RESEARCH PAPER

Applications of Lasers in Oral Medicine

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ABSTRACT
Background
Lasers have become increasingly integrated into clinical dentistry, offering a minimally invasive alternative for a wide range of oral medicine applications. This review provides a comprehensive overview of the current applications of lasers in oral medicine.
Objective
To evaluate the clinical applications, efficacy, and safety of various laser systems used in the diagnosis and management of oral mucosal diseases, soft tissue lesions, and other oral medicine conditions.
Applications
Laser applications in oral medicine include biopsy and excision of oral lesions, management of oral potentially malignant disorders, treatment of recurrent aphthous stomatitis, herpes labialis, oral lichen planus, and other autoimmune conditions, as well as photobiomodulation therapy for oral mucositis and pain management.
Conclusion
Lasers offer significant advantages in oral medicine including reduced bleeding, minimal postoperative discomfort, improved precision, and faster healing. However, proper training and adherence to safety protocols are essential for optimal outcomes.
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INTRODUCTION

The term "laser" stands for "Light Amplification by Stimulated Emission of Radiation." Lasers produce concentrated beams of light that can be used to cut, shape, or remove tissue with precision. Lasers operate at different wavelengths, each suited for specific dental procedures. Their use in dentistry can be categorized into hard tissue (teeth and bone) and soft tissue (gums and other oral tissues) applications, offering an array of benefits, including reduced discomfort, minimized bleeding, faster recovery times, and enhanced accuracy [1, 2]. Laser technology has significantly transformed the field of dentistry, offering precise, efficient, and minimally invasive treatments for a variety of oral health conditions. With its ability to target specific tissues without damaging surrounding areas, lasers have become indispensable tools in modern dental procedures [3]. This technological advancement began in the 1960s with the development of the first dental laser, and since then, it has evolved dramatically, leading to a wide array of applications in both diagnostic and therapeutic dental practices.

One of the key advantages of laser dentistry is its ability to perform procedures with a high degree of accuracy, reducing the need for traditional surgical methods that often require stitches and long recovery times. Lasers are now commonly used in procedures such as cavity removal, gum reshaping, teeth whitening, and soft tissue management, offering patients less pain and faster healing times. In addition, lasers have proven effective in treating conditions like periodontal disease, oral infections, and canker sores. They also contribute to a more comfortable experience for patients, as laser treatments generally require little or no anesthesia and cause minimal bleeding [4, 5]. As laser technology continues to advance, newer lasers with greater precision and improved capabilities are entering the dental market. These innovations promise even less discomfort, shorter recovery periods, and more effective outcomes. For instance, advancements in erbium and diode lasers have made it possible to treat both hard and soft tissues with equal efficiency. The future of laser dentistry holds even greater promise, with ongoing research focusing on

expanding the range of conditions lasers can treat and further improving their precision. As more practitioners adopt laser-based techniques, the potential for enhanced patient care and satisfaction continues to grow [6, 7]. The integration of laser technology in dentistry is also expected to play a key role in the future of preventive care, offering dentists the ability to detect and treat oral diseases in their earliest stages. With continued advancements and increasing adoption, laser dentistry is poised to revolutionize the field, setting new standards for precision, patient comfort, and overall treatment efficacy in oral healthcare [8.9].

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The aim of this study was to conduct a literature review about the use of laser for the treatment of some oral pathologies as alterations of the normal standards, such as: leukoplakia, mucositis, pyogenic granuloma, burning mouth syndrome, hemangioma, fibrous hyperplasia, mucocele, papilloma and frenectomy.

History

The therapeutic use of light is an ancient practice. In Ancient Greece, sunlight, known as heliotherapy, was employed to promote health [10] . In 1903, Danish physicist Niels Finsen introduced carbon arc phototherapy, utilizing ultraviolet rays to treat lupus vulgaris. The earliest known use of photochemotherapy, involving an external photosensitizer to absorb light for therapeutic purposes, dates back to 1400 BC [11]

In 1916, Albert Einstein's "Zur Quantentheorie der Strahlung-Quantum Theory" laid the groundwork for laser technology by proposing that substances can emit radiation when stimulated. This theory, which forms the core principle of lasers, involves the concept of corpuscular radiation in quantum mechanics. Arthur L. Schalow and Charles H. Townes constructed the MASER (Microwave Amplification by Stimulated Emission of Radiation) apparatus in 1958, building upon this foundation[12] . The first laser device was created in 1960 by Theodore Maiman, who used a ruby crystal to produce a beam of intense red light. This groundbreaking invention initially found application in retinal surgery [13] .

In 1965, dermatologist Dr. Leon Goldman pioneered one of the first medical applications of laser technology by using a laser to remove a tattoo [14] . Expanding on this innovation, Dr. Goldman also employed the ruby laser in dentistry, performing painless enamel surface abrasion on his dentist brother's tooth [15] .

