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USE OF DIODE LASER IN SURGERY

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ABSTRACT: **the aim of the present clinic study was to evaluate the therapeutic results obtained by means of diode laser devices in the surgical treatments of oral-gingival pyogenic granuloma.**
The clinical study has been conducted in three dental clinics on a sample of 38 subject, 13 of which has systemic immunodeficiency.
This sample has been to a group of 56 patients with the same oral pathologies but treated with the conventional blade surgery.
For both group the same research protocol and clinical follow-up schedule were chosen.
The clinical results obtained in the short and long elapse of time and the clinical observations performed during and after the surgery as well as in the follow-up were considered to be satisfactory.

The use of diode laser clearly has reduced septic risks, healing time and recidivation occurrence

In immunodeficiency patients with HIV, HBV and HCV infections, the results were the same with respect those obtained in the patients without viral pathologies.

INTRODUCTION

LASER devices (*Light Amplification by Stimulated Emission of Radiation)* can induce extremely positive powerful effects on tissues and organs. Electromagnetic waves generated by the various types of laser show different physical properties such as high intensity and coherence, that allow to concentrate the laser power on an only, tiny point, smaller than 1μm, the collimation, the monochromatic pattern and the possibility to issue the signal with very short impulses. Such electromagnetic waves, conveyed through special optic fibres, strike at high power the tissue targets with absolute precision and without causing related damages to the neighbouring structures [1].

The employment of lasers in oral dental stomatology has brought to, compared with traditional methods, a great implement in technical treatment of lesions of oral mucosa resulting in a relevant quickening of the healing process and in an improvement of the post-surgical outcome, which in turn increases the

patients' compliance. The treatment of hyperkeratosis and leukoplakia of oral mucosa, the removal of benign neoplastic or dysplastic lesions, the treatment of vascular lesions, undoubtedly represent the main goals of the laser assisted oral medicine.

In the last years various types of LASER were used in dental and stomatologic circle, and as far as clinic and experimental studies are concerned it emerged different opportunities in specific laser use targeted to a peculiar pathology or towards a specific tissue.

The goal of the present multi-centre clinical study is to evaluate the therapeutic results obtained in the treatment of gingival-paradental lesions, as pyogenic granuloma, by means of a special Diode-Laser (*Doctor Smile*® SIMPLER, LAMBDA SpA-Italy).

The research protocol was performed in three different places, in which three groups of patients were examined. The first place was the Dental Stomatological Unit of the Community of S. Patrignano (Rimini, Italy), in which were selected a homogeneous group of 18 ex drug-addicted patients, positive for HIV, HBV and HCV. The second place was the Ambulatory of Oral Medicine (Dental School of university of Milan), in which 19 patients were selected. The third place was the Operative Unit of Oral and Maxillo-facial Surgery of the Health Authority of Modena (Italy), in which 16 patients were inserted in the clinic program research. Moreover, a control group of 68 patients (homogeneous for gender, age and pathology) was considered for the study and treated with conventional surgical methods. In the three different places were used three models of laser with similar power features, manufactured and marketed by the same Company.

BIOLOGICAL WORKING OF LASERS

The goal of each surgical procedure is to remove a pathological lesion, avoiding tissue damages and allowing the healing without complications in short or long time. Such aim, that can be shared by all branches of medicine and surgery, is the specific aim of the employment of laser devices in the treatment of various pathologic lesions.

Various laser devices are available on the market, all of them having particular features in relation to different parameters: the type of cut to be performed in the tissue, the lapse of time in which to operate, the depth of surgical wounds and the absorption of laser waves by the tissue.

The laser can be considered not only an advanced device, from the technological viewpoint, that allows us to perform easily the surgical treatment of lesions with high accuracy, but also a peculiar therapeutic method targeted to a specific structure in the tissue to recover. This goal is in line with a theory proposed by Anderson at all 1980 regarding the organic and physical principles of selective photo-thermo lysis. The terminology "selective photo-thermolysis" was proposed to describe a tissue thermal damage induced at the microscopic level as a consequence of impulses selectively absorbed by the tissue. The light releases energy only in the absorption sites; later, in the same tissue sites, the wavelength-associates energy

release heat absorbed by chromophore structures like blood vessels or cells containing melanine. Three chief elements are needed to achieve a selective photo-thermolysis:

1) a wavelength able to reach and to be absorbed by selected targeted tissues;

2) an exposure time equal or inferior to the time needed to cool the structures constituting the chromophor targets or photopigment;

3) a fluence able to reach a temperature that produces wounds in the tissue targets.

