

A REVIEW ON USAGE OF LASER IN ORAL SURGERY

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ABSTRACT: *In this review collected from the literature on usage of laser in oral minor surgery based on a Medline search in the time period between the years: 2008 and 2013, the most current evidence on laser-assisted oral minor surgery is going to be surveyed. Lasers in oral surgery are much useful in almost all surgical procedures in dentistry. More developed and innovative lasers are available in commercial markets. Dentists will be more knowledgeable if they tend to attend seminars regarding lasers to get used to the latest technologies. Laser is a monochromatic, collimated, coherent, and intense beam of light produced by stimulated emission of radiation from a light source. Lasers are classified according to different factors among which is the classification based on laser active medium such as gas, liquid, solid and semiconductor, which identifies and distinguishes the type of emitted laser beam.*

Keywords: *laser; oral surgery; dentists.*

1. INTRODUCTION

Laser is a monochromatic, collimated, coherent, and intense beam of light produced by stimulated emission of radiation from a light source. Lasers are classified according to different factors among which is the classification based on laser active medium such as gas, liquid, solid and semiconductor, which identifies and distinguishes the type of emitted laser beam¹. Visible beams (i.e. the Argon laser at 488 or 518 nm) and invisible beams in the infrared range (i.e. CO₂ (Carbon Dioxide Laser), Ho:YAG (Holmium Yttrium Aluminium Garnet), Er:YAG (Erbium substituted: Yttrium Aluminium Garnet), Er-Cr: YSGG (Erbium, Chromium Doped Yttrium Scandium Gallium Garnet), ND:YAG (Neodymium-Doped Yttrium Aluminium Garnet), Diode (Gallium Arsenide) (GaAs)) are used in dentistry. The properties of a specific laser beam, particularly wavelength and the optical characteristics of the particular target tissue determine the type and the extent of interaction which may occur.(Maiman, 2017)

Low level laser therapy (LLLT) which has therapeutic effects without inducing a lot of heat is established in clinical dentistry because of its anti-inflammatory, bio stimulant and regenerative effects. Its use has been widely reported with satisfactory results in the literature.(Miserendino and Cozean, 1998) The recent rapid developments in laser technology and better understanding of bio-interactions of different laser systems have broadened the clinical use of lasers in dentistry.(Coluzzi and Parker, 2017) Common lasers used in oral surgeries are CO₂, Er. Family, Diode and Nd:YAG. Also low level lasers are used in assisting the procedures of disinfection and healing. CO₂ was the first laser introduced to dental practitioners in the mid-1980s, because of its outstanding cutting abilities and surprisingly, after more than 25 years, it still remains as a desirable choice in facial cosmetic surgeries (10,600 nm).(Goldman, Goldman and Van Lieu, 1987)

The Erbium family lasers (Er:YAG 2940 nm and Er,Cr:YSGG 2790 nm) are the lasers mainly used in dentistry for cavity preparation (Paghdiwala 1988, Keller 1989). Their emission wavelengths are perfectly matched to the absorption maximum of water which is a component of oral tissue. Nd:YAG laser, is currently cleared by the U.S. food and drug administration for certain periodontal procedures and some vascular lesions. Its deep extinction length and penetration depth in soft tissue create significant lateral tissue damage, desirable for vascular lesions, but not for other pathology.(Frentzen and Koort, 1990) Diode laser (810-1064 nm) has become very popular in general dentistry because of their small size, low cost, fiber optic delivery and ease of use for minor surgery of oral soft tissue. The use of low level Diode laser for noninvasive athermal laser therapy is popular in European countries.(Aoki *et al.*, 1994) The application of these aforementioned lasers in surgery in the literature will be surveyed in this review article.(Lakshmi*et al.*,2017)

Removal Of Oral Mucosa Lesions

A clinical study described the application of the potassium-titanyl-phosphate (KTP) laser (532 nm), used with low power parameters (1 Watt – CW) to evaluate the intra and postoperative pain. They proposed that KTP laser with low parameters permits to perform oral surgery with good pain control and good wound healing (Fornaini).(Pelagalliet *al.*, 1997)

