

**Applications of a diode laser (980nm) in oral and maxillofacial surgical procedures.**

**Preliminary clinical observations.**

George E. Romanos, D.D.S., Dr. med. Dent.\*, Georg-H. Nentwig, D.M.D., Dr. med.  
Dent., Ph.D.

Johann Wolfgang Goethe-University Frankfurt, Dental School – Carolinum, Dept. of  
Oral Surgery, Frankfurt a.M., Germany

\*Correspondence to: Dr. George Romanos, Dental School Frankfurt (Carolinum), Dept.  
of Oral Surgery, Theodor-Stern-Kai 7, D-60590  
Frankfurt a. M., Germany  
Tel: 0049-69-6301-4098  
Fax: 0049-69-6301-6741  
E-mail: Dr. G.E. Romanos @t-online.de

**Background and objectives:** The aim of this study was to examine the wound healing of soft tissue after the application of a diode laser (980nm) in oral surgical procedures.

**Study design/Patients and methods:** 22 patients with different oral surgical indications included in this report. All of the patients were treated with the diode laser. The spectrum of clinical applications included especially removal of soft tissue tumors, frenectomies, excision of gingival hyperplasias, vestibuloplasties, haemangioma removal and periimplant soft tissue surgery. The continuous and the pulsed mode were used. The handpiece was applied in contact and in non-contact with the lased tissue. Intraoperative as well as postoperative clinical observations were examined and reported.

**Results:** According to our preliminary clinical findings we were able to observe an excellent haemostasis and incision quality in all of the surgical procedures. The coagulation properties were of great importance especially in the removal of vascular lesions. The postoperative advantages, i.e. lack of swelling, bleeding, pain or scar tissue formation and the good wound healing were observed in all of the clinical applications and were only dependent on the used laser physical parameters.

**Conclusion:** The clinical application of the diode (980nm) laser in oral and maxillofacial surgical procedures seems to be of beneficial effect for the daily practice, Lasers Surg. Med. 24:..., 1999.

Key words: dentistry; diode; oral surgery; soft tissue surgery

## **INTRODUCTION**

Many different laser wavelengths have been used in the field of oral and maxillofacial surgery with many advantages especially because of the high coagulation properties, the incision quality, and the postoperative benefits for the surgeon and the patient. Parallel to the CO<sub>2</sub> laser, which is the most used and accepted alternative method to the conventional techniques with the surgical blade, other laser typed (the Nd: YAG, the argon, the dye, the Ho:YAG, the Er-YAG and the diodes) can also be used effectively. Because of the selective physical properties the Nd: YAG, the dye and Argon lasers can be applied especially in the removal of vascular lesions [1-3]. The Ho:YAG laser is the main surgical tool for the TMJ surgery [4] and the Er: YAG laser for the hard tissue removal [5].

The relatively new semiconductor diode lasers (GaAs, GaAlAs) are portable, compact surgical units with efficient and reliable benefits. They are designed according to the economic and ergonomic considerations and they have reduced costs in comparison to other modern hard laser equipments. Diode lasers have a wavelength between 805 and 980nm. They can be used in the continuous as well as pulsed mode and according to the clinical indication with a contact or non-contact handpiece. Non-contact applications are performed with bare fibers or focusing handpieces to coagulate superficial lesions with moderate power densities (i.e. vascular lesions in the oral cavity) or to cut tissue (i.e. excision of soft tissue tumors) with high power densities. Special glass fibers are available for the different surgical applications. Especially in the wavelength of 980 nm the optical penetration depth seems to be smaller than in the level of 1064nm (Nd:YAG laser). This physical benefit can be used effectively in the coagulation of superficial and

interstitial lesions. The diode lasers offer special effects in the oral cavity. They reveal a bactericidal effect and reduce inflammation in the periodontal pockets additionally to the conventional scaling [6-7]. Moreover, they can be used in different oral surgical procedures with many beneficial effects [8-10]. The aim of this study was to present clinical effects of the diode laser irradiation on the oral soft tissues during oral surgery and to demonstrate the wound healing characteristics after laser surgery.

## **MATERIAL AND METHODS**

22 patients with different oral surgical indications included in this report. All of the patients were indicated for oral surgical procedure with the diode laser. We used the diode laser CERALAS D15 (CeramOptec GmbH, Bonn, Germany), which is a portable unit with an integrated GaAlAs semiconductor and wavelength 980nm. The maximum output power was 15 Watt and had a continuous as well as a pulsed mode. In the pulsed mode the pulse duration was 0.1-99.9 sec and an air cooling device was incorporated into the unit. A wide spectrum of oral surgical procedures, like frenectomies, vestibuloplasties, excision of soft tissue tumors (i.e. papillomas, fibromas, adenomas etc.), removal of gingival drug-induced hyperplasias, coagulation and removal of vascular lesions and periimplant soft tissue surgery included in this report. The soft tissue surgery was carried out with different power settings, continuous or pulsed mode and the use of a contact (focused) or non-contact (defocused) handpiece. For the most of the clinical cases we used as a delivery system a glass fiber with 200-400 um diameter. The surgical procedures were performed with a topical or local anaesthesia (see Table 1). All of the clinical cases were examined in the first three days, one week, two weeks and

four weeks after surgery. Postoperative complications like pain, bleeding, swelling, sensory disturbances, functional and/or mobility disorders, as well as wound healing characteristics were reevaluated.

