

Laser a Novel Method in the Management of Oral Soft Tissue Lesions

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ABSTRACT

Light amplification by stimulated emission of radiation stands for LASER. The field of dentistry is revolutionised by the recent advances in laser technology. The excited atom stimulates emission of photons, which triggers the release of a subsequent photon is responsible for the generation of collimated, coherent, monochromatic beam of light or LASER. It is considered as light scalpel. Development in laser is tremendous with more specific for hard tissue and soft tissue treatments such as biopsy, photo biomodulation and photodynamic therapy by just altering their wavelength. Treatment procedure of oral soft tissue lesion using laser with minimal pain and blood less field and ease of post operative healing is fortunate in the field of oral medicine and radiology to make these as chair side procedures.

Keywords: Laser, oral mucosal lesions, Low level laser therapy, Photobiomodulation, Photodynamic therapy

INTRODUCTION

Albert Einstein (1916) theorized that an additional quantum of energy traveling in the field of the excited atom that has the same excitation energy level and would result in a release of two quanta, this phenomenon was termed stimulated emission. Laser was the name was coined by Gordon Gould (1957).^[1] Laser is

abbreviation of Light Amplification of stimulated emission of radiation. In 1960, the laser was used in dentistry for the first time by Maiman during the treatment of carious enamel and dentine.^[2] Laser is monochromatic, coherent and collimated beam of photons. Laser is a form of electromagnetic radiation which converts light energy to heat energy. Most of the dental laser devices available have emission wavelengths of approximately 500 nm to 10,600 nm. Dental procedures done with laser today are very effective in reducing need of local anesthesia, minimal bleeding during the procedure, no need for suture, minimal scarring and reduced post operative pain and discomfort patient. In management of soft tissue lesions of oral cavity, it helps in surgical management of premalignant disorders and there by arrest their progress and malignant transformation.^[3]

COMPONENTS OF LASER

- Active medium, it is the core of the cavity is comprised of chemical elements, molecules, or compounds.
- Pumping mechanism is an electrical coil or flash lamp which provides the energy into the active medium.
- Optical resonator are two mirrors, one at each end of the optical cavity, placed parallel to each other. The photons are

then amplified by the mirrors and emerge as laser light.

- Finally control panel and laser delivery system that consist of articulated arm, flexible hollow wave guide or glass fibre optic cable.

MODES OF LASER:

- Based on contact of tip with tissue- Contact mode and non-contact mode
- Based of delivery of energy to tissue- Focused mode and non-focused mode
- Based on laser emission mode- Continuous mode, Gated pulse mode and Free running pulse mode.

LASER TISSUE INTERACTION:

Laser interaction with tissue is of four types, reflection, absorption, transmission and scattering. The most desired interaction for treatment purpose is the absorption of the laser energy by the intended tissue. The amount of energy that is absorbed by the tissue depends on the tissue characteristics, such as pigmentation (hemoglobin and melanin) and water content and on the laser wavelength and emission mode.^[1]

LASER EFFECT ON TISSUES:

After absorption of laser by the tissue there are four types of responses that can occur on tissues. ^[4]

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

COMMONLY USED LASERS IN DENTISTRY

- **Carbondioxide Laser (10,600nm, 9300nm)**

Ideal laser for soft tissue which has 90% water content, which is an excellent absorber of CO₂ laser. By photo thermal effect, cellular vaporisation occurs. This is basis for tissue cutting by CO₂ laser light. It can be used for both soft and hard tissue. Advantage of CO₂ laser is minimal lateral

thermal damage up to 500micrometer and reduced post operative bacteraemia.^[1]

- **Diode Laser (805 to 1064nm)**

Diode lasers are compact, portable and relatively in-expensive. It is absorbed by pigments (haemoglobin, melanin) and water. 980nm diode laser has high water absorption, so precise incision margin can be made. It is used for bio stimulation and soft tissue surgeries.^[1]

- **Neodymium: Yttrium- Aluminium- Garnet Laser (1064nm)**

Nd: YAG lasers have minimal surface tissue absorption and maximal penetration leading to coagulation at a depth. It is used in angiomas lesions, for haemostasis, bleeding disorders, arthroscopy in TMJ, palliative for advanced neoplasm and periodontal therapies.^[1]