A highly selective tissue damage is obtained when these three conditions are reached, without the need to direct the laser on each microscopic target.

With the *selective photo-thermolysis* it is possible to obtain a wide range of heat-mediated damages, like thermal denaturation, mechanical injury as a consequence of the rapid heat spread or of the changes of phases (cavitation) as well or, at least, of the changes into the primary chemical structures (pyrolysis). For the above mentioned reasons, this method represents the most precise employment of heat, or of an energy source, obtained so far in medical circle.

The more used laser devices, in dental and stomatological fields, are the following models: CO2 LASER, Erbium Laser –Yag (Erbium: Yttrium Aluminium Garnet) Nd Laser –Yag (Neodimium Y Yttrium Aluminium Garnet) and Diode Laser.

CO2 Laser is considered the best laser from the surgical viewpoint. It is the most used laser because of its high absorption by water. Its emission frequency is 10600nm and it is possible both to choose two use patterns, pulsing or continuous, and to diminish the impulse range down to few nanoseconds. This type of laser is particularly indicated for surgical removal (also in those regions extremely difficult to reach), for a good superficial haemostasis, for the thermal therapy in some solid tumors. Since the thermal effect could be important, during the laser treatment, extreme caution is needed in those zones highly sensible to the temperature.

In Erbium Laser -Y.A.G. (Erbium: Yttrium Aluminium Garnet) the emission frequencies are of 2940 nm. It is greatly absorbed by water and it is used in pulse pattern. The possibility to work using very short impulses (ranging between 50 and 100 microseconds) allows the mechanical removal of superficial vascularized or sessile lumps, and the recovery of wide oral lesions in extremely temperature-sensible zones as well. The higher the water content of the tissue, the greater the laser removing effect. On the contrary, regarding the haemostasis, its effect is minimum, except when using longer impulses and high frequencies. The laser can be transmitted by different devices.

Nd Laser YAG (Neodimium : Yttrium Aluminium Garnet) is surely one of the most versatile devices for the wide range of emission frequencies it allows (corresponding to the values of 1064nm,1320nm, 532nm, 266nm). The light ray is absorbed mainly by water (at 1060nm and particularly at 1320nm) and haemoglobin (at 532nm). The using pattern can be pulsing or continuous with variable time. This device is particularly indicated for the thermal destruction of vascularized or sessile lump tumours and in the surgery

of vascular lesions. It is not suitable the employment of this type of device for lesions located in thermic-sensible anatomical district (as periosteum) because of the heat release by deep (in depth).

DIODE LASER: The nucleus of a diode laser consists of a semi-conductive material, the diode (Indium Gallium Arsenic. The most common laser used in oral-dental surgery has a wavelength of 810nm or 980nm and shows a high affinity for the haemoglobin; so that this type of device is particularly devoted to the treatment of vascular lesions both by removal directly or by means of lesion clotting. Moreover, all the other surgical procedures can be performed with Diode laser concerning both the major and minor oral surgeries.

Diode Lasers, on the basis of their photo-chemical and photo-mechanical features, are particularly indicated in both superficial and middle-deep surgery of soft tissues. So they represent a valid instrument in most dental surgery. Moreover, Diode laser is strongly indicated in treatment on mucous-membranous lesions with concomitant newly forming vessels and consequently with haemorrhagic risk. Another positive consideration about laser surgery, compared to traditional blade-surgery, concerns not only the clinical results but also the running surgical procedures and especially the post-surgical comfort of the patient.

PYOGENIC GRANULOMA

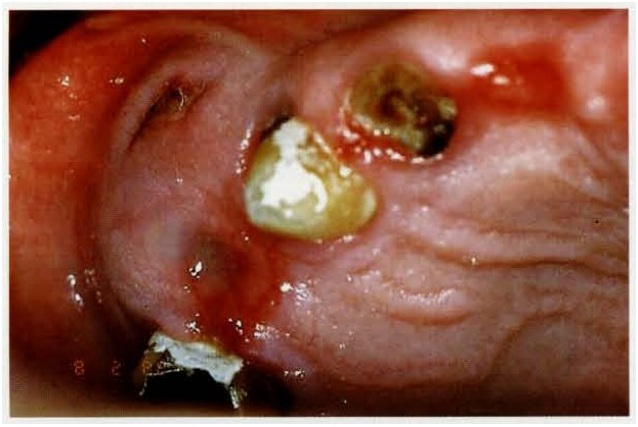
Pyogenic granuloma, also known generically as epulis, is a topic, superficial and nodular lesion in respons to local immuno-reactive and irritative phenomenons. From the clinical point of view, they are identifiable as lesions following exophytic pattern, traceable in both free and adherent gengival mucosae, histologically included in inflammatory reactive hyperplasiae of connective matrices.