Oral Leukoplakia

Oral leukoplakia is a premalignant lesion of the oral mucosa. A randomized clinical trial compared the pain and swelling after removal of oral leukoplakia with CO₂ laser and cold knife. They concluded that CO₂ laser caused only minimal pain and swelling, thus suggesting that it may be an alternative method to conventional surgery in treating patients with oral leukoplakia. A nonrandomized, single-arm, single-site phase 1/2 pilot study determined the safety and efficacy of photodynamic therapy in the treatment of oral leukoplakia with 5-aminolevulinic acid and pulsed dye laser.(Convissar, 2015)

Photodynamic therapy with 5-aminolevulinic acid and pulsed dye laser could be used to achieve regression of oral leukoplakia. The treatment is safe and well tolerated. An application time of 1.5 hours and laser radiant exposure of 8 J/cm with 1.5-ms pulse time were found to be the optimal settings in this study. The high-power laser used in this study allows completion of laser therapy within 1 to 3 minutes. Further studies are necessary to determine the optimal laser radiant exposure and drug application to maximize the response rate (Einstein, 2005) . The

curative effects of photodynamic therapy (PDT) and cryotherapy in the treatment of oral leukoplakia were compared. They found that the advantages of PDT are connected to the minimally invasive and localized characters of the treatment with no damage to collagenous tissue structures; therefore normal cells will repopulate these arrangements. PDT is more convenient for patients, less painful, and more esthetic.(Patel, Moran and Nakada, 2017)

A prospective study evaluated clinical healing of a leukoplakia lesion after laser surgery, which was associated with a normal functional status of the new epithelium, also pathological alterations were related to the risk of local recurrence. They concluded that clinical healing of leukoplakia treated by laser surgery may be accompanied by altered cell turnover in 20% of the cases. Ki67, as a marker of proliferative status, may be a prognostic indicator in the mucosa replacing the lesion.(Fujiyama *et al.*, 2008) Yang et al. evaluated the associated factors of recurrence in patients who received laser surgery for dysplastic oral leukoplakia. This study suggested that continuous smoking after surgical treatment and widespread multiple-focus lesions are the prognostic indicators for recurrence after laser surgery. Changes in oral habits could be of great importance to the outcome of laser surgery of dysplastic oral leukoplakia.(Fornainiet *al.*, 2007)

Lichen Planus

Oral lichen planus (OLP) is a common chronic disease of uncertain aetiology. Treatment of patients with symptomatic OLP represents a therapeutic challenge. One study evaluated the efficacy of diode laser (940 nm) in the management of oral lichen planus. Their results demonstrated that diode laser therapy seemed to be an effective alternative treatment for relieving the symptoms of OLP10 (Misra, 2013 #491). Low-level laser and CO2 laser were compared in the treatment of patients with oral lichen planus. They showed that low-level lasers displayed better results than CO2 laser therapy as an alternative or additional theory.(Slot *et al.*, 2009)

A clinical report demonstrated the efficiency of Er:YAG laser in reducing symptoms and lymphoplasmacytic infiltrate in case of oral lichen planus (OLP). The parameters used were: energy, 80-120 mJ; frequency, 6-15 Hz; non-contact hand piece; spot size diameter, 0.9 mm; pulse duration, 100 µsec (very short pulse) to 300 µsec (short pulse); fluences, 12.6-18.9 J/cm²; and air/ water spray (ratio: 6/5). The use of this wavelength offers several advantages including, a good and fast healing process, a very low level of discomfort during and after intervention, and a rapid disappearance of symptoms.(Harashimae *et al.*, 2005) A case report presented a histologically diagnosed oral lichen planus excised by CO2 laser. CO2 laser was used to remove the lesion and the conclusive histopathological diagnosis was oral lichen planus. The patient was followed up over 1 year with no signs of lesion recurrence. The use of the CO2 laser was found to be useful and effective to treat lichen planus.(Freitas and Simões, 2015)

Gingival Melanin Pigmentation

A clinical and histologic study compared surgical stripping; erbium-doped:yttrium, aluminum, and garnet laser; and carbon dioxide laser techniques for gingival depigmentation. They concluded that clinical repigmentation after gingival depigmentation is an outcome of histologic changes in the melanocyte activity and density of the melanin pigments. Surgical stripping for gingival depigmentation remains the gold standard; however, Er:YAG laser and CO2 lasers can

be effectively used but with distinct differences.(Hilgers and Tracey, 2004)Simsek et.al compared the use of diode and Er:YAG lasers in treating gingival melanin pigmentation (GMP) in terms of gingival depigmentation, local anesthesia requirements, postoperative pain/discomfort, depigmentation effectiveness, and total treatment duration. Their results demonstrated the total length of treatment was significantly shorter with the diode laser than with the Er:YAG laser. No melanin recurrence was detected during any follow-up session. They concluded Diode and Er:YAG lasers administered at 1 W both result in satisfactory depigmentation of GMP15.(Carroll and Humphreys, 2006)