During the 1970s and 1980s, research shifted towards CO2 and YAG (Nd:YAG) lasers, which interacted more effectively with dental hard tissues, leading to their increased use [16] .Early medical applications of the CO2 laser were conducted by Jako and Polanyi in the early 1970s. In 1971, Hall et al., and in 1972, Jako, investigated tissue reactions and wound healing in animal experiments using the CO2 laser [15] Frame (1985), Pecaro (1983), and Pick (1985) demonstrated the successful use of CO2 lasers for treating oral soft lesions and periodontal procedures. The first portable laser device, an Nd:YAG laser, was introduced in 1987, and by 1989, Myers and Myers obtained FDA approval for dental use. [16] The early 1990s witnessed the development of 'Erbium'-based lasers, which overcame challenges in effectively cutting hard tissues and performing tissue abrasion without thermal damage. Today, dental lasers are categorized into soft tissue lasers (Nd:YAG and Diode) and hard tissue lasers (Er:YAG and Er,Cr:YSGG) [17] .

Recent scientific congresses report over 750,000 articles on laser use in healthcare, with approximately 15% focusing on the biostimulation effect [18] . Low or medium power laser devices can achieve this effect, but understanding their mechanisms and technical differences remains complex. Despite numerous publications, standardization in usage methods and dose ranges for low and medium power lasers remains elusive[18] .

Types of lasers

Lasers can best be described according to their gain medium and are broadly classified on this basis as: **Gas lasers**

These include:

- **Helium-neon lasers:** Nitrogen laser
- **Argon laser:** Carbon dioxide laser
- **Krypton laser:** Carbon monoxide laser
- **Xenon ion laser:** Excimer laser.

Solid-state lasers

These include:

- **Ruby laser: Nd:** YAG laser
- **Er: YAG laser: Ho:** YAG laser.

Other types of lasers

Diode lasers, dye lasers, semiconductor lasers, and chemical lasers are the other lasers that are available currently.

PRINCIPLE OF LASER

Dental lasers use the energy generated by atomic electron shifts, producing coherent monochromatic electromagnetic radiation between the ultraviolet and the far IR section of the electromagnetic spectrum, producing both visible and invisible lights with particular wavelength and colour, which act on the particular tissue site to attain the desired effect. The basic principle involved in laser action is quantum nature of light and stimulated emission. Lasers produce heat that converts electromagnetic energy into thermal energy. Emitted laser has three characteristic features: monochromatic, coherent, and collimated.

MECHANISM OF LASER INTERACTION WITH SOFT TISSUE

The oral cavity contains a variety of soft tissue types including but not limited to dental pulp, mucosa, keratinized and non-keratinized gingiva. Furthermore, specific differences can exist for each tissue type, depending on location, tissue thickness, and degree of health.5-6 Depending on the wavelength of the laser device, the following interactions can be seen in varying degrees:7

- **Reflection** – no interaction occurs as the beam reflects off the surface
- **Transmission** – no interaction occurs as the beam passes directly through the tissue
- **Scattering** – an interaction as the beam disperses in a nonuniform manner throughout the tissue
- **Absorption** – light radiation is absorbed by specific tissue elements. The predominant laser interactions within oral soft tissue are absorption and scattering.8-10 As will

be explainedfurther, tissue composition, laser emission mode, fluence, and thermal relaxation also affect tissue interaction.

CLASSIFICATION OF LASERS

Lasers have been classified by wavelength and maximum output power into four classes and a few subclasses since the early 1970s. The classifications categorize lasers according to their ability to produce damage in exposed people, from class 1 (no hazard during normal use) toclass 4 (severe hazard for eyes and skin). There are two classification systems, the **"old system"** used before 2002, and the **"revised system"** being phased in since 2002. The latter reflects the greater knowledge of lasers that has been accumulated since the original classification system was devised, and permits certain types of lasers to be recognized as having a lower hazard than was implied by their placement in the original classification system. The revised system is part of the revised IEC 60825standard. From 2007, the revised system is also incorporated into the USoriented

ANSI Laser Safety Standard (ANSI Z136.1).5

The classification of a laser is based on the concept of accessible emission limits (AEL) that are defined for each laser class. This is usually a maximum power (in W) or energy (in J) that can be emitted in a specifiedwavelength range and exposure time that passes through a specified aperture stop at a specified distance. For infrared wavelengths above 4 _m, it is specified as a maximum power density (in W/m2).

OLD SYSTEM

The safety classes in the "old system" of classification were established in the United States through consensus standards **(ANSI Z136.1)** and Federal and state regulations. The international classification described in consensus standards such as **IEC 825** (later IEC 60825) was based on the same concepts but presented with designations slightly different from the US classification.

This classification system is only slightly altered from the original system developed in the early 1970s. It is still used by US laser product safety regulations. The laser powers mentioned are typical values. Classification is also dependent on the wavelength and on whether the laser is pulsed or continuous.

