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**Review Article** 

# **ROLE OF LASERS IN MUCOSAL LESIONS**

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#### ABSTRACT:

Dentistry has changed tremendously over the past decade to the benefit of both the clinician and the patient. The search for new devices and technologies for dental procedures was always a challenge and in the last two decades much experience and knowledge have been gained.1New materials and technologies have improved the efficiency and predictability of dentistry for clinicians. One such technology that has become increasingly utilized in clinical dentistry is that of LASERS. The word LASER is actually an acronym that stands for "Light Amplification by Stimulated Emission of Radiation". Better understanding of tissue reaction and refining of the technique are expected to improve the scope of lasers in clinical dentistry.

#### الملخص العربى

# دور اليزر في علاج أمراض الغشاء المخاطي نيها بانسال<sup>1</sup> و ريتشا بانسال<sup>2</sup>

<sup>1</sup>قسم أمراض الفم والاشعة، كلية سورنديرا لعلوم وطب الاسنان ،الهند 2 قسم أمراض الفم والوجه و الفكين ، كلية سيما لطب الاسنان ،الهند

لقد تغيرت طب الأسنان بشكل كبير خلال العقد الماضي لصالح كل من الطبيب المعالج والمريض. كان البحث عن أجهزة وتقنيات جديدة لإجراءات طب الأسنان دائما تحديا، وقد شهد العقدين الماضبين الكثير من الخبرة والمعرفة و تطوير الموادالمبتكرة . أدى التقدم التكنولوجيات الى تحسن كفاءة وقدرة أطباء الأسنان في علاج الحالات و كذلك على التنبؤ المبكر للامراض. واحدة من هذه التكنولوجيا التي أصبحت تستخدم بشكل متزايد في طب الأسنان السريري هو أن أشعة الليزر. و كلمة LASERهو في الواقع التي تقف والمختصر ل "تضخيم الضوء بواسطة الانبعات المستحث للإشعاع". يناقش هذا المقال تأثير الليزر على أنسجة الفم و رد فعل تلك الأنسجة و استطبابته المتعددة في طب و جراحة الفم والاسنان.

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#### DIFFERENT TYPES OF LASERS 1. Carbon Dioxide Laser

The Carbon dioxide laser was introduced by Kumar N Patel in 1964 at The Bell Telephone Laboratories. Carbon dioxide laser was perhaps the first laser that had hard tissue and soft tissue applications. The CO2 laser is a gas-active medium laser that incorporates a sealed tube containing a gaseous mixture with CO2 molecules pumped via electrical discharge current <sup>1, 2</sup>. The light energy, with a wavelength of 10,600 nm, is placed at the end of the mid-infrared nonionizing portion of the spectrum. It is delivered through a hollow tube-like waveguide in continuous or gated pulsed mode. <sup>3</sup> The carbon dioxide laser is the gold standard in ablative lasers.

## 2. Argon Lasers

Argon laser is a light with an active medium of argon gas that is energized by a high current electrical discharge. It is fiberoptically delivered in continuous waves and gated pulsed modes. It is the only available surgical laser device whose light is radiated in the visible spectrum. There are two emission wavelengths used in dentistry. One is of the wavelength 488 nm, which is blue in color, and the other is of the wavelength 514 nm, which is blue-green in colour. Acute inflammatory periodontal disease and highly vascularized lesions, such a hemangioma, are ideally suited for treatment by the argon laser. Wavelength is neither well absorbed in dental hard tissues nor in water. The poor absorption into enamel and dentin is advantageous when this laser is used for cutting and sculpting gingival tissues because there is minimal interaction and thus no damage occurs to the tooth surface during these procedures 4, 5, 6.

# 3. Diode

Diode is a solid active medium laser, manufactured from semiconductor crystals using a combination of aluminium, indium, gallium, and arsenic. This "chip" of material has the optical resonator mirrors directly attached to its ends, and an electrical current is used as the pumping mechanism.

#### 4. Neodynium:Ytrrium-Aluminium-Garnet Lasers

Neodynium: Yttrium-Aluminum-Garnet Lasers (Nd:YAG) has a solid active medium, which is a garnet crystal combined with the rare earth elements yttrium and aluminum, doped with neodymium ions. This active medium is much different than the semiconductor wafer of the diode laser, and the pumping mechanism is a Citation:Libyan Dent J 2015, 5: 17421172 -http://dx.doi.org/10.5542/LDJ.v5i0.17421172

flash lamp. This can be used for procedures such as hemostasis, treatment of aphthous ulcers and pulpal analgesia.