- **Erbium Laser (2780nm and 2940nm)**

It has highest absorption for hydroxyapatite and for water. It is used for both hard and soft tissue surgeries like caries removal, osteotomy, crown lengthening procedures.^[1]

LASER APPLICATIONS IN ORAL SOFT TISSUE LESIONS:

Recurrent aphthous ulcer:

Recurrent aphthous ulcers (RAU) most common oral ulcerative lesion. They are various possible etiologic factors like family history, allergy, trauma, stress, lack of sleep, vitamin B12 deficiency, iron deficiency, hormonal imbalance or immune reactions. It interferes with daily activities of life like speaking, eating and swallowing. ^[5] Low level laser therapy (LLLT) helps in immediate pain relief and accelerates wound healing by stimulating oxidative phosphorylation in mitochondria and modulating inflammatory responses. ^[6] De Souza et al. assessed the effect of Photobiomodulation (PBM) using InGaAlP diode laser on consecutive days for pain control and the repair of RAU. The results concluded that 75% of the patients had

reduction in pain in the same session after laser treatment, and total regression of the lesion occurred after 4 days. It is best to treat aphthous ulcers within the first 48 hours.^[7] Shariq Najeeb et al in his systematic review concluded that CO₂ lasers have the unique advantage of requiring a very short exposure time (5–10 s) in the management. ^[8] Laser treatment done with or without topical anaesthetic, at lowest setting 1-2 W. It is brought in highly defocused mode where minimal energy is delivered to the site and then beam is brought closer to ulcer until patient just begins to feel a slight sensation of heat or discomfort. At this point, using circular motion, the aphthous ulcer is lased from its centre to just beyond the erythematous halo. The surface alteration of aphthous ulcer should be noted.^[9]

Herpes simplex type 1 and Recurrent labialis:

Herpes simplex type 1 and Recurrent herpes labialis (RHL) is an acute viral infection of oral cavity. Lesions appears the keratinized mucosa such as gingiva and hard palate and lips and skin around the mouth. Initially they appear as a collection of small vesicles, later, they break to form ulcerations covered by yellowish fibrin. LLLT presents both analgesic and anti-inflammatory effects, contributing to tissue repair and fibroblast proliferation and an increase in the interval between infections; moreover, it does not contribute in viral resistance. ^[4] It is ideal to use LLLT in herpetic lesions during their prodromal stage, where pain relief is immediate. The effect is supposed to be similar to that provided by acyclovir, but without any side-effects. In addition, the laser radiation can be applied on the vertebrae C2-C3 where the resident ganglion of the virus is located and post-herpetic neuralgia could also be treated. ^[10] Vélez-González et al, ^[11] demonstrated a significant reduction in the relapses of RHL, and period of relapses in the laser group were significantly extended when compared to the acyclovir group. The

main advantage of laser treatment is the absence of side effects and drug interactions, which are especially beneficial for older and immune compromised patients.^[12]

Frictional keratosis:

Frictional keratosis, as the term suggests results from chronic low-grade friction derived mechanically either from cheek biting, ill-fitting denture or sharp cusps of the teeth, or food intake. The lesion appears as by white colour patch which is non scrap able. It often disappears on elimination of trauma. Small doubtful lesions can be excised by using CO₂ laser with a 0.2mm spot size. ^[13]

Tobacco pouch keratosis

These lesions are induced by the chronic usage of smokeless tobacco. It appears as a characteristic white plaque on the mucosa which is in direct contact with the tobacco and appears wrinkled. It is soft and velvety on palpation. After cessation of the habit the lesion disappears. The lesions that persist even after cessation gradually becomes thickened plaque. They can be excised by using the laser in a focused mode. They usually occur in mucolabial or mucobuccal fold in the mandible which are accessible. ^[14,15]

Nicotinic stomatitis:

Common mucosal change of hard palate associated with tobacco smoking. It clinically presents as white leathery lesions of the palate with red dots representing orifices of accessory salivary glands which is inflamed. These lesions are usually asymptomatic. If there is burning sensation, pain or ulceration, laser treatment can be done to eradicate it. The lesions are vaporized after multiple punch biopsies have been taken. A carbon dioxide laser is used in a defocused, continuous mode perpendicular to the tissue surface along the long axis of the lesion. The lesion is wiped with saline to remove the lased surface so that the non lased surfaces will be revealed.