Class I

Inherently safe; no possibility of eye damage. This can be either because of a low output power (in which case eye damage is impossible even after hours of exposure), or due to an enclosure preventing user access to thelaser beam during normal operation, such as in CD players or laser printers

Class II

The blink reflex of the human eye (aversion response) will prevent eye damage, unless the person deliberately stares into the beam for an extended period. Output power may be up to 1 mW. This class includes only lasers that emit visible light. Most laser pointers are in this category.**5**

Class IIa

A region in the low-power end of Class II where the laser requires in excess of 1000 seconds of continuous viewing to produce a burn to the retina. Commercial laser scanners are in this subclass.**5**

Class IIIa

Lasers in this class are mostly dangerous in combination with optical instruments which change the beam diameter or power density, though even without optical instrument enhancement direct contact with the eye for over two minutes may cause serious damage to the retina. Output power does not exceed 5 mW. Beam power density may not exceed 2.5 mW/square cm if the device is labeled with a "caution" warning label, otherwise a “danger” warning label is required. Many laser sights for firearms and laser pointers are in this category.**5**

Class IIIb

Lasers in this class may cause damage if the beam enters the eye directly. This generally applies to lasers powered from 5–500 mW. Lasers in this category can cause permanent eye damage with exposures of 1/100th of a second or less depending on the strength of the laser. A diffuse reflection is generally not hazardous but specular reflections can be just as dangerous as direct exposures. Protective eyewear is recommended when direct beamviewing of Class IIIb lasers may occur. Lasers at the high power end of this class may also present a fire hazard and can lightly burn skin. Many laser pointers at this output level are now available in this category**.5**

Class IV

Lasers in this class have output powers of more than 500 mW in the beam and may cause severe, permanent damage to eye or skin without being magnified by optics of eye or instrumentation. Diffuse reflections of the laser beam can be hazardous to skin or eye within the Nominal Hazard Zone. Most industrial, scientific, military, medical, and some hand held

REVISED SYSTEM

Below, the main characteristics and requirements for the classification system as specified by the **IEC 60825-1** standard are listed, along with typical required warning labels. Additionally, classes 2 and higher must have the triangular warning label and other labels are required in specific cases indicating laser emission, laser apertures, skin hazards, and invisible wavelengths. This newly revised standard contains several important additions and changes to the last **ANSI Z136.1** document that was published in **1993.**

Class 1

A Class 1 laser is safe under all conditions of normal use. This means the maximum permissible exposure (MPE) cannot be exceeded when viewing a laser with the naked eye or with the aid of typical magnifying optics (e.g. telescope or microscope). To verify compliance, the standard specifies the aperture and distance corresponding to the naked eye, a typical telescope viewing a collimated beam, and a typical microscope viewing a divergent beam. It is important to realize that certain lasers classified as Class 1 may still pose a hazard when viewed with a telescope or microscope of sufficiently large aperture.**5**asers are in this category.**5**

Class 1M
A Class 1M laser is safe for all conditions of use except when passed through magnifying optics such as microscopes and telescopes. Class 1M lasers produce large-diameter beams, or beams that are divergent. The MPE for a Class 1M laser cannot normally be exceeded unless focusing or imaging optics are used to narrow the beam. If the beam is refocused, the hazard of Class 1M lasers may be increased and the product class may be changed. A laser can be classified as Class 1M if the power that can pass through the pupil of the naked eye is less than the AEL for Class 1, but the power that can be collected into the eye by typical magnifying optics (asdefined in the standard) is higher than the AEL for Class 1 and lower than the AEL for Class 3B.**5**

Class 2
A Class 2 laser is safe because the blink reflex will limit the exposure to no more than 0.25 seconds. It only applies to visible-light lasers (400– 700 nm). Class-2 lasers are limited to 1 mW continuous wave, or more if the emission time is less than 0.25 seconds or if the light is not spatially coherent. Intentional suppression of the blink reflex could lead to eye injury. Many laser pointers and measuring instruments are class 2.**5**

Class 2M
A Class 2M laser is safe because of the blink reflex if not viewed through optical instruments. As with class 1M, this applies to laser beams with a large diameter or large divergence, for which the amount of light passing through the pupil cannot exceed the limits for class 2.**5**

Class 3R
A Class 3R laser is considered safe if handled carefully, with restricted beam viewing. With a class 3R laser, the MPE can be exceeded, but with a low risk of injury. Visible continuous lasers in Class 3R are limited to 5 mW. For other wavelengths and for pulsed lasers, other limits apply.**5**

Class 3B
A Class 3B laser is hazardous if the eye is exposed directly, but diffuse reflections such as those from paper or other matte surfaces are not harmful. The AEL for continuous lasers in the wavelength range from 315 nm to far infrared is 0.5 W. For pulsed lasers between 400 and 700 nm, the AEL is 30 mW. Other limits apply to other wavelengths and to ultrashort pulsed lasers. Protective eyewear is typically required where direct viewing of a class 3B laser beam may occur. Class-3B lasers must be equipped with a key switch and a safety interlock.**5**

