbia University in 1957. [1]

Since the 1960s, when lasers were first used in dentistry, their clinical uses have been evaluated.[1] Roundabout 1600 systematic reviews have been published in the literature on advances of lasers in dentistry. Many dental procedures involve lasers because of their easy handling, efficiency, and superior properties compared to older methods. Lasers have been employed in various therapies, from identifying minor caries to planning and treating even more severe lesions like cancers.[1]Miaman was the first to employ "lasers to treat both hard and soft tissue"[2]. Diode lasers are most often utilized lasers for soft tissues.[2] Gingival contouring and troughing, unerupted teeth and operculectomy, frenectomy, soft tissue incision, gingivectomy, and oral mucosal lesions (mucositis, leukoplakia, lichen planus) ablation are some of its applications.[2] Scientists discovered that "carbon dioxide (CO2) and Nd: YAG lasers" could be utilized for oral soft tissue to treat in the 1970s.[3]

This article highlights the use of Lasers in Oral medicine and how lasers have been a boom to the field of dentistry and in treatment of oral lesions

Lasers in field of Oral Medicine-

a) Laser treatment of oral papilloma and fibroma

Oral squamous papilloma and Fibroma can be adequately managed with high power lasers. As previously stated, adequate hemostasis at the surgical sites and postoperative comfort can be achieved with laser surgery. Some authors have suggested the feasibility of performing laser removal of OSP and FH under topical anesthesia, mostly when using the Er,Cr:YSGG laser.

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Nevertheless, operative pain may become significant, depending on the lesion size and laser type. Compared to the diode laser (808nm) and conventional surgery for the removal of oral lesions, the Er,Cr:YSGG laser is less traumatic and provides better healing. The advantages and clinical success of the treatment of oral lesions with a high power laser indicates that it is a safe and effective alternative to conventional surgery. CO2 laser, high power diode laser, and Nd:YAG laser surgery should be performed under local anesthesia, and similar postoperative results can be obtained. Interestingly, laser surgery of IFH warrants immediate use of an adjusted prosthesis without pain or discomfort during oral function.[4] Fig 1, 2.

Fig 1. Fibroma before and after laser treatment

Fig 2. Oral papilloma before and after laser treatment

b) Laser treatment of oral hemangioma

The mouth, and particularly the lip, may present an aesthetic challenge when surgery and/or sclerosing agents are used, particularly for large lesions. These VLs may be treated efficiently with high power lasers, such as diode lasers, due to the properties of this kind of irradiation. The benefit of this treatment is demonstrated by the fact that almost all procedures can be accomplished on an outpatient basis, blood loss is minimal with no requirement for blood replacement, and postoperative pain and edema are virtually non-existent. Argon lasers, Nd:YAG lasers, CO2 lasers, and diode lasers have all been found to be safe and effective for the treatment of VLs.[5] Fig 3(a) and 3(b)

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Fig.3 (a). Oral hemangioma before treatment

Fig.3(b). Oral hemangioma after laser treatment

c) Laser treatment of oral mucocele

Several clinical reports have described protocols for application of laser irradiation in the excision of oral mucoceles. The large majority have used high power CO2 lasers for excision or vaporization of the lesions, with a power range from 4 to 10W. Only four studies have described the use of Nd:YAG, Er:Cr:YSGG, and diode lasers.[6] Fig 4(a) and 4(b).

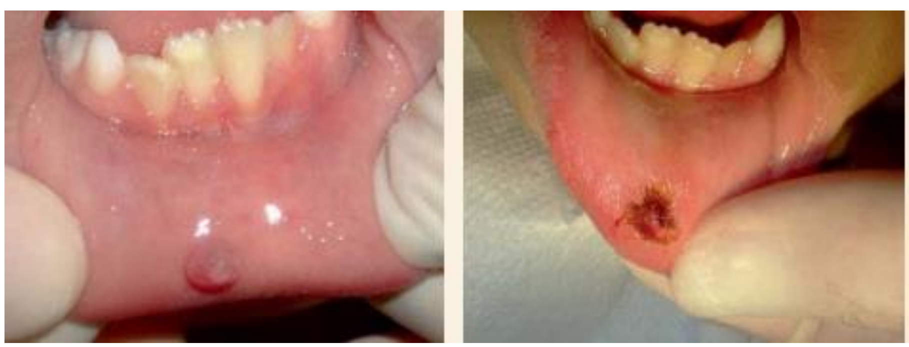

Fig 4(a). Oral mucocele before laser treatment

Fig 4(b). Oral mucocele after laser treatment

d) Laser treatment of potentially malignant disorders of the oral mucosa

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1) Oral Leukoplakia

Advantages of surgical excision of oral leukoplakia by high power lasers over conventional method (i.e. scalpel) include bleeding control and less bacteremia, among others, and this can be a particularly favorable technique when large areas of oral mucosa are affected, as wound healing occurs by secondary intention.[7]