## **RESULTS**

All of the reevaluated clinical cases showed not any complications. Not any surgical procedures showed any postoperative bleeding. In one case, minor remarkable swelling in the first three postoperative days was recorded. Only five patients complained about some postoperative pain; this was acceptable from the patients and not any medication to relieve pain was indicated.

The postoperative clinical observations showed normal healing without any scar tissue formation or functional disturbances (Table 2). High power setting, higher than 8 Watt, in the continuous mode and the focused contact handpiece seems to lead to some superficial tissue necrosis, which is associated with delayed wound healing for some days. In general, the patient treatment acceptance with the laser was very positive.

## **CASE PRESENTATIONS**

### ***Case 1: Excision of an oral fibroma***

A 52 year old female patient consulted the Department of Oral Surgery for diagnosis and treatment of a soft tumor in her buccal mucosa. According to the clinical examination the tumor was a fibroma (Fig. 1). With the use of a topical anaesthesia we excised the tumor using the continuous mode and 5 Watt power setting (Fig. 2). The tissue was well coagulated during the diode laser irradiation. The excised specimen was examined

histologically. According to the histopathological examination it was a fibroma of the oral mucosa. The postoperative healing was without complications (Fig. 3). A bleeding, swelling and postoperative pain were not found. No scar tissue formation could be observed.

### ***Case 2: Removal of an oral haemangioma***

A 43 year female patient consulted the Dept. of Oral Surgery because of treatment of a vascular lesion in the buccal mucosa. The clinical examination revealed a big haemangioma (Fig. 4). We removed the vascular lesion in one session after local anesthesia. We irradiated the tumor using 6-10 Watt power setting with the non-contact mode of the diode laser. In order to have a flat surface during irradiation, which allows to focus better the beam, we placed an ice cube on the vascular lesion during irradiation (Fig. 5). In addition to that, the ice application with the cooling effect is able to avoid the increase of the tissue temperature and therefore to control necrosis in the tissue. One week after surgery we found a superficial layer of fibrin (Fig. 6) and four weeks after surgery the oral mucosa was completely healthy (Fig. 7). Postoperative complications, such as bleeding, pain, swelling or other functional and sensory disturbances were not recorded.

### ***Case 3: Adenoma removal of the sublingual salivary gland***

A 73 year male patient presented in his mouth floor a soft tissue tumor as well as disturbances in the secretory function of the right sublingual salivary gland. A sialolith was radiographically not presented. According to the clinical findings, the clinical

diagnosis was adenoma of the sublingual salivary gland (Fig. 8). We excised the tumor with the contact mode handpiece and because of the big tumor size we removed also the salivary gland using the diode laser and a power setting of 8-10 Watts (cw). Before laser surgery a preparation of the salivary gland duct was mandatory. The coagulation of the tissue as well as the incision quality were excellent (Fig. 9). Postoperatively, we were not able to show any bleeding. Only a minor remarkable swelling was observed in the first three days. The tissue was covered by fibrin deposits in the first ten days of healing. Six weeks after surgery we showed a complete healing without scar tissue formation, sensory or functional disturbances (Fig. 10).

## **DISCUSSION**

This report presents our preliminary clinical experience from the application of diode laser (980nm) in the field of oral and maxillofacial surgery. In comparison with our previous surgical experience using other laser systems, we found out that the incision quality using the diode laser is much better compared to the other systems. The cutting effect can be similar to the CO<sub>2</sub> laser and the coagulation properties comparable to the Nd:YAG laser. The similar effects in the tissue coagulation between a diode laser with a wavelength of 810 nm and the Nd:YAG laser have been extensively analyzed in the theoretical paper by Rastegar et al [11]. The excellent tissue coagulation performed by the diode laser in our clinical report is of great importance especially in surgical procedures with high vascularity, like inflamed tissues or vascular lesions. Because of the good coagulation, suturing after surgery was not necessary (economical advantage), the surgical period was extensively reduced and the person may be protected from high

risk infections. Moreover, the small, portable size of the unit is of beneficial effect for the general practitioner, who is not able in his Clinic to move easily from operator to operator or from office to office the big-size laser equipments.

