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ORIGINAL PAPERS

Laser Applications in Oral Surgery

Doriana AGOP-FORNA[1], Claudiu TOPOLICEANU [1*], Norina FORNA[2]

[1] Lecturer, "Gr.T.Popa" University of Medicine and Pharmacy Iasi, Romania, Dental Medical Faculty
[2] Univ.Prof, "Gr.T.Popa" University of Medicine and Pharmacy Iasi, Romania, Dental Medical Faculty, ASM titular, AOSR member, CID-CDF president
Corresponding author*: Topoliceanu Claudiu; e-mail claudiu.topoliceanu@umfiasi.ro

Abstract. Oral surgery can be assisted by surgical lasers: diode, erbium, CO2, Nd:YAG. The surgical lasers are used in various procedures on oral soft and bone tissues: aesthetic procedures (gingival recontouring, gingival depigmentation); operculectomy; pro-prosthetic surgical procedures (remodeling of mucosa on edentulous sites, dental crown lengthening, frenectomies, vestibuloplasty); excision of gingival or mucosa hyperplasia; peri-implantitis treatment; the removal of small exophytic lesions; the removal of oral benign lesions (ranula, mucocele, pyogenic granuloma, fibrous hyperplasia, epulis fissuratum, hemangioma). For optimum effects at the level of the target oral tissues, the laser energy parameters should be set in relation to the wavelength, the type of intervention, the nature of the inflammatory process (acute-chronic), the tissue penetration depth, tissue pigmentation, and systemic status. The oral surgical procedures performed by surgical lasers are recommended in modern dentistry due to lower risk of soft and hard tissues necrosis, decreased rate of complications, higher patients' compliance (decreased postoperative pain and discomfort) and the acceleration of the healing processes.

Keywords: *oral surgery, lasers, incision, ablation, biostimulation*

Introduction

The comparisonsbetween scalpel oral surgery and laser-assisted oral surgical procedures favor the surgical lasers both in the relation to the intraoperative stage parameters (bleeding, pain, discomfort) and postoperative evolution (pain, discomfort, healing time).The lasers used in oral surgery emit light at specific wavelengths with various effects on the soft and hard tissues related to laser parameters, optical properties of oral tissues, distribution and absorption of laser beam in target area (1) (table I). The surgical lasers interact with the oral soft tissues in relation to pigmentation degree, the water content and tissue thickness, by absorption, reflection, diffusion, transmission (2). For optimum effects at the level of the target oral tissues, the laser energy parameters

should be set in relation to the wavelength, the type of intervention, the nature of the inflammatory process (acute-chronic), the tissue penetration depth, tissue pigmentation, and systemic status (3,4). Different wavelengths of surgical lasers will have different absorption coefficients.

Table 1.II. Types of lasers in dental medicine

	Brand	Manufacturer	Type of laser	Wavelength
1.	EPIC	BioLase	Diode	980nm
2.	Elexxion	Elexxion	Diode	810nm
3.	Picasso Plus	AMD Lasers	Diode	810nm
4.	Picasso LiteTouch	AMD Lasers	Diode	810nm
5.	Cheese II	Gigaalaser	Diode	980nm
6.	Peralas	Wuhan Dimed	Diode	810nm, 980nm
7.	K.E.Y.	KaVO	Er:YAG	2940nm
8.	WaterLase	BioLase	Er,Cr:YSGG	2780nm
9.	Lightscalpel	Lightscalpel	CO2	10600nm
10.	Opelaser Pro	Yoshida	CO2	10600nm

The properties of the oral mucosa that influence the postoperative reactions in interventions assisted by diode laser are (5):

- optical properties – absorption, spreading, anisotropy, reflection, refraction indices of the tissue and of the environment;
- thermal properties – temperature, thermal capacity, thermal diffusivity;
- mechanical properties – density, elasticity, tonicity, mechanic anisotropy;
- chemical composition – water content, the presence of endogenous or exogenous chromophores;
- tissue anatomy – microstructure, physical distribution of the cells, organelles and tissues;
- the homogenous or heterogenous structure of the tissue;
- tissue physiology;
- tissue metabolic condition;
- tissue and body functions;
- the body's response to regeneration and healing.