The etio-pathogenic aspects of pyogenic granuloma are generally multifactorial and a concomitance of *noxe* and predisposing factors can be often surmised in the genesis of the related clinical circles. Various are the circumstances related to the clinical circle due to the presence of topic or generalized reactive hyperplasiae of gingival mucosae: the presence of infective centres of tissues surrounding the dental elements, subjective features of paradontium, possible alterations of the physiologic bio-hormonal cicles (tipical in pregnancy), particular pharmacologic therapy supplied (anti-conceptional pill, anti-hypertensive drugs as calcium-antagonists, anti-epileptic remedies and immunosuppressor factors).

Some immuno histochemical investigations reported in literature have attempted to evaluate the influence of some chemical-tissutal mediators in the pathogenesis of clinical circles. In particular, the action of an important fibroblast growth factor (*Basic Fibroblast Growth Factor* BFGF) has been investigated: this factor is demonstrated to play an important role in the healing processes of the lesions. The studies examined have demonstrated that some cellular lines located in cronic phogistic circle, as macrophages and mastocytes produce and realise in the extracellular matrix elevated levels of BFGF in presence of growing vessels or granuloma of inflammatory origin.

1-PYOGENIC GRANULOMA OF THE PERIODONTIUM

2-EPULIS REACHING THE VESTIBULAR AND PALATAL AREA



3-PERIPHERIC GRANULOMA WITH GIANT CELLS AND GIANT EPULIS

4-ANGIOMATIC EPULIS

The distinction among the different types of reactive inflammatory oral hyperplasiae is often based on their histomorphological features. The following types of hyperplasiae are recognised: pyogenic granuloma (Figures 1 and 2); peripheral granuloma with giant cells, or magnicellular epulis, according the old terminology (Figure 3); gravidic epulis or angiomatous epulis (Figure 4).

From the histological viewpoint, it is possibile to describe other cases in which a prevalence of fibrous reactions or lymphocytic infiltrations are observed; in these cases, the terms used are those of plasmacellular epulis and fibromatous or rimose epulis. The last type of epulis is observed in patients with partial or total movable prostheses: in these cases, the main cause is a chronic local injury implying an abnormal mechanical load that triggers a reactive fibromatosis, generally at the vestibular sulcus; under the clinical view, they are movable lesions, of rosy complexion and adaptable to the prosthesis edges (Figure 5).

These type of lesions generally require a classic removing surgery, performed by blades and subsequent surgical toilette by smoothing the dental roots and the bone alveolus. Frequently, recidivations can occur and consequent problems of bleeding to be controlled arise, because of the abundant vascolarization of the anatomical district.

MATERIALS AND METHODS

The aim of the present paper is to analyse and quantitatively evaluate the results of surgical treatment of gingival-periodontal pyogenic granuloma by means of a model of Diode Laser used in three distinct places. The first is the Dental Stomatological Unit of the Community of S. Patrignano (Rimini, Italy); the other two are the Ambulatory of Pathology and Oral Medicine (Dental School of University of Milan –ICP) and the Operative Unit of Oral and Maxillo-facial Surgery of the Health Authority of Modena (Italy).

In all the three places, the same Diode Laser device (*Doctor Smile*® Simpler, LAMBDA SpA-Italy) with the same technical features (Figure 6) has been employed.

In each place, the patients follow a standard clinic and diagnostic *iter* consisting in: a first medical visit in which an accurate local objective-clinical examination (LOE) was performed; filling a case sheet; signing the informed consent. Moreover, to all the patients an ortho-pantomography of the dental arches and a series of haemato-chemical screenings were prescribed.

The parameters considered in post-surgical phases included the bleeding evaluation during and after the surgery, the post-surgical pain, the time of recovery and the onset of recidivations.