**TABLE 1*****Oral surgical procedures performed with the diode laser (980nm)***

<i>Patient</i>	<i>Indication</i>	<i>Mode</i>	<i>Power Setting</i>	<i>Anaesthesia</i>
C.M.	haemangioma	cw	2W	TA
S.A.	fibroma	cw	4W	TA
W.H.	fibroma	cw	8W	TA
R.D.	fibroma	cw	6W	TA
K.L.	Condyloma Acuminata	cw	5W	TA
C.W.	fibroma	cw	8W	TA
S.D.	periimplant Hyperplasia	cw	6-8W	TA
L.W.	periimplant Hyperplasia	cw	7W	LA
A.U.	adenoma	cw	8-10W	LA
S.K.	gingivectomy	cw	10W	LA
F.R.	haemangioma	cw	6W	TA
A.O.	epulis	cw	6W	TA
D.K.	mucocele	cw	6W	LA
J.P-L	haemangioma	cw	6W	TA
J.P.-L	papilloma	cw	6W	TA
C.K.-R.	fibroma	cw	5W	TA
R.K.	haemangioma	cw	10W	TA
S.H.	frenectomy	cw	4W	TA
P.L.	gingivectomy	p	10W/20pps	LA
K.C.	vestibuloplasty	p	15W/20pps	LA
A.F.	gingivectomy	p	14W/20pps	LA
S.M.	vestibuloplasty	p	15W/20pps	LA
D.R.	gingivectomy	p	15W/20pps	LA

TA = topical anaesthesia

LA = local anaesthesia

cw = continuous wave

p = pulsed mode

**TABLE 2*****Postoperative observations***

- no reported bleeding
- no reported uncontrolled pain
- no remarkable swelling (except of one case)
- no scar tissue formation
- no functional disturbances

## REFERENCES

1. Shinoff r. Geronemus RG. Capillary hemangiomas and treatment with the flashlamp pumped pulsed dye laser. *Arch Dermatol* 1991; 127: 202-205.
2. Sexton J. O'Hare D. Simplified treatment of vascular lesions using the argon laser. *J. Oral Maxillofac Surg.* 1993; 51: 12-16.
3. Romanos GE, Nentwig GH: Der Einsatz des Nd:YAG-Lasers bei der hereditären hamorrhagischen Teleangiektasie (Morbus Osler). *Quintessenz* 1997; 48: 1613-1618.
4. Koslin MG, Martin JC. The use of the holmium laser for temporomandibular joint arthroscopic surgery. *J Oral Maxillofac Surg* 1993; 51: 122-123.
5. Keller U, Hibst U: Er:YAG laser effects on oral hard and soft tissues. In: Miserendino LJ, Pick RM (eds), *Lasers in Dentistry*, pp. 161-172. Chicago, Quintessence 1995.
6. Moritz A, Gutknecht N, Doertbudak O, Goharkhay K, Schoop U, Schauer P, Sperr W. Bacterial reduction in periodontal pockets through irradiation with a diode laser; a pilot study. *J Clin Laser Med Surg.* 1997; 15: 33-37.
7. Moritz A, Schoop U, Goharkhay K, Schauer P. Doertbudak O, Wernisch J, Sperr W. Treatment of periodontal pockets with a diode laser. *Lasers Surg Med* 1998; 22: 302-311.
8. Manni J. Surgical diode lasers. *J Clin Laser Med Surg* 1992; 10:377-380.
9. Bach G, Krekeler G. Einsatz eines Dioden-Halbleiterlasers in der Zahnheilkunde. *Zahnarztl Welt Reform* 1996; 105: 314-319.
10. Hartmann HJ, Bach G. Diodenlaser-Dekontamination in der Periimplantitis-Therapie. Eine Drei-Jahres-Studie. *Zahnarztl Welt Reform* 1997; 106: 524-526.
11. Rastegar S, Jacques SL, Motamedi M, Kim B-M. Theoretical analysis of equivalency of high-power diode laser (810nm) and Nd: YAG Laser (1064nm) for coagulation of tissue: Predictions for prostate coagulation. *SPIE Vol. i646 Laser-Tissue Interactions* 1992; 150-160.

## **LEGENDS OF THE FIGURES**

**Fig. 1:** Fibroma of the buccal mucosa

**Fig. 2:** Excision of the fibroma with the use of the diode laser (980nm).

**Fig. 3:** Wound healing without any pathological findings two weeks after laser surgery.

**Fig. 4:** Big haemangioma of the oral mucosa

**Fig. 5:** Coagulation and removal of the haemangioma with the diode laser (980nm). An ice cube was placed on the tumor surface during laser irradiation. The power setting was 6-10 Watt and a non-contact handpiece was used in the continuous mode.

**Fig. 6:** Wound healing one week after laser surgery.

**Fig 7:** Complete wound healing one month after laser surgery.

**Fig 8:** Adenoma in the mouth floor.

**Fig 9:** Laser surgery (a) and removal of the tumor and the sublingual salivary gland.(b)

**Fig. 10:** Complete wound healing without any scar tissue formation.