Class 4
Class 4 is the highest and most dangerous class of laser, including all lasers that exceed the Class 3B AEL. By definition, a class 4 laser can burn the skin, or cause devastating and permanent eye damage as a result of direct, diffuse or indirect beam viewing. These lasers may ignite combustible materials, and thus may represent a fire risk. These hazards may also apply to indirect or non-specular reflections of the beam, even from apparentlymatte surfaces—meaning that great care must be taken to control the beam path. Class 4 lasers must be equipped with a key switch and a safety interlock. Most industrial, scientific, military, and medical lasers are in this category, notably those at the US National Ignition Facility or at the UK Central Laser Facility.**5**

CLINICAL APPLICATION OF LASER IN ORAL MEDICIME
In oral pathology, lasers dispositive can offer important advantages, especially on the treatment of certain lesions1. These advantages includes a higher precision on tissue excision, disinfection of the surgical area, reduction of edema and physical scarf, without a necessity or decreasing the quantity of suture, hemostasis and reduction or elimination of postoperative pain .

The majors lasers of high power are recommended for oral surgeries in soft tissue are the Nd:YAG and CO2 . Both can be used on frenectomy, lesion ablation, removal of the gingival operculum, incisional and excisional biopsy, gingivectomy and gingivoplasty . Despite the literature, mention the superiority of laser in comparison with the conventional surgery, this requires a complementary study that proves its effectiveness and applicability on the oral cavity lesions5,6

Burning mouth syndrome
Burning mouth syndrome is a common disease that represents a diagnostic and therapeutic challenge for the clinical. It is clinically characterized by the burn sensation on the tongue or other oral sites, many times without clinical and laboratory findings1.

The pilot study of Romeo *et al*. (2010) investigated the bio stimulator effect of the laser therapy of low intensity could improve the quality of life of these patients with burning mouth syndrome. Among 160 affected patients by the oral burning sensation, treated on the operative oral pathology unit on the science department complex of stomatology at Sapienza, University of Rome, 77 belonged to the neurological subgroup. Twenty-five of these patients, 16 of the female sex and 9 of the male sex, were random selected for the application of laser of low power. [21] All the patients were irradiated with diode laser (Lumix 2 Prodent, Italy) contemporaneously emitting at 650 nm and 910 nm, with a fluency of 0,53 J/ cm during 15 minutes, twice a week during 4 weeks. The irradiated areas were the tongue edges towards the taste fibers. The authors reported that seventeen patients (68%) had relevant benefits from the treatment, however concluded that more investigations are necessary to clarify, for a bigger number of cases and control group, the real efficiency of this innovative therapy.

The study performed by Santos (2011) aimed to evaluate the effect of low intensity laser on the treatment of burning mouth syndrome. For this, ten patients diagnosed with this syndrome were included on the study. All of these patients were submitted for a weekly section of LBI during 10 weeks. It was utilized a continuous wave length of 660 nm, power of 40 mW, 20J/cm2, 0,8J/ point, with irradiation of each point during 10 seconds. In all sections the intensity of oral burning sensation were evaluated with an analogical visual scale of 10-cm (VAS), with 0 indicating none symptom and 10 indicating the worst burning sensation possible. This evaluation of intensity by VAS was performed immediately before and immediately after each section of laser therapy of low intensity. In accordance to this, the authors considered the laser therapy as an alternative treatment to relief the oral burning on patients with burning mouth syndrome. [22]

Inflammatory fibrous hyperplasia

The inflammatory fibrous hyperplasia (IFH) is a benign proliferative lesion, of high frequency, which occurs in response to chronic injuries of low intensity (FALCÃO, LAMBERTI, LORENS, *et al.* [24] . Its appearance is frequently associated with the usage of dental prostheses badly adjusted or with suction chamber)[25] . The treatment of choice consists on the removal of the irritant agent, conventional surgical removal, microabrasion, cryotherapy and laser)[24].

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*. [26] 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.

Pedron *et al.* , is his case report, described the excision of a lesion of IFH, localized on the groove background, on the right anterolateral region, utilizing the Nd: YAP laser and observed a good evolution of the case, absence of post-operative discomfort, as well as good tissue reparation, suggesting that, the administration on laser on IFH lesions is a rapid procedure, secure and is an important tool on the clinical care of the dentist surgeon[27] .

Frenectomy

Frenulum are folds, have congenital origin, composed by fibrous tissue, muscular or fibromuscular, covered by a mucous membrane49. In normal conditions, the frenulum does not cause pathological consequences, however, the presence of anomalous frenulum can be trigger a series of prosthetic alterations, orthodontics, phonetics and of periodontal nature [28,29] . The surgical removal of the frenulum, named frenectomy, can be performed by conventional scalpel mode, with electric scalpel or by the surgical lasers [30,31] The principals effects observed on the surgeries of soft tissue Meanwhile, the laser has demonstrated to be a secure alternative, efficient and acceptable on frenectomy. Haytac & Ozcelik., [32] in a prospective study with 40 patients the authors looked to evaluate the degree of post-operative pain, such as de discomfort and functional complications, experimented by the patients that were submitted to frenectomy with CO2 laser compared with the ones that has received the conventional surgery with scalpel. The results indicated that patients treated with CO2 laser had less post-operative pain and less number of functional complications in comparison with the patients treated with the conventional technique.