Oral Dysplasia

A prospective study evaluated recurrence, residual disease malignant transformation, and overall outcome in patients undergoing such procedure. They demonstrated that recurrence and malignant transformation was mainly identified in erythroplakia and non-homogenous leukoplakia. Laser resection/ablation was recommended for oral dysplasia to prevent not only recurrence and malignant transformation but also postoperative oral dysfunction encountered by other conventional modalities.(Olivi and Olivi, 2015)

Mucocele

Mucocele are benign lesions of the minor salivary glands that are common in children. The most frequent localizations of these lesions include the lower lip and the cheek mucosa.(Tracey, no date)Agarwal et.al described the case of a 4-mm extravasation mucocele located on the lower lip with an erbium laser. They showed the wound healed excellently and rapidly without sutures. No relapse was observed a year after the surgery.(Agarwal, Mehra and Agarwal, 2013) Lasers apply modern technology and are useful for soft tissue surgery in pediatric dentistry, as operations are rapid and wounds heal well without sutures. Oral mucocele resection with the scalpel versus the CO2 laser was compared. Their results showed that oral mucocele ablation with the CO2 laser offered more predictable results and fewer complications and recurrences than conventional resection with the scalpel.(Weiner, 2004)

Ranula

Ranulas are mucus extravasation phenomenon formed after trauma to the sublingual gland or mucus retention from the obstruction of the sublingual ducts. Lai et.al presented a case series report on the use of carbon dioxide laser treatment for ranula and a literature review of cases treated using carbon dioxide laser. The authors' experience and reports in the literature indicated that carbon dioxide laser excision of ranula was safe with minimal or no recurrence.(Tominaga, 1990)

EpulisFissuratum

Epulisfissuratum is a pseudo tumor growth located over the soft tissues of the vestibular sulcus caused by chronic irritation from poorly adapted dentures. Treatment indication for these lesions is surgical excision with appropriate prosthetic reconstruction. One study proposed treatment of epulisfissuratum with a carbon dioxide laser in a patient with antithrombotic medication. The lesions were excised with CO2 laser, and no significant complications, such as hemorrhage, pain, swelling or infection, were recorded. They proposed that use of CO2 lasers is currently the gold standard in the excision of this type of lesion, especially in patients with hemorrhagic diathesis or under antithrombotic therapy.(Loevschall and Arenholt-Bindslev, 1994)

Treatment of epulisfissuratum with CO₂ laser and prosthetic rehabilitation of three patients with vesiculobullous diseases (VBDs) was presented with Işeri et al. The excision of fibrous tissue was performed with CO₂ laser, and the wounds formed by laser were left open to secondary epithelialization. They demonstrated that the CO₂ laser might be a useful instrument in the treatment of soft tissue pathologies in VBDs patients due to minimal damage to surrounding tissue. Use of complete or partial dentures had been considered a practical, economic, and nonsurgical treatment option for patients who have been diagnosed with VBDs.(Noble *et al.*, 1992)

Cancer of Oral cavity

A retrospective study assessed the efficacy of Nd:YAG laser for stage I squamous cell carcinoma of the lip. Their results reported the use of Nd:YAG laser for treatment of Stage I squamous cell carcinoma of lip in accordance with principles of minimal invasive and morbid surgery.(Asencio-Arana *et al.*, 1992) A retrospective study analyzed two hundred thirty-two patients with cancer of the oral cavity were treated by enoral laser microsurgery ± selective neck dissection ± postoperative (chemo) radiotherapy. They concluded that enoral laser microsurgery is an efficient therapeutic option in the treatment of oral cavity cancer.