This is continued till the final lased surface layer is left undisturbed which act as barrier and protect the healing surface. The lased surfaces can be protected during eating and drinking by fabricating a palatal splint fabricated. Nd:YAG laser in contact with round surgical probe can also be used in a similar manner to the carbon dioxide laser. [13,14]

Actenic cheilitis:

It is a premalignant lesion involving the vermilion border of the lips a due to prolonged chronic UV exposure. Clinically the lesion appears pale and silvery grey with wrinkling. The wrinkling later becomes deep fissures and ulcerations which do not tend to bleed, although a superficial exudative crust may be present. The lesion may transform into a squamous cell carcinoma if not treated. Laser has been found to effective in the removal of the lesion. A carbon dioxide laser in focused spot is used to outline the lesion, such that 2-3 mm of the surrounding normal mucosa is included. Keeping the laser tip 4-6- cm away from the tissue a crosshatching pattern is made in the defocussed mode is made on surface of lesion. After the lasing procedure is done completely, a moistened gauze sponge is used to wipe the lased surface. Then the surface is coated with an antibiotic dressing and a nonadherent pad is taped.^[9] Raymond et al in 1997 in his extended treatment review of therapeutic modalities of angular cheilitis concluded laser should be used in extensive lesion with improved cosmetic result than scalpel vermilionectomy. [16]

Oral leukoplakia:

Oral leukoplakia is defined by WHO a white patch or plaque that cannot be characterised clinically or pathologically as any other disease. It is white, well demarcated plaque with smooth texture, leathery appearance referred as cracked mud. It is of homogenous and non-homogenous type. It commonly occurs in lips, buccal mucosa, tongue, gingiva and

floor of the mouth. Based on the texture and thickness of the lesion, excision or vaporization should be done is. Thickened hyperkeratotic lesions have less water content, so vaporization cannot be done. Diffuse lesions cannot be managed by excision. In such lesions LLLT is done using carbon dioxide lasers can be used in a defocussed mode. [14,15] P.S. van der Hem et al. h 282 oral leukoplakias were treated by CO2 laser evaporation. In a mean follow up period of 52 months range 251 treated leukoplakias (89.0%) did not show a recurrence. [16]

Erythroplakia:

Erythroplakia is defined as a red lesion of oral mucosa that excludes other known pathologies. The lesion comprises an eroded somewhat submerged red lesion that is frequently observed with distinct demarcation against normal- appearing mucosa. It is usually asymptomatic, but sometimes associated with burning sensation in conjugation of food intake. Erythroplakia can be managed by surgical excision and CO2 laser. It is important to excise the lesion widely rather than deeply due to superficial nature of dysplastic and in situ lesions. [14,15]

Lichenplanus:

Lichen planus is a common dermatologic disease that often affects oral mucosa that causes bilateral white striations, papules, or plaques on buccal mucosa, tongue and gingiva. Erosive lichen planus appears as erythematous area with central ulcerations can be controlled by laser treatment. Carbon dioxide laser, Nd:YAG laser, Diode laser can also be used. It is used in continuous, defocused mode and cross hatched pattern is made on surface of lesion. It has been reported from patients that there is a significant decrease in burning sensation from the lesion. [14] In a study by Jajarm et al., 630-nm diode laser, twice daily was used to treat 30 patients with erosive lichen planus. It was as effective as topical

corticosteroid therapy without any adverse effects. [18]

Oral submucous fibrosis:

Oral submucous fibrosis (OSMF) is a chronic disease affecting oral mucosa characterized erythema, pallor giving marbled appearance with increased fibrosis of connective tissue and progressive decreased ability to open the mouth. Laser is used to release these fibrotic bands leads to healing with minimal scarring, thereby decreasing the probability of procedure induced trismus. Diode laser with fiberoptic cable is relatively easy to access areas which are considered 'difficult to- access'. Since its cutting depth is less than 0.01 mm, it helps to preserves tissues beyond this depth. So there is precise line of controlled cutting and not damaging the muscles and deeper structures. Hence, laser therapy eliminates the use of grafts to close the defect despite of extensive resection. It yields excellent functional results. [4] Zainab Chaudhry et al in 2014 16 cases of moderate OSMF treated with Erbium Chromium Yttrium Scandium Gallium Garnet (ErCr:YSGG) laser fibrotomy under local anesthesia in combination with cessation of habits, topical steroids, lycopene and oral physiotherapy concluded ErCr:YSGG laser fibrotomy under local anesthesia is a minimally invasive, cost effective, chairside procedure and an useful adjunct in management of moderate OSMF. [19]

