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To develop dental prostheses and improve the addition of polymers (Atridox, Fort Collins) in dental procedures

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Abstract

The majority of the studies analyzed show modest beneficial effects of pulsed lasers (Er: YAG or Er, Cr YSGG) compared to conventional therapies (with manual and / or ultrasound instrumentation) in the initial treatment of patients with peri-implantitis. OHLLT photodynamic therapy, using penetrating and super-pulsed lasers (980 nm), thanks to the biological hypotheses that support it, and by the preliminary results obtained with this study, seems to be a good complement to the surgical treatment of the perioperative -implantite. The effectiveness of the proposed protocol highlights the possibility of acting on the site in the least traumatic way possible, but with efficiency capable of offering a real improvement of the bacterial flora condition. The reduction of inflammation of the peri-implant tissues, with a decrease in the sounding depth, the rate of bleeding and a massive reduction of the bacterial load, especially for aggressive strains very often found in affected sites, refractory to conventional protocols, are tangible elements as to the potential effectiveness of this protocol for the treatment of peri-implant disease. It will be necessary to complete this pilot study with RCTs or other forms of research referenced in the pyramid of scientific evidence in dentistry.

Keywords: dental prostheses, polymers, Atridox, Fort Collins, dental procedures

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INTRODUCTION

Oral implant-prosthetic rehabilitation is now a clinical reality and dental implants, unanimously recognized, tend to take a predominant part in the treatment of dentations. 30 years of clinical and experimental research have resulted in high predictability of results, but while osteo-integrated implants offer a viable alternative to traditional prostheses, this type of rehabilitation is not without complications.

In 1986 Albertson determines the following criteria for implant success:

- An individual implant, without prosthesis, is clinically immobile.
- Radiographs show no bone scarcity around the implant.
- Marginal bone resorption <1.5 mm during the first year of loading and <0.2 mm for each subsequent year.
- Absence of signs and symptoms such as: pain, infection, involvement of the mandibular canal, paresthesia and neuropathy.

With such criteria, the percentages of success were 85% at 5 years after lying, and 80% at 10 years. In view of the increasing number of implants placed, peri-implantitis, namely the infection of the peri-implant bone tissue, will represent a pathology in constant growth of observation. It is thus obvious that the treatment of peri-implant diseases will be an ever more important part of the future dental practice. This is precisely why finding an effective treatment that ensures the health of hard and soft peri-implant tissue is fundamental to extending the life of the implant in situ.

IMPLANTORYSURFACE

Titanium is the material mostly used in implant surgery and is used pure or as an alloy. Aluminum is added to increase the hardness of titanium, reduce its specific gravity and improve its modulus of elasticity. When titanium is exposed to air, a thin layer of titanium oxide is produced on its outer surface. The oxides found on the surface are: titanium monoxide (TiO), dioxide (TiO2), trioxide (TiO3) and traces of aluminum oxide and vanadium. The most stable and predominantly present form is TiO2, which gives titanium a very high resistance to corrosion and is one of the decisive factors for the osseo integration of titanium and its alloys.

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To improve the peri-implant bone tissue response, and to reduce the healing time at the bone-titanium interface, many surface treatments have been proposed. The unique goal is to successfully create a strong and durable bond between bone tissue and implant. The strength of this bond should contribute, among other factors, to the durability of the attachment of the mineralized tissue to the implant.

Several types of implant surfaces have been proposed over the years, but the surface roughness that can be considered optimal has not yet been defined with certainty. It seems, however, that a roughness of 1.5 microns, can determine a better response of peri-implant bone tissue, than that observed with surfaces of more or less significant roughness. Machined titanium surfaces were first used. They have a roughness of 0.5-0.9 microns, consisting of grooves and ridges of small dimensions. These surfaces have a lower density of bone tissue at their interface compared to those with greater roughness.