From March 2005 to February 2005, in the units of Milan and Modena, 25 patients with clinic evidences of pyogenic granuloma against gingival-periodontal components were selected. In both units the groups of patients examined were homogeneous and displayed common clinic and anamnestic features. In S. Patrignano unit 13 HIV positive patients were selected, all with pathologies due to secondary immunodeficienzy and hemostasis problems as well. In these patients, a high incidence of clotting deficit was observed, mainly as a consequence of HIV-dependent thrombocytopenia and of both the altered synthesis of coagulation factors and the unbalanced vitamin K metabolism, due to active chronic hepatopathy.

The total amount of the patients included in the study was, therefore, 38 (25 of which female and 13 male) with age ranging from 22 to 77 years (mean age 38,97 years).

In the three units the standard surgical procedure implies: mouth-rinsings with 0.2% clorexidine (not diluted) for 1 minute, before and after the surgical treatment; the use of protective eye glasses both for the patients and the surgeon; environment and wound irrigations with physiological solution during the surgery; control of local hemostasis with sterile surgical gauzes only soaked in physiological solution; and patient discharge with instructions for post-surgical behaviour treatment consisting in ice compress for 2 hours and abstention of warm food and drinks intake. Moreover, to all patients was suggested a topical therapy with 0.2% clorexidine pure (not diluted in water solutions). In all cases, minimum doses of local anesthetic by infiltrating 0.5cc solution of mepivacaine, without vascocostrictor agent.

The manners of employment of Diode Lasers, viz the parameters effectively used and the related power values, were the following: 2 Watt of power in continuous manner, according to the suggestion specified for the laser device *Doctor Smile*® Simpler, LAMBDA SpA-Italy by the manufacturing company; the drills considered for the treatment were 300 μm in diameter (Surgical tip).

The *follow- up* consisted in subsequent control visits after 7, 14, 21, 30 and 60 days from the surgery, during which the clinical data collected were recorded and analysed. Each patient follows the post-surgical behaviour suggested and regularly undergo control visits for 2 months after surgery.

The control group consisted in 56 patients selected in the three places of S.Patrignano, Milan and Modena, and treated and monitored with a *follow-up* overlapping with those of the laser-treated group. In the period from January 2005 to February 2005, the patients of the control group were treated with conventional removal techniques by means of blades, in the same three places and with the same medical aids.

RESULTS

On the basis of the clinical data collected and recorded it emerged that the employment of Diode-laser device in removal surgery of pyogenic granuloma only of the gingival-periodontal complex allows positive therapeutic results and advantages for the patients. The parameters evaluated are the following:

- amount of bleeding during and after the surgical treatment
- post-surgery pain symptomatology
- healing time
- recidivation occurrence.

For these reasons, in the present study the results from three groups of population were compared. The first is a group of patients treated with Diode-laser in Milan and Modena units, represent patients with minor oral pathologies whose general clinic conditions of good health are considerable normal (25 patients). A second group of 13 patients, treated with Diode-laser in S. Patrignano unit, with important immunologic deficit and various organ-systemic problems. The third group, considered as the control group, without evident systemic problems, whose oral pathologies were treated by the conventional surgical blade manner.

Bleeding

The bleeding during the surgical removal of the inflammatory gingival-periodontal lesions can be considered a typical feature of such treatments. In fact, the important phlogistic and erythematous component typically associated to the epulis and the abundant new formation of vessels trigger, in the various removing phases, a generally intense bleeding. In those patients considered normal, under the clinic general systemic conditions, treated in Milan and Modena units, the bleeding observed can be considered poor and easy to be controlled from the early surgical phases (Figure 7).

Fig.7 *Minimal Intra-op bleeding* Fig.8 *Same case 21 days post-op*

Only in 3 patients out of 25 (representing the 25%), in which the angioma component resulted to be particularly developed, a local packing for some minutes was needed. Among those immunodeficient and HIV-HCV-HBV positive patients only 2 (15.38%) showed problems about local hemostasis. In these cases, after a short period of about 30 minutes and applying local packing with sterile surgical gauzes and physiologic solution, the bleeding was definitively stopped and remained solved until the first hours after the surgical treatment.

Finally, as regards the patients treated with the conventional surgical instruments for cutting and smoothing the dental roots, the 67.85% (viz, 38 patients on a total of 56) needed prolonged packing, silk sutures for containment and mean stillicidium time of about 15 minutes.

Pain

The second parameter evaluated was the post-surgery pain symptomatology. Only one patient out of 38 patients treated with Diode-laser in the three units, reported pain when the effects of local anesthesia stopped. Such pain spontaneously decreased after about one hour, with the only local application of synthetic ice pack. The other patients (37) had an optimal post-surgical comfort, without any referred pain or other symptomatology (tension, pulsations, burning sensations).