Usually the laser of choice for oral leukoplakia treatment is the CO2 laser as it is efficient in cutting oral soft tissues and only produces superficial thermal damage, resulting from the intense energy absorption of this particular wavelength (10600nm) by its main chromophore, water, abundant in the oral mucosa. Whenever oral leukoplakia is distributed in areas that are difficult to access with the CO_2 articulated arm, a laser with a flexible optical fiber, such as the diode laser (808–980nm), can be used in a contact mode.[8] Fig 5a and 5b

Fig 5a. Oral leukoplakia before laser treatment

Fig 5b. Oral leukoplakia after laser treatment

2) Oral Lichen Planus

Oral lichen planus can be difficult to treat and is sometimes refractory to conventional therapies. Surgery is rarely performed, but can be used, especially when the first-line approach is not producing any benefit. Although there is little information in the literature regarding the treatment of oral lichen planus with lasers, some authors have reported that in recalcitrant or refractory cases of oral lichen planus high power lasers should be considered as an option.[8]

As the CO_2 laser evaporation technique has been shown to be effective in the treatment of superficial mucosal lesions, it can also be applied to oral lichen planus lesions. The technique is similar to the one already described for oral leukoplakia ; however, instead of resecting the lesion, the laser beam swipes over the treatment area, penetrating to a depth of 5mm. In recent case reports, low power lasers (excimer, 308nm; diode laser, 830nm, 904nm, and 630nm) for recalcitrant cases of oral lichen planus have been shown to be effective for pain control.[9] Fig 6(a) and 6(b)

Fig 6(a). Oral Lichen planus before laser treatment

Fig 6(b). Oral Lichen planus after laser treatment

3) Laser in treatment of oral submucous fibrosis

The diode laser has a wavelength ranging from 805 nm to 980 nm that can be well absorbed by melanin and haemoglobin and poorly absorbed by the HA and H2O present in the enamel. It is a portable device that transmits energy in gated or continuous pulse mode delivering rays through a flexible fibreoptic cable and hence can be reached even to poorly accessible areas such as trismus in OSMF.[7]

Its cutting depth <0.01mmand thus preserves tissues beyond this depth. It gives a precise line of controlled cutting without damaging the muscles and deeper structures. Therefore, the healing is rapid even without any graft or biological dressing.[7] Fig 7

Fig 7. Fibrotomy with diode laser (980nm) in OSMF

e) Laser treatment for hyposalivation and xerostomia

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With use of InGaAIP diode emitting infrared light (780 nm, continuous wave, punctual and contact mode) was used. The output power was 20 mW, with an energy density (dose) of 5 J/cm2, spot size of 0.04 cm^2, and irradiation time of 10 seconds, totaling 0.2 J of energy per point damage to the salivary gland structure is repaired and there was increase in glandular stroma change in secretory pieces.[7] Fig 8

Fig 8. Laser treatment for xerostomia

f) Laser treatment for herpes

High power lasers (HPLs) can be used to promote rupture of and to drain herpetic vesicles. It is hypothesized that HPL irradiation can reduce the amount of herpes virus present in the fluid, by increasing the local temperature and, consequently, decreasing the frequency and duration of the infection. The erbium laser is one of the most commonly used HPLs for the treatment of herpes labialis at the vesicle stage.[10] Erbium lasers (Er,Cr:YSGG emitting at 2780nm; Er:YAG emitting at 2940nm) are highly absorbed by water and hydroxyapatite, and consequently, also by enamel, dentin, and soft tissue. One of their advantages compared to lasers emitting other wavelengths (such as the Nd:YAG and diode lasers) is the possibility of using a water spray, which may reduce the pain experienced during irradiation. While HPLs produce satisfactory results, when used together with low power lasers (LPLs) and photodynamic therapy (PDT), the clinical results and patient response seem to be even better.[10] Fig 9a and 9b