Studies as the Kara [33] revealed a significant decrease on the degree of fear on frenectomy performed with the Nd: YAG laser in relation to the conventional technique. On the other hand, Junior *et al*. [34] , pointed some advantages on the realization of labial frenectomies with Nd: YAG laser, with an absence of trans-operative bleeding, not necessity of suture, as well as a significant reduction of the surgical time when compared to the conventional technique. However, despite the large part of the literature present the superiority on standards of clinical post-operative such as pain and oral function when using laser, in this study this could not be observed. The same study also strove to the fact that bone problems can occur, regarding that the Nd: YAG laser is characterized by an important dissipation of thermal energy36 and, the periosteum and superior jaw are in close contact with the mucous of papillary gum, making difficult the excision of this papillary region; because the laser ray should not reach the periosteumthe bone structure, to not provoke local necrosis[35] .

Pyogenic granuloma

Pyogenic granuloma is a mucocutaneous benign lesion relatively common. The term is a mistake once the lesion does not contain pus and it is not granulomatous. The most common intraoral site is the gum margin, but the lesions have been reported on the palate, oral mucous, tongue and lips33.

The lesion appears as a non-neoplasic growth, the choosen treatment being the excisional therapy, but some alternatives approaches, such as cryosurgery, the excision by ND: YAG injection of corticoid or ethanol, and sclerotherapy with sodium tetradecyl sulfate has also been reported as efficient34.

The study of Rai *et al*. (2011)35 reported a case of a patient with 50 years of age with lesion on the gum between the elements 23 and 24 which was treated with diode laser produced by Picasso (Kavo, US), with the following specifications: wave length of 808 nm ([+ or -] 10), the energy production 0,1- 7,0 W, and entrance power of 300 VA. The wavelength that was utilized was of 810 nm and 7 W of power, maintaining the pulse mode continue/ interrupted. The local anesthetic was not utilized. The tip was maintained at a distance of around 1 mm from the soft tissue during the process, and took 4-5 minutes to completely exscind the lesion. It was not prescribed any antibiotics, anesthetic or anti-inflammatory on the post-operative. The cut off mass was sent to histopathological and there was a complete resolution of the lesion without any complication. Therefore, the authors concluded that the diode laser could be a good therapy option to intraoral pyogenic granuloma.

White *et al*. (1991)36 proposed that the excision with laser is well tolerated by the patients, without adverse effects.

They also state that the CO_2 and irradiation with the Nd: YAG laser it is successful on the surgical treatment 34. The diode laser has shown excellent results on cutaneous pyogenic granuloma with minimum pigments and textural complications. Gonzales *et al*. (1996)37 demonstrated compensation both symptomatic as clinical of the lesions, with excellent cosmetics results with 16 of 18 treated patients. However, there is not a minimum convincing proof of its efficiency on intraoral pyogenic granuloma.

Oral lichen planus (OLP)

Oral Lichen planus (OLP) is a chronic inflammatory mucocutaneous disease of unknown etiology in which apoptosis of basal keratinocytes is induced by CD8 +T cells. It usually affects the middle and old age population with the female: male ratio being 2:1 and the age range documented is between 30–60 years. [36]

Typically, the disease presents with multiple lesions with the bilateral symmetrical distribution. Andreasen's classification divides oral lichen planus (OLP) into six clinical forms: reticular, papular, plaque-like, atrophic (erythematous), erosive-ulcerous, and bullous-erosive. [37]

At the early disease stage treatment is usually aimed to abolish the symptoms and extend the periods of remission while complete disease eradication cannot be achieved by any approach. Corticosteroids, despite their various adverse effects like thinning of the oral mucosa, secondary candidiasis, and tachyphylaxis is considered the gol standard in the treatment of OLP. Topical calcineurin inhibitors such as tacrolimus; topical and systemic retinoids such as tretinoin and immunosuppressants such as azathioprine have been considered as an alternative to corticosteroids. The alternative promising non-pharmacological modality that should be considered is LASER phototherapy.

Aphthous Ulcers

Aphthous ulcers are painful and often recurrent. Laser treatment of aphthous ulcers is an alternative to temporary palliative pharmacologic therapy. The laser provides relief of pain and inflammation, with normal wound healing of this uncomfortable and potentially recurrent oral lesion. Lasers when used in defocused mode removes exposed nerve endings. The lesion can be rendered insensitive at low wattage within 4 minutes or less. Healing time is reduced markedly [38].