The sandblasted titanium surfaces are treated with particles of various types (aluminum oxide, Al2O3, titanium dioxide, TiO2, hydroxyapatite, HA) and of various sizes which produce a surface irregularity. This contributes to the modification of the biological and biomechanical behavior of the implant. Osteoblasts tend to approach and adhere to sandblasted surfaces by first depositing the osteoid matrix directly on the surface of the implant, called “contact ontogenesis”; surface roughness affects the proliferation and differentiation of osteoblastic cells. The treatment of implant surfaces by acid etching has been proposed in order to avoid the disadvantages that can occur with sanding processes.

The “plasma-spray titanium” process involves coating smooth-surface implants with titanium powder. The technique uses a plasma arc furnace. Inside, particles of titanium powder are sprayed in hydride form. They decompose in the plasma stream and the metal droplets thus formed are “pulled” towards the body of the implant, at a distance of 15/20 cm. These particles of titanium, with a particle size of 50 to 100 μm, are in this way welded to the implant body, producing an interesting surface roughness while increasing the contact area of the structure. The newly formed bone was observed inside the micro-irregularities of the surface.

Hydroxyapatite has also been used to coat titanium to improve bone-implant anchorage. HA-covered surfaces appear to improve the quantity and quality of peri-implant bone. Nanostructures surfaces: Nanotechnologies can be used to modify the surface characteristics of dental implants, both in terms of microstructure and surface chemistry. This can cause changes in adhesion, mobility and orientation of the various cell lines. In 2008, On et al. dictated new criteria for implant success:

- No mobility

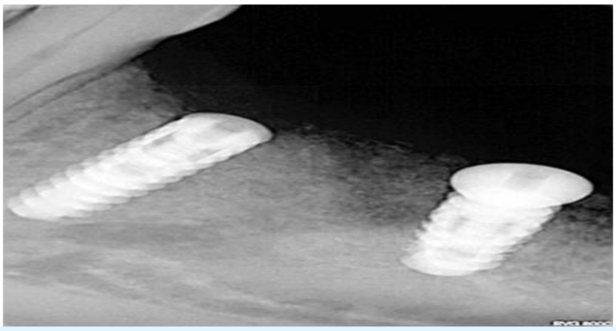

Fig. 1. Implants 34 and 36 on the day of insertion with crestal apposition graft

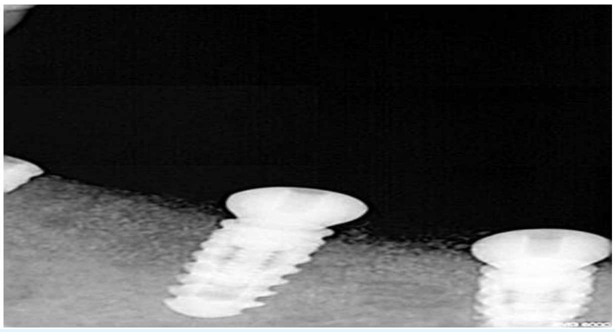

Fig. 2. Implant 36 radios graphically ousted-integrated at 5 months

- Absence of persistent subjective discomfort (pain, sensation of foreign body and / or dysesthesia).
- Absence of recurrent peri-implant infections with suppuration.
- No radiofrequency around the implants Peri-implant sounding less than or equal to 5mm (PPD ≤ 5 mm);
- No bleeding on probing (BOP-)
- Bone loss less than 1.5 mm in the first year of loading and 0.1 mm per year (mesial and distal).

The resorption of 1.5 mm after the first year of wearing is no longer regarded as a constant, but a response related to the formation of the biological space, in cases where:

- The implant is inserted deeper.
- The fabrics are fine [1].

Presence of bacterial colonization in the micro-gap (10 μm) fixture-abutment[2].

Success criteria, however, are distinct from survival criteria. Survival is when an implant has a marginal bone loss greater than 2.5 mm, a peri-implant sounding> 5mm (with BOP - / +), or a recession of the peri-implant mucosal margin. Translated by the marginal discovery of the implant, without inflammatory manifestations clinically obvious, without problems of functional and aesthetic type, with the durability of the implant in the mouth for an indeterminate number of years[3].