Among the patients treated with conventional blade surgery, 13 patients out of 56 (23.21%) referred pain solved by cold pack and anti-inflammation drugs for some days.

Healing time

The third parameter evaluated in the control visits during the *follow-up* was the healing time of surgical wounds. The most rilevant observations were made in the early three control visits performed 7, 14 and 21 days after the treatment. In those patients with normal systemic conditions, treated with LASER, the healing time was consistent with the extension of gingival lesions. In the early 7 days a partial repair of wounds were observed, with an evident fibrinous surface and the connective tissues in recovering phase; a very poor and physiological bleeding was observed. In the successive control visits a gradual trophic condition of the tissues was reached accompanied by a new epithelization (Figure 8).

Only 2 of the 13 patients with immunodeficiency treated with Diode-Laser showed difficulties of wound recover during the early 15 days. Such difficulties can be ascribed to the compromised and precarious health conditions of oral mucosae of the patients. In fact, in such patients, chronic erythematous lesions, likely of dependent by chronic candidiasis, were visible in the oral mucosae, particularly widespread adjacent to the treated zones.

On the basis of the data reported from the patients treated with the conventional blade surgery, 19 patients out of 56 (33.92%) showed delays in the healing time, due to local septic problems favoured from the difficulties in protecting the surgical edges and controlling the local hemostasis.[42]

Recidivation occurrence

Finally, a common problem related to this type of surgery is the high tendency of recidivation occurrence of the epulis. Generally, recidivations result to be rather frequent, even after an accurate root smoothing and meticulous removal of pathologic tissue. In literature, data are reported according whose recidivations occurred between the 10% and 15% of the cases. It is important, therefore, performed a complete and accurate excision of the lesions, often widening the surgical field, as a preventing measure.[6-19-20]

In all the patients treated with Diode-laser recidivations were never observed. Moreover, after two months from the surgery, an attempt of gingival tissues emerged in order to remodel the removal sites and to restore the morphologic aspect of the adjacent tissues.

On the other hand, in 8 patients (14.28%) treated with conventional blade surgery recidivations were observed in the site previously treated.

DISCUSSION AND CONCLUSIONS

On the basis of both the author's experience and the data reported in literature, it emerged that in etio-pathogenic circle of reactive hyperplasiae of oral mucosae and gingival-periodontal structures, local and systemic multifactorial conditions are important. The clinical progress and the evolution of mucous-gingival lesions are related to the type of reactive hyperplasia of the soft tissues in which they develop [-].

On the basis of the results of the present study, notwithstanding the limited statistical and clinical significance of the examined groups, it emerged the undoubted advantages of the employment of Diode-laser with continuous waves (CW), in the treatment of mucous-gingival pyogenic granuloma.

The main significative result is the high percentage of healing (95%), considered optimal between 30 and 60 days after the surgical removal. Moreover, this type of little invasive surgery allows to minimize the recidivation occurrence and to improve post-surgical *compliance* in the healing processes, thus also improving the *comfort* of the patients in post-surgery period. [1-3-7-9] In fact, both local septic problems and important pain were never referred by the patients. These results are based on two distinct facts: the first is

the biological triggering action of electromagnetic waves issued by the laser, which, in turn, improve the local cell and tissue trophism, thus triggering the activity of the cellular line implies in healing processes; the second, but not less important, is the antimicrobial action of laser rays against the germs responsible of the inflammation of superficial and deep paradontium.

Also in the group of HIV positive patients that showed a clear acquired immunodeficienzy, the results obtained were more satisfactory in comparison with the control-case. It has been ascertained, both during and after the surgery, a significative decrease of problems that typically affect the patients with primary or secondary immuno-deficit and that show systemic chronic-degenerative pathologies.

On the basis of the data reported in literature concerning the therapeutic employment of Diode-laser, it can be assumed that the laser-assisted therapies are very little invasive methods, from the surgical point of view, with extremely positive therapeutic effects and long-term results. 12-14-20

Moreover, on the basis of previous author's experience, the clinical results obtained under laser with the parameters used have been satisfactory.

The different mechanisms of interaction between laser and tissues and the photo-dynamic properties of laser devices, previously discussed, justify the attitude to spread the employment of laser devices in the treatment of the different types of lesions of oral soft tissues, contemporary reducing recidivations and improving healing processes.