Oncological and functional results are comparable to any other treatment regimen, whereas morbidity and complications tend to be lower. A retrospective analysis evaluated 296 cases of early glottic squamous cancer with and without the involvement of anterior commissure (AC) treated by transoral CO₂ laser microsurgery. Transoral laser surgery is an excellent treatment option in patients with early glottic cancer irrespective of whether or not the AC is involved. Transoral laser microsurgery for early glottic cancer involving AC requires adequate exposure, proper assessment, good experience, and advanced surgical skills.(Poureau-Schneider *et al.*, 1992) An experimental analysis evaluated tungsten carbide bur, piezoelectric and laser osteotomies. They concluded that currently, purchase and management elevated costs, minor versatility of use, and long training times for equipment such as Piezosurgery and laser limit their general use, but remain advantageous in case of risky interventions near noble structures.

Choice of device dependent on experience matured by operator in time, characteristics of operation and patient's clinical condition. An experimental study compared thermal changes of the bone surface, procedure time, and volume of the removed bone after drilling with an erbium: yttrium aluminum garnet (Er:YAG) laser (pulse energy, 1,000 mJ; pulse duration, 300 µs; frequency, 20 Hz) versus a low-speed surgical drill. They concluded that the Er:YAG laser produced preparations with regular and sharp edges, without bone fragments and debris, in a shorter time, and with less generated heat. Thermal alterations in the treated surface were minimal³⁵. Luna-Ortiz et al. reported that transoral laser microsurgery was recommended for treatment of soft palate tumors. This treatment could be considered a better option when compared with other modalities such as radio- or chemoradiotherapy which required a longer time. of treatment, were more expensive and tend to produce significant toxicity³⁶. Photodynamic therapy (up to three rounds) is a comparable modality to other traditional interventions in the management of low-risk tumors of the oral cavity.(Gálet *et al.*, 2009)

Although, sometimes, multiple rounds of the treatment are required, morbidity following PDT is far less when compared to the three conventional modalities: surgery, radiotherapy, and chemotherapy. A clinical case evaluated the healing of the site after removal of the lesion with use of the laser diode. The laser diodes gave a significant contribution to improving the surgical treatment of tumors of the oral cavity, in fact during the surgery reduce bleeding and surgical time, and while in the process of healing by reducing swelling and post-operative pain and better results appearance without scarring.(Xiong and Li, 2012)

Excisional Biopsy

A prospective randomized controlled clinical trial evaluated and compared clinical and histopathologic findings of excisional biopsies performed with CO₂ laser (10.6 μm) modes in 60 patients with similar fibrous hyperplasias of the buccal plane. No significant difference was found in the widths of thermal damage zones between the CW and CF groups. The visual analogue scale (VAS) values and analgesic intake were low in the 2 groups. The 2 CO₂ laser modes were appropriate for the excision of intraoral mucosal lesions. A safety border of at least 1 mm was recommended regardless of the laser mode used. A prospective animal study compared operative time and hemostasis of fiber-enabled CO₂ laser (FECL) energy to that of the electrocautery (EC) technique for oral tongue resection.

They determined both EC and FECL are effective for resection of the tongue in rats. EC has the advantage of shorter operative time and lower mucosal wound-healing scale scores by postoperative day 3; FECL has the advantages of less intraoperative bleeding, faster return to baseline body weight, and lower mucosal wound-healing scale score by postoperative day 740. One study compared the conventional surgery with carbon dioxide (CO₂) laser applied on oral soft tissue pathologies and evaluated the effect of collateral thermal damage on histopathological diagnosis. They reported that CO₂ laser is an effective instrument for soft tissue excisional biopsies with minimal intraoperative and postoperative complications and good pain control. CO₂ laser applications are suggested as an alternative method to conventional surgery on oral soft tissues.(Miserendino and Pick, 1995)

Treatment of Oral Cavity Venous Malformations

Mucosal involvement of venous malformations can cause bleeding, pain, and functional impairment. Treatment options include surgery, sclerotherapy, or laser therapy. A retrospective study surveyed 4 patients (5 subsites) with oral cavity venous malformations treated with the Nd:YAG laser using an underwater technique. Their study demonstrated that the Nd:YAG laser can be a feasible option in the treatment of venous malformations of the oral cavity. One study reported two treatment strategies using intralesional laser photocoagulation (ILP) for large venous malformations (VMs) in the oral cavity. Treatments included a combination of ILP and transmucosal irradiation; compartmentalization and serial step irradiation. They demonstrated both treatment strategies, improved the safety, reliability, and effectiveness of ILP and made the method less traumatic for patients. Miyazaki et al. described an ultrasound-guided intralesional photocoagulation (ILP) technique using a laser for treatment of deep venous malformations in the oral cavity.