Fig 9a. Herpes labialis before laser treatment

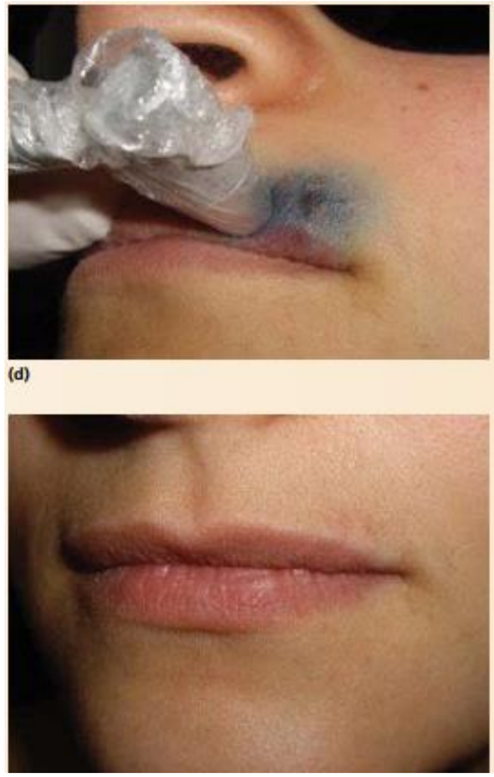

Fig 9b. Herpes labialis after laser treatment

g) Laser treatment for recurrent apthous ulcers

LLLT is known to modulate the inflammatory process, promote analgesia, and accelerate wound healing, and these effects can be expected in the treatment of aphthous ulcers.[11] **Zand et al.** performed a randomized controlled clinical trial to evaluate the efficacy of a single session of nonablative CO_2 laser irradiation in reducing pain in minor RAU.[141] The results showed that a low power, non-thermal, single-session of CO_2 laser irradiation reduced pain in RAU immediately and dramatically, with no visible side effects.[12] Another clinical evaluation comparing LLLT and a topical corticosteroid agent demonstrated that 75% of the patients treated with LLLT reported a reduction in pain after LLLT and total regression of the lesion after 4 days, while lesion regression took 5–7 days in the corticosteroid group.

Also, LLLT was described to be an alternative treatment for primary herpes simplex infection in children, with an immediate positive outcome in severe painful gingivostomatitis lesions.13 The immediate analgesic response of phototherapy can be explained by blockage of the neuronal action potential.[12] In addition, the anti-inflammatory response to laser irradiation contributes to the long-term analgesic effects, such as acceleration of the microcirculation, increased natural opioid peptides; decreased release of histamine, interleukin-1β (IL-1β), tumor necrosis factor α (TNF-α), and interferon-γ (IFN-γ); blockage of acetylcholine15; and reduction of the synthesis of bradykinin.[13] Fig 10(a) and 10(b)

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Fig 10(a). Recurrent apthous ulcers before laser treatment

Fig 10(b). Recurrent apthous ulcers after laser treatment

h) Laser treatment for nerve repair

Many studies have investigated the effects of phototherapy on nerve regeneration in humans. More time and money needs to be invested to achieve a sufficiently convincing body of data in this field. The nerve repair process is lengthy, and it is difficult to collect data and compare them to regular clinical and surgical treatments. It is known that injury of a major nerve trunk frequently results in considerable disability associated with loss of sensory and motor functions. Spontaneous recovery of long-term severe incomplete peripheral nerve injury is often unsatisfactory.[14]

A pilot study was conducted to investigate prospectively the effectiveness of LLLT (780nm) in the treatment of patients suffering from incomplete peripheral nerve and brachial plexus injuries for 6 months up to several years. A randomized double-blind placebo-controlled trial was performed in 18 patients who were randomly assigned to placebo (non-active light: diffused LED lamp) or LLLT (780nm, 250mW).[14]

Twenty one consecutive daily sessions of laser or placebo irradiation were applied transcutaneously for 3 hours to the injured peripheral nerve (energy density 450 J/mm2) and for 2 hours to the corresponding segments of the spinal cord (300 J/mm2). Clinical and electrophysiological assessments were done at baseline, at the end of the 21 days of treatment, and 3 and 6 months thereafter. The laser-irradiated and placebo groups had clinically similar conditions at baseline. The analysis of motor function during the 6-month follow-up period compared to baseline showed a statistically significant improvement in the laser-treated group compared to the placebo group.[14] Fig 11

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Fig 11. Laser treatment for facial nerve paralysis

Conclusion

Laser is an acronym for Light Amplification by Stimulated Emission Radiation which consists of tube housing, optical cavity, lasing medium, pump energy source, cooling system, delivery system and control panel. Lasing medium can be solid, liquid and gas which produces photons and light. An energy source is used that is electrical, chemical or thermal/ optical energy to excite or pump the atoms in the lasing medium to their higher energy levels that are necessary for the procedure which works in contact and non contact modes as well as focused and defocused modes. Initially 1960s ruby laser was used in dentistry. Later the clinicians began to use other lasers such as carbon dioxide, argon, erbium group, diode, xenon chloride and Nd: YAG.

Dentistry like other health care profession is in midst of major transitions. In this fast changing arena of dentistry the laser can be very useful tool for dental practitioners. Lasers have become a ray of hope in dentistry. It has applications in all the fields of dentistry including oral medicine and maxillofacial radiology, prosthetics, periodontics, pedodontics, oral and maxillofacial surgery, endodontics, implantology, cosmetic and operative dentistry. The high quality state of art has been employed in various procedures such as in diagnostics the laser is used for examining the caries, pulpal blood flow using laser Doppler flowmetry. The soft laser therapy is widely applied in diseases of oral mucosa and temporomandibular joint disease. The surgical lasers are applied in preprosthetic surgeries, precancerous conditions, vascular lesions pigmented lesion and tumor surgery. In restorative dentistry lasers may be used for removal of incipient caries and cavity preparation. Thus lasers may replace mechanical drills in future.

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