Recurrent aphthous ulcers are also known as canker sores. It is the most common oral ulcerative lesion. The exact cause of these ulcers is unknown. They can various possible etiologic factors like trauma, stress, lack of sleep, vitamin B12 deficiency, iron deficiency or immune reactions. These lesions are usually found on the lips, buccal mucosa, tongue, soft palate and floor of the mouth. Clinically they appear as a yellowish white pseudo membrane surrounded by erythematous halo. The ulcer is painful on palpation. Recently Low Level Laser Therapy (LLLT) has been used. It helps in immediate pain relief and accelerates wound healing. According to De Souza et al, 75% of the patients reported that 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 5-7 days for regression, Bladowski et al also found that diode laser used at low levels reduces the wound healing period to half compared to pharmaceutical method [39,40]

It is best to treat aphthous ulcers within the first 48 hours. 400 micron tip is used for small lesions. The laser defocused mode 5-6mm away from the lesion and advanced towards the periphery 2mm away. Continual movement from the periphery to the centre is done.15-20 seconds period is given between the laser allowing the tissue to cool. The area, a wet gloved finger to determine if there is reduced pain felt. 2nd and 3rd pass need to be done to completely reduce the pain. After every application of laser, the area should be palpated to check for reduced pain. [41,42]

Oral mucosites

The oral mucositis is an inflammatory response of the oral mucous, being a secondary detrimental effect to treatments with anti-neoplastic drugs or usage of ionizing radiation, on neoplastic diseases of head and neck. Lino *et al*. [43], reported the efficiency of the laser phototherapy (LPT) on the treatment of oral mucositis induced by RT (radiotherapy) after the surgical removal of the carcinoma of squamous cells with bone invasion of the jaw. The lesions of the palate and commissural were treated with LPT λ660 nm, 40 mW e Ø = 4 mm2, in contact mode, 5 x 2,4 J/cm2 per point, 14,4 J/cm2 per section. For the treatment of the lesions on the nasal mucous, the dose utilized were of λ780 nm, 70 mW and ∅ = 4 mm2, 3 x 2,1 J/cm2 per point, 6,3 J/cm2 per section, in contact mode, applied on the outside area of the nose. One single dose (2,4 J/cm2) with the laser λ660 nm, as was described before, was applied on the entrance of each nostril. A LPT was used 3times/week during 4 weeks. After the treatment, the study had concluded that a significant improvement in relation to the pain symptoms, difficulty of swallowing of solids and liquids, as a progressive decrease on the gravity of the lesions, which allows the patients the return to daily activities, an improvement on the quality of life and an adherence to radiotherapy treatment.

Elad *et al.* [44] evaluated the efficiency of the dispositive of a new visible light therapy (MLV) to prevent oral mucositis in patients undergoing to transplantation of hematopoietic stem cells (TCTH), having good results in relation to the level of pain and acceptance of the patients of the group undergoing to the laser treatment, as the level of gravity of the lesion in relation to the control group.

According to the meta-analysis held by Figueiredo *et al*, [45] it is possible claim that the LT, when applied on patients undergoing to oncotherapy, is efficient on the control of Oral Mucositis on advanced degrees, demonstrating the importance of prevention imposed by the oral mucositis degree ≥3, which can even lead to the non-adherence and consequently interruption of the treatment. On the other hand, the randomized clinic assay published by Lima *et al*., [46] , concluded that the therapy with low intensity of laser was not efficient on the reduction of oral mucositis on advanced degrees, although a marginal benefit cannot be exclude in terms of reduction on the interruptions of the radiotherapy, which can translate into a greater efficiency.

Leukoplakia

Leukoplakia is a common mucous pathology with power of 0,1- 17 % of risk of malignant transformation22,23. Etiology of the leukoplakia still is not clearly established. Smoking, alcohol abuse, mechanic injuries, infection by *Candida albicans* and the different locations of galvanic potential are reported as most important casual factors [47] .

As its etiology cannot be established, the treatment is difficult anshoinsufficientefficiency[48].

However, the possibilities of treatment include the resection of the lesion, cryotherapy, use of laser, as well as administration of vitamin A and retinoids.

Lodi *et al*. [51] , through a systematic literature revision, addressed the different modalities of the treatment of leukoplakia, aiming to compare the results between affected patients by oral leukoplakia, submitted to medical treatments or surgical, or both (group of study), in relation to patients which has received placebo or any treatment (control group). Among the therapeutic modalities evaluated on the group of study, were: the surgical removal of the lesion, including the traditional surgical excision, laser surgery, cryotherapy; topical treatment, including anti-inflammatory, antifungal agents, carotenoids and retinoids and cytotoxic agents; systematic treatment; removal of predisposing habits, as example, tobacco and alcohol; other treatment, as photodynamic therapy and last, combined treatment. Such authors concluded that until the moment there is no evidence of efficient treatment on the prevention of malignant transformation of the leukoplakia, the treatment can efficient on the resolution of the lesion, however, malignant alterations and adverse effects can occur.