#### 5. Holmium:YAG

It contains a solid crystal of yttrium aluminum garnet sensitized with chromium and doped with holmium and thulium ions. However, the manufacture of holmium laser dental instrument was ceased in around the year1987.

#### 6. The Erbium Family

Erbium, chromium: YSGG, with 2780 nm wavelength, has an active medium of a solid crystal of yttrium scandium gallium garnet that is doped with erbium and chromium. Erbium: YAG, with 2940 nm wavelength, has an active medium of a solid crystal of yttrium aluminum garnet that is doped with erbium.

### 7. Alexandrite Laser

The Alexandrite laser is a solid-state laser employing a gemstone called Alexandrite, which is chromium doped: Beryllium-Aluminum-Oxide chrysoberyl (Cr+3; BeAl2O4). Alexandrite is one of the trichroic minerals.

#### LASERS IN ORAL MEDICINE

Laser technology is developing very quickly. It is an instrument that achieves maximum oral health in a minimally invasive fashion. Lasers are available with a wide range of characteristics and are being used in the various fields of medicine and dentistry<sup>2</sup>. In the specialty of Oral Medicine, today, lasers play an important and a vital role in the treatment & management of oral mucosal lesions.

#### **Oral lichen planus:**

Oral lichen planus is a T-cell mediated autoimmune, chronic inflammatory disease that causes bilateral white striations, papules or plaques on buccal mucosa, tongue and gingiva. Autotoxic CD8+ T cells trigger apoptosis of the oral epithelial cells. Steroids have been the drugs of choice in the treatment of this disease, used both topically and systemically. Nonsteroidal anti-inflammatory drugs have also been used as an alternative to corticosteroids. But not only were the results less beneficial, the side effects of these drugs had adverse outcomes. Kollner K et al in 2003 demonstrated the use of 308 nm excimer laser as a possible additional method in the treatment of Oral Lichen Planus. The procedure was painless and well tolerated by patients. Soliman in 2005 demonstrated that, the use of diode laser of wavelength 980nm provides a marked clinical improvement in Oral Lichen

Planus, without the need for neither local nor systemic treatment with drugs. The CO2 laser acts only superficially and removes the superficial layers of the affected area. The deeper layer of subepithelial connective tissue and lymphocytic layer cannot be reached by laser beam. In case of re-deposition of surface antigen on the new formed surface epithelium, activated T lymphocytes are ready to destroy their target. CO2 laser leaves a row of connective tissue surface that causes prominent postoperative pain. On the other hand, Diode laser 980nm possesses a deeper power of penetration that reaches about 1.5 mm. Application of diode 980 in 8w power, in defocused continuous mode, raises the temperature of the affected tissues up to 50 degrees to 100 degrees Celsius. This temperature causes protein denaturation. The sign of protein denaturation is the blanching of the treated mucosa. Denaturation of protein at the affected area means destruction of the diseased epithelium, along with its surface antigen. In addition, all the immune reaction components present in the range of diode laser treatment, as antigen-antibodies, cytotoxic proteins and subepithelial lymphocytes, are all denaturated due to its deeper penetration. There is enhanced healing with less risk of secondary infection. The technique is very easy, fast and safe. Diode laser 980nm provides an alternative technique for treatment of OLP with marked clinical improvement as well as high degree of patient acceptance.

#### **Biopsy:**

Biopsy is a surgical procedure performed to confirm a suspected clinical diagnosis and to establish a clear diagnosis of a lesion. There are many advantages of performing biopsies of oral lesions by diode, Nd:YAG and KTP lasers. A completely bloodless surgical area, which is very important in the treatment of highly vascularised lesions and in the management of patients with infectious diseases like HIV, HBC and HCV, is achieved. Good healing by secondary intention is usually achieved. This is particularly useful in critical anatomic sites such as the hard or soft palate. The technique also associated with minimal or even complete absence of postsurgical pain and oedema. Lasers, with their physical characteristics, can be considered as great tools in facilitating the excision of some oral mucosal lesions that would be difficult to treat by traditional methods because of anatomical or vascular characteristics. These are:

a) clinically non-suspicious lesions like fibromas, hemangiomas, gingival hyperplasia, mucocele, and nevus. b) Suspected dysplastic or neoplastic lesions like leukoplakia, lichen planus, cancer, and melanoma <sup>7</sup>. The disadvantage of laser biopsy of the thin epithelial lesions e that the laser may evaporate the whole lesion and with no tissue left for histopathological examination.