ILP is basically a blind operation and has a risk of unintended destruction of surrounding normal tissue; therefore the authors now routinely use guidance by ultrasonography using a mini-probe

to improve the safety and reliability of ILP. The authors conclude that ultrasound-guided ILP with a laser is a promising technique for less-invasive treatment of a vascular malformation in the oral cavity. Álvarez-Camino determined the efficacy of the diode laser in the intralesional treatment of the orofacial venous malformations (OFVM). The advantages associated to the use of non-invasive techniques in the treatment of OFVM, along with the success rate and low number of relapses, showed the use of the diode laser as a therapy to be considered in the treatment of these lesions. A retrospective study evaluated the safety and efficacy of CO₂ laser resurfacing in the symptomatic treatment of intraoral lymphatic malformations (LM). They proposed CO₂ that laser resurfacing appeared to be both safe and efficacious in treatment of symptoms related to intraoral LM. Intermittent treatments for recurrent symptoms were expected.

Bisphosphonate-associated Osteonecrosis Of The Jaws

Bisphosphonates (BSPs) are used for the treatment of multiple myeloma, metastatic breast and lung cancer, Paget's disease, osteoporosis, hypercalcemia due to malignancy, and many other skeletal diseases. BSPs reduce osteoclastic functions, which result in bone resorption. Bisphosphonates-related osteonecrosis of jaws (BRONJ) is a newly developed term that is used to describe the significant complication in patients receiving bisphosphonates. BSPs are known to exhibit an antiangiogenic effect that initiates tissue necrosis of the hard tissue. There is currently no consensus on the correct approach to this issue. A retrospective study compared the effects of laser surgery with biostimulation to conventional surgery in the treatment of BSP-induced avascular bone necrosis.

They reported that there were no statistically significant differences between laser surgery and conventional surgery. Treatment outcomes were significantly better in patients with stage II osteonecrosis than in patients with stage I osteonecrosis. Their findings suggested that dental evaluation of the patients prior to medication was an important factor in the prevention of BRONJ. Laser surgery was a beneficial alternative in the treatment of patients with this situation. A clinical protocol supported by Nd:YAG low-level laser therapy proposed for extractions in patients under bisphosphonates therapy. Their experience supported the hypothesis that the association of antibiotic treatment and low level laser therapy (LLLT) through Nd:YAG laser (1064 nm--power 1.25 W; frequency 15 Hz; fibre diameter: 320 µm) could be effective in preventing BRONJ after tooth extractions in patients under bisphosphonates therapy. Surgical treatment with Er,Cr:YSGG-laser was reported in 5 cases of Bisphosphonate-associated osteonecrosis of the jaws. ErCrYSGG laser was successfully applied in surgical treatment of BRONJ. Stable mucosal coverage could be achieved in all of 5 cases. They proposed laser surgery could be considered as a promising technique for the effective treatment of BRONJ. Kan et.al presented the successful management of two dental patients who had high potentials for BRONJ development as a result of chemo and radiotherapy combined with IV zoledronic acid application.

They proposed LLLT application combined with atraumatic surgical interventions under antibiotics prophylaxis is a preferable approach in patients with a risk of BRONJ development. Adjunctive effect of LLLT in addition to careful infection control on preventing BRONJ was reported and concluded. A prospective study investigated the clinical efficacy of low-level laser therapy (LLLT) for the management of bisphosphonate-induced osteonecrosis of the jaws (ONJ-

BP). This study suggested that LLLT would appear to be a promising modality of treatment for patients with ONJ-BP, providing that clinical efficacy is safe and well tolerated, especially by those patients who require conservative treatment. (Fariaset al., 2014) Of course, this needs to be addressed further in larger and randomly controlled studies in different clinical settings. Vescovi et al. proposed Surgical approach with Er:YAG laser on osteonecrosis of the jaws (ONJ) in patients under bisphosphonate therapy (BPT). They concluded that it was possible to observe that an early conservative surgical approach with Er:YAG laser associated with LLLT, for BP-induced ONJ could be considered as more efficient in comparison with medical therapy or other conventional techniques. (Onoda et al., 2014)

2. CONCLUSION

Lasers in oral surgery are much useful in almost all surgical procedures in dentistry. More developed and innovative lasers are available in commercial markets. Dentists will be more knowledgeable if they tend to attend seminars regarding lasers to get used to the latest technologies.

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