In the last years the photodynamic therapy has been introduced as a new method of alternative treatment for the lesion. The photodynamic therapy uses the light that has a defined wavelength to activate the photo-sensitizers ac cumulated on the cells28,29.

On the study of Pietruska *et al*. [52] , twenty three patients with age between 21 and 79 years were included, in which 44 flat homogenous lesions, clinically diagnosed and histopathologically confirmed as leukoplakia, were submitted to photodynamic therapy held with the utilization of the photo sensitizer Photolon®, containing 20 % of cloro-e6 and 10 % of dimethylsulfoxide and a semiconductor laser, with power up to 300 mW and wavelength of 660 nm. Ten sections were performed utilizing the superficial density of light energy of 90 J/cm2. On the initial evaluation the average size of the lesion were of 6,5cm ± 2 while after the photodynamic therapy the average size were of 3 cm ± 2,99 centimeters with significant reduction (an average, 53,8 %) of the size of the lesion, observed after the therapy. Eleven (27,27 %) remains unchanged. The authors still report that there were no adverse local effects during the treatment and conclude that the photodynamic therapy with the use of cloro-e6 can lead to a considerable reduction of the leukoplakia oral lesions being useful on the clinical practice.

The usage of CO2 laser has turned the base of the treatment of leukoplakia and pre-cancerous lesions all over the world and has demonstrated efficiency and with low morbidity31, and can be better obtained by ablation or vaporization of the lesion .

On the study performed by Tambuwala *et al*. [53] thirty patients with bilateral lesions was allocated into two groups, one experimental, where was performed the excision of the lesion utilizing laser of carbon dioxide and a control group where the excision of the lesion was performed with scalpel. The authors concluded, through this study, that the CO2 laser replaces the conventional scalpel in terms of better intra-operative bleeding and reduction on the formation of scars, however, in relation to the post-operative pain and edema after the excision the laser has not shown a statistically significant difference than the scalpel.

Hemangioma

The hemangiomas are the mesenchymal tumors formed by blood vessels, which exhibit an increase on the cellular proliferation11. It grows quickly, regress slowly, and never reappear. All the three phases of the life cycle of an hemangioma are characterized by a single set of markers and biological processes, which are:

(1) Proliferative Phase (0 To 1 Year Of Age),

(2) Involution Phase (1 To 5 Years Of Age), M

(3) Involute phase (>5 years of age);

However, the spontaneous involution can be incomplete and around 15% to 20% of the residual lesions can remain12. A total of 65,3 % of the affected patients is children and approximately 20% of the patients have multiple lesions. On average, 80% of the lesions are localized on the head and neck regions and the mucous membranes are involved in 10 % of the cases (JINNIN, ISHIHARA, BOYE *et al* [54].

According with Van Doorne *et al*. [55] many therapies have been administrated on the treatment of vascular lesions, including oral corticosteroids, intralesional injections of fibrosing agent, therapy with alpha interferon 2 b, treatment with laser and embolization.

The usage of lasers of diode and Nd: YAG laser in surgeries of soft tissues of the oral cavity is extremely useful due the fact that it is highly absorbed by the chromophores, as hemoglobin, melanin, and collagen, and also due the cutting capacity, coagulation, and hemostasis, with a higher capacity of tissue ablation and similar properties of the laser of potassium titanium phosphate (KTP) [56] . Thus, the laser is currently considered the gold standard for the treatment of the major part of vascular lesions.

Transmucosal thermo-coagulation is a technique without accent, widely used for the treatment of vascular lesions. The energy of the diode laser is continually liberated by a flexible optical fiber, which is slowly moved over the lesion, by a 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. This effect is called the “forced dehydration”, and occurs due the increased absorption of laser energy by the hemoglobin on the interior of the lesion. As it passes through the tissues, the laser beam generates heat and, so, coagulates the tissue to a depth of around 7 to 10 mm, a process called photocoagulation where, a dehydration and whitening of the hemangioma can be observed on immediate post-operative16.

Different authors[56-59] recommend the technique of the endoluminal sclerosis for hemangiomas on the orofacial area. Lapidoth *et al*. [53,58] even combines the use of intralesional diode laser with radiofrequency, with a rate of success of 90%, with few post-operative complications. The success rate of 95,24% for one or two sections of treatment is referred by Torres *et al* [59]

On the study of Álvarez-Camino *et al*. [60] it was performed on a single section the application of the intralesional diode laser through the active optical fibre of 1W on continuous mode, insert into the interior, through one intramuscular needle injection, from the most depth portion to the surface of the lesion. From a total of 10 hemangioma cases on oral mucous, with an average age of 25,4 years, in 8 cases it was made necessary only one section, before the clinical verification of a total reduction of the size of the lesion. In two cases, were necessary at least 2 sections of intralesional photocoagulation to reach a satisfactory static result. There was no complication of any kind. After a follow-up period of at least 6 months, only one case of recurrence was described. It was concluded that the treatment of the lesions by the endoluminal diode laser is a practical, quick, simple, minimally invasive technique, held by local anesthetics at ambulatory, with low rates of complications.