Implant failure exists in two forms: “early” failure and “late” failure. The failure of early implant, due to lack of

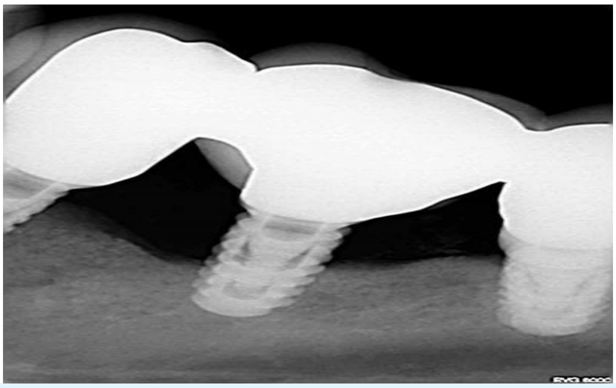

Fig. 3. Bone loss of 4 mm over 36 to 10 months

osseointegration, can be explained by factors not related to the susceptibility to periodontitis, such as overheating of bone> 47 ° C during the preparation of implant site, resulting in peri-implant bone necrosis, early infection, lack of primary stability or early mechanical overload.

Late implant failure, occurring after osseointegration, may be biomechanical or biological. Biomechanical failure is manifested by a fracture of the implant that may be related to the inadequacy / inadequacy of the implant or to peri-implant bone loss that moves to the implant apex where the occlusal forces are exerted. Peri-implant bone loss may be related in turn to peri-implantitis or, according to some authors, to a traumatic mechanism of occlusal forces when implanted in a non-axial position[4].

Biological failure, related to bacterial agents, is manifested by the appearance of inflammation of the mucous membranes, called mucositis, or by a loss of hard tissue, called peri-implantitis. The pathogenic mechanisms and risk factors are very similar, but not identical to gingivitis and periodontitis. They define peri-implant disease.

PERI-IMPLANTARY DISEASE

The term "peri-implantitis" was introduced over twenty years ago to represent a state of infection of peri-implant tissues[6]. Peri-implant inflammations, known as mucositis and peri-implalntitis, are the main implant biological complications involving respectively 63.4% and 18.8% of implant-prosthetic rehabilitation patients[7]. The term peri-implant mucositis refers to an inflammatory lesion of the peri-implant mucosa with redness, swelling and bleeding, without loss of bone tissue[8].

Periimplantitis is characterized, in addition to inflammation of the peri-implant mucosa, by bone loss (more than 2 mm) and is able to progress long-term pathology and lead to the loss of the system and the failure of implant-prosthetic therapy.

Anatomical Aspects

Structural Differences between Periodontal Soft Tissues and Peri-implant Soft Tissues

The fundamental distinction between an implant and a dental root is the absence of the periodontal ligament typical of the natural dentition which makes the implant an absolutely rigid structure, ankylosed in the bone. The periodontal ligament absorbs the trauma of the occlusal load up to one micron in the three planes of space.

At the apical end of the sulcular epithelium, present in both cases, begins the supra-crestal conjunctiva. This differs not only in the direction of the collagen fibers, perpendicular to the root of the tooth and firmly inserted in the root cement, while they are tangent to the implant and create a kind of sleeve with weak connections. on titanium. Its composition also differs, with a high proportion of collagen in the peri-implant conjunctiva and a low density of fibroblasts that makes it similar to scar tissue. Hence the increased vulnerability of peri-implant soft tissue to trauma and infection.

In periodontal tissues there are sensitive nerve endings and a vascular network that anastomoses with the capillary network of the superficial mucosa. In the peri-implant tissue, the absence of a nerve part makes it virtually insensitive and the only blood supply comes from the peripheral bone circulation. Another essential point for supra-crestal peri-implant tissues is their proximity to the connectivity between the implant and the abutment. In the presence of plaque or tartar, periodontal and peri-implant soft tissues show, at an early stage, gingivitis or mucositis, which must be the alarm signal for periodontal or implant complications. Their progression will have an exponential and destructive velocity in the peri-implant tissues with bone resorption (peri-implantitis), slower and progressive in the periodontal tissues (periodontitis).