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# Melanosis or hyperchromias:

Melanosis or hyperchromias are circumscribed pigmented lesions, with extracellular melanin pigment. They can be epidermal, dermal or mixed. They range in colour from black in superficial melanoses to brown in deep melanoses.

#### Angiomas

Angiomas are small elevated lesions. telangiectases which are 0.1-1mm in diameter and are capillary dilatations of the subpapillary plexus. Angiomas show parietal endothelial proliferation. For some pigmented lesions, the etiology is unknown. For other pigmented lesions and vascular lesions, the etiology could be solar irradiation and artificial irradiation. There could also be genetic predisposition for the development of the lesions. Apollonia Desiate in 2009 evaluated the safety and efficacy of 980 nm diode laser for the treatment of benign facial pigmented and vascular lesions. Diode Laser appeared to be justified, as it proved to be effective, safe and well-accepted by the patients<sup>8</sup>.

#### Oral Leukoplakia:

Oral Leukoplakia is defined as a white patch or plaque on the oral mucosa that cannot be removed by scraping and cannot be classified clinically or microscopically as another disease entity. Because of the risk for progression to carcinoma, it is important to diagnose these lesions as early as possible and manage it appropriately. There is remarkable lack of consensus on the appropriate management of leukoplakia, the commonly recognized premalignant lesion.

Table 1.	The	advantages	of CO2	laser	ablation
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The advantages of CO2 laser ablation are:				
1.	Precise dissection			
2.	Immediate tissue destruction			
3.	Minimal damage to adjacent structures			
4.	Bloodless field allowing good visibility			
5.	Very little post-operative scarring and			
	wound contraction			
6.	Minimal interference in oral function			

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aphthous lesions may also be the manifestation of

available such as cryosurgery, CO2 laser, topical and systemic retinoids, topical bleomycin and electrocautery. Antonio L.B. et al in 1996 evaluated the surgical management of Leukoplakia in the oral cavity with CO2 laser. He concluded that, carbon dioxide laser presented several advantages over conventional techniques when treating soft-tissue pathology. Chu Fw et al in 1998 used CO2 laser in the treatment of oral leukoplakia. It had many advantages like selective removal of the affected tissues and minimal damage to surrounding tissue, leading to excellent wound healing with no or minimal scar and good functional results. The technique of CO2 laser evaporation of oral leukoplakia is more easily performed than excision with the knife. This is especially of interest if the lesions are large or if the lesions are around ducts of salivary glands. General anaesthesia is not usually required. The CO2 laser has the ability to ablate tissues rapidly in the defocused mode with minimal tissue damage. At low powers, the CO2 laser allows the tissue to blister and causes the lesions to separate at the basement membrane, allowing the clinician to "laser peel" the lesion away. The laser beam destroys the tissue in a precise and a bloodless manner by vaporizing intra and extracellular fluid and causing degeneration of the cell structure. The most remarkable observation after healing of CO2 laser treated leukoplakia is the limited formation of scar tissue. This type of wound healing is the result of the selective removal of epithelium and the minimal thermal damage to the surrounding tissues. If there is a clinical suspicion of recurrence, then biopsy is mandatory and laser retreatment is indicated. One of the disadvantages of the use of CO2 laser is that, it produces a straight light beam. Therefore it cannot reach every site of the oral cavity. Long term review is necessary to determine the incidence of recurrence and malignant transformation <sup>9</sup>.