The phototermal effects of surgical lasers are as follows (6):

- Incision/excision (the beam is focalized with small diameter);
- Ablation/vaporization (beam is focalized with a large diameter);
- Hemostasis/coagulation (defocused beam);
- Ablation of granulomatous tissues (at temperatures over 60°C);
- Bonding of wound margins, no need for suture (temperatures between 70°-80°C).

The photochemical effectappears in the bio-stimulation procedures, that have anti-inflammatory effects, and allows the acceleration of the healing

processes at the level of surgical wound The fibroblasts are stimulated to increase the revascularization degree and the synthesis of neo-formed bone tissue (7).A faster healing of the surgical wound is explained by the stimulation of the macrophages activity, which eliminate more rapidly the fibrin layer formed within the first 48-72 hours and accelerates the initiation of epithelization processes(8,9). The effects of biostimulation on bone tissues is associated with the following favorable effects (10,11):

- Increase of the bone trabeculae formation rate;
- Increase of the vascularization rate;
- Increase of the activity of osteoblasts;
- Increase of the differentiation of osteoblasts;
- Increase of DNA production.

The surgical lasers are used in various procedures on soft oral tissues:

- aesthetic procedures (gingival recontouring, gingival depigmentation);

-operculectomy;

-pro-prosthetic surgical procedures (remodeling of mucosa on edentulous sites, dental crown lengthening, frenectomies, vestibuloplasty);

-excision of gingival or mucosa hyperplasia;

-peri-implantitis treatment;

-the removal of small exophytic lesions;

-the removal of oral benign lesions (ranula, mucocele, pyogenic granuloma, fibrous hyperplasia, epulis fissuratum, hemangioma).

The diode lasers are mostly used in the surgical oral procedures due to the absorption of laser beam by tissue pigment and haemoglobin, and poor absorption by hydroxyapatite and water (12). Convissar (2016) recommend diode lasers in oral surgery procedures at the level of the soft tissues due to the following advantages:

- rapid hemostasis;
- antalgic effect;
- reduction of surgical traumatism;
- acceleration of postoperative healing processes
- trophic effect through cellular biostimulation (stimulation of mitochondria, amelioration of cellular metabolism);
- anti-inflammatory effect (reduction of prostaglandins secretion);
- antalgic effect (stimulation of alfa nervous fibers and blocking painful influx).

Table II presents the conclusions of researches related to the postoperative evolution following diode lasers interventions on oral soft tissues.

Table 3.I. Postoperative evolution
(oral surgery interventions using diode lasers)

	Authors	Year	Procedure	Wavelength	Postoperative evolution
1.	Suter et al. (13)	2010	Excision of minor benign lesions	800-940nm	Absence of postoperative complications for most patients
2.	Gargariet al. (14)	2011	Oral fibromatosis excision	940nm	- absence or amelioration of postoperative complications
3.	Mathur et al. (15)	2015	Hyperplasia of oral mucosa. Oral benign tumors	810nm	- absence of bleeding, edema and postoperative scars. - postoperative healing in 2-3 weeks
4.	Angiero et al. (16)	2012	Fibrous lesions excision	808nm	Low level postoperative pain and discomfort in biopsy excisions of oral mucosa lesions of minimum 5 mm diameter
5.	Kalakonda et al. (17)	2016	Vestibuloplasty	808nm	More significant reduction of VAS pain and discomfort scores in the first 7 days after surgery in the lot treated with laser therapy compared to the lot treated using classical methods
6.	Ize-Iyamu et al. (18)	2013	Gingival hyperplasia excision	810nm	Significant reduction of bleeding, pain and postoperative edema
7.	Kumar et al. (19)	2015	Gingival hyperplasia	980nm	83.7% of the patients showed self-limited bleeding 94% of the patients showed postoperative pain of low intensity