Epidemiology

Zitmann et al. reported that the incidence of peri-implantitis progression in patients with periodontal disease is nearly six times higher than in patients who do not have a history of periodontal inflammation. After 10 years after placement 10% to 50% of dental implants showed signs of peri-implantitis. At the Sixth European Workshop in Periodontology, Lindhe and Meyle reported an incidence of mucositis greater than 80% and peri-implantitis between 28% and 56%.

Etiopathogenesis

In recent years, numerous experiments on animals and clinical studies have defined the accumulation of bacterial biofilm as the main etiological factor in the development and progression of peri-implant infections. Biolfilm refers to microbial colonization of surfaces of any type. After organizing bacteria into biofilms, these can act as multicellular organisms. In addition to streptococci, fusobacteria (especially Fusobacterium nucleatum) play an important role in the first phase of bacterial growth. They have the ability to bind to all oral microorganisms known to date.

Generally, it can be said that the formation of the subgingival biofilm depends on the surface roughness. In some studies, Staphylococcus aureus® have been found in the peri-implant pockets as important pathogenic factors. After a 3-week period of plaque accumulation, periodontal and peri-implant soft tissues both exhibit an inflammatory infiltrate that is quite similar in composition, volume, and distance from bone.

Risk Factors

Patients with poor oral hygiene have a higher risk of implant failure (13.8%), due to peri-implantitis, than patients with good / average oral hygiene (2.5 / 2, 9%)" In addition to the accumulation of bacterial biofilms, several risk factors may have additional effects and negatively affect the progression of the disease. These risk factors are smoking, diabetes, systemic diseases, osteoporosis, menopause, and their therapies (biphosphonates ...), radiotherapy, genetic factors, occlusal overload, mucosal condition (there is evidence of fact that it is necessary to have keratinized gingiva for the maintenance of peri-implant health), local factors.

DIAGNOSTIC

Differential Diagnosis

Mucositis has a depth of sound ≤ 4 mm (PD ≤ 4 mm), redness, swelling, marginal bleeding (MBI), pain and bleeding on probing (BOP +), and peri-implantitis, in addition Inflammatory symptoms common to mucositis, which are otherwise inconstant, include PD ≥ 5 mm, horizontal and vertical bone resorption on radiographic examination, BOP +, suppuration and, in the terminal phase, mobility. (Zitzmann and Berglundh 2008).

PD ≥ 5 mm (with BOP), however, is not sufficient in itself for the diagnosis of peri-implantitis, as implants inserted deeper than the bone crest may have a transmucosal pathway. Above the standard and have a probing depth ≥ 5 mm in the absence of peri-implantitis. It is a bone loss ≥ 2 mm given by the definition of peri-implantitis.

The primary diagnostic procedure for peri-implantitis, as well as periodontal disease, is the sounding. The use of a periodontal probe proved to be very practical, apart from the imperfection of the tests as to their reproducibility of results or their objectivity. In this way, the following clinical parameters can be determined:

- PLATE INDEX (PI)
- BLEEDING INDEX (BOP)

$$BOP = \frac{NUMBER\ OF\ BLEEDING\ POINTS}{NUMBER\ OF\ SURFACES\ TESTED}$$

A BOP + in less than 20% of the polls, repeated on the same peri-implant site, represents a healthy site in 100% of cases[12]; comparable to what is found in the case of teeth[13].

Conversely, if for teeth a BOP is positive several times, it represents a prognosis of progression of periodontitis of 30% (Lang et al., 1990 and 1996). A BOP

Fig. 4. Suppuration 36 to 20 months

+ in more than 50% of repeated probes on the same peri-implant site is an index of certainty (100%) of the progression of peri-implant disease[14]. A high BOP index is therefore linked to a strong inflammatory state.

The interpretation of a probing depth increment (PD) must always be performed relative to a determined value directly before the prosthetic rehabilitation, in order to take into account the implant and the specific factors of the implant positioning.