Apart from behaviour modification and surgical

excision, various treatment modalities are

#### **Recurrent Apthous Stomatitis:**

Recurrent Apthous Stomatitis is characterized by localized, painful, shallow ulcers that affect the soft mucosa of the oral cavity. The precise etiology and patho-physiology of RAS are unknown. However, many predisposing factors immunological, like genetic factors, hypersensitivity to food and drugs, hormonal changes, trauma, environmental factors and psychological stress are known to precipitate Recurrent aphthous stomatitis. Recurrent Citation:Libyan Dent J 2015, 5: 17421172 -http://dx.doi.org/10.5542/LDJ.v5i0.17421172

more complicated diseases such as Behcet's Syndrome. In the past, oral aphthous lesions have been treated with anesthetic pastes and mouthwashes, topical or systemic steroids and antibiotics. Topical and systemic drug treatments help to reduce the symptoms and duration of the ulcer but are not effective in preventing recurrences. Immunosuppressive drugs, such as thalidomide, are effective in decreasing the number of lesions and the length & severity of ulcers, as well as in increasing the latency period. However, these drugs can have severe side effects. Most of these remedies only help to provide temporary pain relief to localized symptoms and do not help to prevent future occurrences. Nasrin Zand in 2012 demonstrated that a single sitting of non-ablative CO2 laser therapy could be used to promote wound healing in minor aphthous ulcers, with no visible side effects. Recently, CO2-lasers have been considered in order to relieve the symptoms of aphthous lesions. This is due to the blockage of action potential and conduction of nociceptive signals in afferent neurons and decrease in the release of chemical mediators. It has been shown that CO2 lasers can offer a transient relief of symptoms when used as monotherapy for treatment of RAS<sup>10</sup>. Demetriades N et al in 2009 showed that patients who suffered from Behcet's Syndrome and RAS showed transient pain relief with the use of CO2 ablative laser as a monotherapy.

# **Orofacial Pain**:

Low-power lasers are a group of lasers with a power less than 250 mW and unlike high-power lasers, they have no effect on tissue temperature. They produce light-dependent chemical reactions in tissues <sup>11</sup>. These lasers have analgesic features with their ability to trigger reactions that reduce pain and inflammatory mediators. Low-power lasers can also be used instead of needles in acupuncture to decrease pain. Due to these features they have been used in the treatment of orofacial pain, including tooth hypersensitivity, post-operative flare up, mucositis, facial myalgia temporomandibular joint disorders and neuralgias. Currently the following analgesic effects are recognized: 1. Low-power lasers inhibit the release of mediators from injured tissues. They decrease concentration of chemical agents such as histamine, acetylcholine, serotonin, H+ and K+, all of which are pain mediators. 2. Low-power lasers inhibit concentration of acetylcholine, a

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pain mediator, through increased acetyl cholinesterase activity. 3. They cause vasodilatation and increase blood flow to tissues, accelerating excretion of secreted factors. On the other hand, the better circulation leads to a decrease in tissue swelling. 4. They decrease tissue edema by increasing lymph drainage. They also remove the pressure on nerve endings, resulting in stimulation decrease. 5. They decrease sensitivity of pain receptors as well as transmission of impulses. 6. They decrease cell membrane permeability for Na+ and K+ and cause neuronal hyperpolarization, resulting in increased pain threshold. 7. Injured tissue metabolism is increased by electromagnetic energy of laser. This is induced by ATP production and cell membrane repolarization. 8. Low-power lasers increase descending analgesic impulses at dorsal spinal horn and inhibit pain feeling at cortex level. 9. They balance the activity of adrenalin and noradrenalin system as a response to pain. 10. Low-power lasers increase the urinary excretion of serotonin and glucocorticoids, increasing the production of β-endorphin. Low-level lasers cause photobiochemical reactions that result in pain relief. Considering the effect of neurotransmitters on nerves, lasers are expected to be effective in eliminating all kinds of pain that result from nerve irritation and nociceptor excitation neuropathic pain. If location of inflammation is within reach, lasers can reduce pain of inflammatory origin through their antiinflammatory properties. If irritated and inflamed sites are not accessible, laser acupuncture can be used. Although low-level lasers have been shown be effective in improving oral and to maxillofacial pain, they are not used widely. The need for several appointments and the novelty of the procedure limit the widespread use of lasers.

Lasers have become a ray of hope in dentistry. When used efficaciously and ethically, lasers are an exceptional modality of treatment for many clinical conditions that dental health professionals treat on a daily basis. But laser has never been the "magic wand" that many people have hoped for. It has got its own limitations. However, the future of lasers in dentistry is bright considering the results of some of the newest ongoing researches <sup>12</sup>.

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