Erbium lasers act on bone tissues by cold ablation, which allows minimally invasive procedures with localized increase of the temperature due to progressive vaporization, which allows the regularization of the bone surfaces and the production of micro-perforations (20,21,22,23). A major advantage of erbium lasers is the reduction of postoperative edema and pain; most patients request no anesthesia during laser-assisted oral surgery procedures (24). The laser beam used

in oral surgery maneuvers may reduce the sensation of pain by direct action on the nervous fibers.In oral surgery, Meletiet al. (2015) recommend the use of erbium lasers due to the capacity of the 2780nm (Er :YAG) and 2980nm (Er,Cr :YSGG) wavelengths to be absorbed by water and hydroxyapatite and a higher protection degree against the soft and bone tissues (small increases of tissue temperature) (25) (table III).

Table III. Postoperative evolution
in oral surgery interventions assisted by erbium lasers

	Laser-assisted intervention	Authors	Results
1.	Dental extraction/ Odontectomy	Abu-Serriah M. et al. (2004) (26)	- the Er:YAG laser is associated with the absence of bleeding and intraoperative pain in the mucosa incision stage - the Er:YAG laser used in odontectomies or partially included teeth extraction significantly reduces the intensity of VAS scores (pain) compared to the lot of patients whose bone tissue removal was performed using conventional means;
		Aras et al. (2010) (27)	Biostimulation using Er :YAG laser after third molar extractions leads to a reduction of the pain intensity, postoperative edema and trismus compared to patients with no laser biostimulation, however without statistically significant differences.
2.	Therapy of pericoronitis	Convissar (2016) (1)	- postoperatively, partial healing takes place due to the formation of a fibrin layer in the first 4-7 days; complete healing (the removal of the fibrin layer) takes place after one week.
3.	Operculectomy	Convissar (2016) (1)	– superior postoperative evolution (pain, discomfort) compared to the classical technique.
4.	Excision of gingival hyperplasia	Colluziet al. (2007) (4)	- the exclusive use of lasers is recommended in the coagulation and gingival remodeling shape and the removal of the hypertrophied tissue by means of a scalpel.
5.	Frenectomy	Vaderhobli et al. (2010) (28)	- absence of intraoperative and postoperative bleeding; significantly lower postoperative pain and discomfort compared to the conventional technique;acceleration of the healing processes.
6.	Vestibuloplasty	Vaderhobli et al. (2010) (28)	- in erbium laser vestibuloplasty, the healing processes take place faster compared to the classical technique.

The use of erbium laser in sinus lifting procedures associated with bone augmentation or in alveolar augmentation procedures shows the following advantages:

- minimum inflammatory response from the soft tissues;
- reduction of the postoperative edema (it decreases the risk of suture tension);
- reduced discomfort for the patient;
- reduced frequency of infections at the level of the surgical site.

Erbium lasers can be used in the therapy of peri-implant mucositis or in the therapy of peri-implantitis (decontamination of surfaces and ablation of pathological tissues), in association with traditional means of removal and control of the bacterial film deposited at the neck of the implant. The advantages of using erbium laser irradiation in the therapy of peri-implantitis are (29):

- there is no bacterial resistance to the laser irradiation;
- *PorphyromonasGingivalis* bacteria, which have a recontamination potential, are destroyed;
- Endotoxins and lipopolysaccharides produced by negative Gram bacteria can be eliminated;
- There is no risk of interaction with drugs or risk of allergic reactions.

Conclusion

The oral surgical procedures performed by surgical lasers are recommended in modern dentistry due to lower risk of soft and hard tissues necrosis, decreased rate of complications, higher patients' compliance (decreased postoperative pain and discomfort) and the acceleration of the healing processes.

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