Oralmucositis:

Oral mucositis (OM) is an inflammatory response of oral mucosa to chemotherapy for head and neck cancer and hematopoietic stem cell transplantation (HSCT). Pathologic evaluation of mucositis reveals mucosal thinning which leads to a shallow ulcer. It is thought to be caused by inflammation and depletion of the epithelial basal layer with subsequent denudation and bacterial infection. In vitro and in vivo studies have further shown an increase in fibroblast proliferation, and maturation, as well as an increase in the production of

procollagen, collagen, and basic fibroblast growth factors. Fibroblasts into myofibroblasts, which have more stability and tensile strength with reduction in neutrophil infiltrate. [20,21,22] International Society of Oral Oncology (ISOO) in 2012 to publish a systematic review of laser and other light therapy for the management of OM, a recommendation for LLLT for the prevention of OM in adult patients receiving HSCT conditioned with high-dose chemotherapy, and "suggestion" for LLLT for the prevention of OM in patients undergoing radiotherapy, without concomitant chemotherapy, for HNC. [23] Mean while a systematic review done by Bjordal et al. and Bensadoun and Nair's meta-analysis recommended PBM with of red (630–670 nm) or infrared (780–830 nm) laser light at 10 and 100 mW at a dose of 2–3 J/ cm² for prophylaxis and 4 J/cm² (maximum limit) for therapeutic effect. The application of laser is on a single spot rather than scanning motion and repeated daily or alternate days, or at least of three times per week until resolution. [24,25] Preventive LLLT in HNC patients receiving chemoradiotherapy is an effective tool for reducing the incidence of grades 3–4 OM.

Pemphigus vulgaris

Pemphigus vulgaris (PV) is a rare, potentially life-threatening, autoimmune-blistering disease of the skin and mucous membranes. Oral lesions in PV are painful which could interfere with eating, drinking, and even speaking. [26] A pilot study by Zand et al. single session of non-thermal, non-ablative CO₂ laser therapy in pemphigus vulgaris immediate pain reduction without thermal damage or aggravation of lesion. [27]

Inflammatory fibrous hyperplasia

Inflammatory papillary hyperplasia or Inflammatory fibrous hyperplasia (IFH) due to ill-fitting dentures, poor denture hygiene or wearing the denture 24 hours a day. It usually occurs on the hard palate beneath the denture base. The laser is set on continuous defocused mode and using

parallel horizontal lines of vaporization on palate, covering the entire area of the lesion is covered. [1] Few studies on the literature evaluate and/or compare the surgical removal of the IFH with laser in relation to conventional surgical techniques. In a retrospective study, Tamarit-Borras et al. evaluated the advantages and disadvantages on the use of CO2 laser, diode laser, laser Er: YAG and cold scalpel on the removal of fibrous hyperplasia and pointed the CO2 laser being the treatment of choice, thanks to the benefits observed on the trans and post-operative. [28]

Mucocele:

Mucocele involves mucin accumulation causing limited swelling. It occurs due to rupture of salivary gland duct and spillage of mucin into surrounding duct. Laser ablation and excision are used in treatment of mucocele. CO2 lasers are ideally used and where the cut is precise and does not affect the muscle layer, causes minimal hemorrhage and almost no acute inflammatory reaction. It is first unroofed and then excised with the gland tissue using laser. This laser due to high frequency technology, helps in precise cutting and reducing the risk of necrosis. The wound margins are sealed with a defocused beam without side effects or complications. Re-epithelialization takes about three weeks. [29] Yagüe-García et al. (2009) performed a clinic nonrandomized assay aiming to compare the results obtained after the resection of the oral mucocele with the scalpel and the CO2 laser and concluded that the ablation of the oral mucocele with CO2 laser offers results more predictable and with minimal complications and reduced relapse than the convention resection with scalpel. [30]

Hemangiomas:

Lasers more often are used to treat vascular lesions extraorally or intraorally. Commonly capillary and cavernous hemangiomas, venous lakes, small telangiectasias, and varicosities are ideally

treated with haemostatic technique. This is because vessels that supply capillary and small venous vascular lesions are coagulated which facilitates en bloc excision of such lesions. The lateral thermal damage which occurs normally due to the laser results in contraction of collagen; therefore, sealing of vessels up to 500 µm in diameter occurs. [1] Diode, Nd: YAG, KTP highly absorbed by the chromophores, and due the cutting capacity, coagulation, and hemostasis, has higher capacity of tissue ablation. Transmucosal thermo-coagulation is a technique, widely used for the treatment of vascular lesions. The laser tip is slowly moved over the lesion, at distance of 2 to 3 mm from the surface and should not be used on the same place for a long period of time. The lesion regresses during the treatment. The laser energy is absorbed by the hemoglobin on the interior of the lesion, as it passes through the tissues, heat is generated which coagulates the tissue to a depth of around 7 to 10 mm, a process called photocoagulation. There is dehydration and whitening of the hemangioma observed immediate post-operatively which called as “forced dehydration”. [31]

Oral exophytic lesions- fibroma, pyogenic granuloma, lipoma, epulis, papilloma

Oral exophytic lesions are pathologic growths projecting above the normal contour of the oral mucosa. There are many underlying mechanisms responsible for oral exophytic lesions such as hypertrophy, hyperplasia, neoplasia, and pooling of the fluid. According to a national epidemiologic study by Zain et al., exophytic lesions account for 26% of all oral lesions. [32] Excisional biopsy of these lesions in total, allowing at the same time to carry both diagnostic and therapeutic procedure. Post operative laser surgical wounds heals by secondary healing and no need for suture. The denatured proteins from tissue and plasma gives rise to surface that shields the wound from frictional and bacterial action. No scarring and free

movement of tissues. BS Santhosh et al in 2018 laser excised 30 oral exophytic lesions and concluded 980nm diode laser can safely and efficiently in maintaining hemostasis, reduced surgical time, faster wound reepithelization and wound healing with no post operative of complications.^[33]

Verrucous carcinoma:

Verrucous carcinoma (VC) is a slow-growing, non-metastasizing form of squamous cell carcinoma that most frequently affects the oral mucosa, although other sites such as the larynx, oesophagus, nasal fossa, skin, and genitals may also be involved. It has an exophytic, cauliflower-like appearance and mostly occurs in the elderly. Common sites mandibular vestibule, buccal mucosa, gingiva, tongue, and hard palate.^[15] The exophytic lesion can be readily excised along with the base of the lesion using a carbon dioxide laser or Nd:YAG contact laser. Luciane H. Azevedo et al 2007 treated 2 cases of extensive large verrucous carcinoma on dorsal surface of tongue using CO2 laser, and recorded that the recovery was highly satisfactory for both patients, without complications such as infection or oedema were reported. The healing process spanned a period of 6 to 8 weeks and concluded with no scar and with altered anatomic form and function of the tongue. ^[34]

Kerato acanthoma:

Keratoacanthoma also known as self-healing carcinoma. It has a strong clinical and pathological similarity to squamous cell carcinoma. It is mostly found on the outer edge of the vermilion border of the lips appears as a firm, sessile, dome shaped nodule with central plug of keratin.^[15] To limit scarring of the tissue, most of the lesions excised with carbon dioxide laser in pulsed mode by creating out line. Then the laser beam is held perpendicular to the outline and a full thickness wedge shape is removed and approximated with suture.^[13]

CONCLUSION

Laser technology has more rapid progress over past few decades. Dental lasers are now well-established equipment and shows many benefits in the management of oral and maxillofacial conditions than conventional treatment. The ability to perform less invasive procedures with greater patient comfort makes laser dentistry something to consider by modern practitioners. Advent of portable diode lasers with affordable cost had made the laser accessible for practitioners and upgrade their skills. Laser has excellent wound healing and tissue repair, progressive coagulation of blood proteins, with reduced inflammatory factors and pain inhibition substantiates the efficiency of laser in management of oral soft tissue lesions.

Abbreviations

Recurrent aphthous ulcers (RAU), Low level laser therapy (LLLT), Photobiomodulation (PBM) Recurrent herpes labialis (RHL), Oral submucous fibrosis (OSMF), Oral mucositis (OM), Hematopoietic stem cell transplantation (HSCT), International Society of Oral Oncology (ISOO), Pemphigus vulgaris (PV), Inflammatory papillary hyperplasia or Inflammatory fibrous hyperplasia (IFH), Verrucous carcinoma (VC)

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