Thus, the intralesional photocoagulation should be considered an excellent to other modalities well established for the treatment of oral hemangioma[61] .

Nuño-González *et al*. [62] in his cross-sectional observational study of a series of 11 patients with venous malformation on the mucous, treated with a single section of Nd: YAG laser, concluded that the therapy is quick, secure and relatively easy to learn besides does not causes bleeding. The post-operative discomfort is minimum, as the potential of occurring scars. Therefore, for theses authors, the Nd: YAG lasers are the choice of approach on the treatment of vascular lesions of the mucous.

Squamous cell papilloma

Papilloma represents a benign oral lesion with epithelial origin, normally associated with infection with the human papilloma virus (HPV) type 6 or 11 [63,64] The HPV is considered a risk factor for the development of carcinomas. Thus, is primordial the correct diagnostic of papilloma, since many lesions caused by HPV can turn to malignant and show a high rate of cure when treated early[64] .

There are few studies on the literature that evaluates the treatment of papilloma with high power laser and/ or compare with conventional surgical techniques. Baeder *et al*. [65] , evaluates the diode laser effects for the removal of oral lesions caused by HPV and the effects caused by the viral load after the process of healing of the tissue on comparison with the conventional surgery involving electro cauterization. The sample was composed by 5 patients that had obtained 2 distinct lesions caused by HPV, in which were control cases of their own composed the sample. All the patients were submitted both electro cauterization, and also the diode laser. Passed 20 days of the lesion treatment, were collected the samples for analysis of the viral load. The authors observed the presence of virus in all samples, however the surgeries with laser reviled a significant reduction on the quantity of virus per cell in comparison with electro cauterization.

Angiero *et al.* [66] evaluated the efficiency of therapeutic of the laser on oral papilloma lesions. They selected 174 patients with lesions of intraoral and lip HPV and performed the excision with diode laser in different wavelengths (810-980 nm), with an average of power of 2,1 W in continuous emission mode. In 95,4 % of the cases there was a complete cure on the first 30 days, there was a relapse on 1 case, in which was treated later with success, and an average VNS score for evaluation of pain was inferior of 1.

In turn, Boj *et al.* [63] , in his case report, described the excision of a lesion of squamous cell papilloma utilizing the ER, Cr: YSGG laser. In the present case, a minimum quantity of local anesthetics was utilized, there was no necessity of anesthetics medication after the surgery and the wound healing occurred rapidly.

The success of the laser of high power on the treatment of papilloma can be explained by the photo-thermic effect, so, the conversion of electromagnetic energy of the bundle of laser on heat. This effect triggers tissue alterations that are observed on the cutting edge, where the temperatures are between 60 °C and 100 °C, reducing the quantity of infected tissue. The photocoagulation can, so, induce on the denaturation of viral proteins, destruction of the virus and at the same time, complete removal of the papilloma [66].

Therefore, the treatment of the viral lesions, the laser appears essential, because besides eradicating lesions, promotes a reduction of relapse, because acts directly over the viral load, reducing it16, . Moreover, the laser of high power is associated with a minor necessity of local anesthetics and suture, reduce surgical time, hemostatic effect, excellent visibility of the surgical area and reduction of pain and post-operative edema [61-63].

Herpes Labialis and Herpetic Gingivostomatitis
Soft tissue lawers is successful in diminishing the effects of herpes virus infections. The infusion of laser disrupts the activity of virus, arresting the lesion progress. Herpes labialis have been treated successfully with Nd:YAG lasers [67,68,69,70].

Salivary Gland Pathologies
Sialolithiasis is the disease of the salivary glands. Most of the sialoliths are found in the submandibular gland. Various types of lasers have been employed to treat sialolithiasis, including carbon dioxide, diode, and Nd:YAG lasers [69,70,71].

Smokeless tobacco induced white lesions
These lesions are induced by the chronic usage of smokeless tobacco. These lesion are treated by carbon dioxide lazers. Nicotinic Stomatitis caused by pipe smoking or cigar smoking. The lesion appears as a red dots surrounded by a halo of white keratin. These lesions are usually asymptomatic. If the patient complains of pain, laser treatment done to as a treatment. The lesions are vaporized after multiple punch biopsies. Carbon dioxide laser is used in this case, continuous mode perpendicular to the tissue surface along the long axis of the lesion [69 - 72].

CONCLUSION
The use of the lasers in the management of oral premalignant lesions has got many advantages over other treatment modalities. The ability to perform less invasive procedures with greater patient comfort makes laser dentistry something the modern practitioner. The other advantages of lasers are-healing faster, no pain, no bleeding and easy to use or perform.

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