For the clinical determination the following points are used:

- PD: Depth of sound => distance between the marginal mucosa and the bottom of the pocket.
- GR: Gingival recession => distance between the shoulder of the implant and the marginal mucosa
- CAL: Clinical attachment level => distance between the implant shoulder and the bottom of the pocket.
- QUANTITY of liquid production from the peri-implant groove.

PUS Training

Numerous histological and immunohistochemical studies of peri-implant tissue biopsies have shown that infection is related to an increase in inflammatory cell infiltrate. Therefore, advanced peri-implant infections are clinically associated with pus formation (**Fig. 4**).

Clinical Assessment of Implant Mobility

Even in the case of advanced peri-implant bone loss caused by inflammation, residual osteointegration can ensure stable anchoring of the implant body and associated superstructure. In contrast to the gradual onset of tooth mobility, less mobility of an implant should be considered as a total loss of osseointegration. Thus, the clinical presence of implant mobility is not a reliable method of evaluation.

Radiographic Diagnosis

Radiological diagnosis can be considered as a routine method for assessing the marginal bone level for an osseointegrated implant. There are different types of radiography to help the clinician in the diagnosis of peri-implantitis.

- PANORAMIC RADIOGRAPHY

- RETRO-ALVEOLAR RADIOGRAPHY
- SCANNER TOMOGRAPHIC CUTS
- CONE BEAM TOMOGRAPHIC CUTS

THERAPEUTIC APPROACHES TO PERI-IMPLANTARY DISEASE currently recommended treatments for the treatment of peri-implantitis are mainly based on scientific evidence resulting from the treatment of periodontal disease. Removal of the biofilm from the implant surface is the primary goal in the treatment of peri-implant disease.

Clinical Guidelines for the Treatment of Peri-Implantitis

* Solving the infection process: removing soft and hard deposits from the surface of the implant.

* Adapt, if necessary, the prosthetic superstructure, to allow optimal oral hygiene, which is necessary for the resolution of the infectious process.

* prevent the reestablishment of an infectious process by reinforcing the oral hygiene habits of the patient.

* Perform non-surgical or surgical treatment to improve the access required for mechanical and chemical cleaning of the implant surface (corrective therapy).

* Put in place regenerative procedures to obtain filling of the defect and reduction of pockets in intraosseous defects (regenerative phase).

* Producing results through patient motivation: the patient's oral hygiene should be encouraged with rigorous follow-up (support phase).

Mucosity Therapy

For the clinician it is extremely important to diagnose early and treat the lesions of implants not yet advanced. Mechanical therapy, with or without the addition of antiseptic mouthwashes has been found useful in the treatment of peri-implant mucositis. For ultrasonic decontamination of implants, inserts have been designed with plastic and Teflon coatings. Good oral hygiene and a routine maintenance program with regular pocket depth assessments, supported by professional implant cleaning, should be an integral part of every postoperative follow-up session following implant placement. Oral hygiene measures can be implemented with antiseptic mouthwashes. In the case of shallow probing around implants, mouthwashes based on essential oils or Chlorhexidine Digluconate may be prescribed.

Peri-Implantite Therapy

Treatment of peri-implantitis aims to stop the progression of the lesion (BOP-, ↓ PD) and, if possible, to reconstruct / re-osteo-integrate the lost peri-implant bone, thanks to the elimination of bacterial infection. Since peri-implantitis is often associated with the exposure of the implant's turns, and the implant surface is irregular, a surgical approach often facilitates access to the infected turns, although it is always preferable to start with non-surgical approach, similar to what is done for periodontitis.

	Paramètres Cliniques				CIST
	VPI	BOP	PD mm	Défauts Rx	
Sain		-	≤ 3 mm	-	A*
Mucosite	+	+	≤ 3 mm	-	A*
Sain ou Mucosite			4-5 mm	-	A+B*
Peri-Implantite	+	+	≥ 5 mm	≤ 2 mm	A+B+C+(D)*
Peri-Implantite	+	+	> 5 mm	> 2mm	A+B+C+D*

(*) A: Mechanical Therapy B: Antiseptic Therapy C: Antibiotic Therapy D: Respective or Regenerative Therapy

Fig. 5. Cist Protocol

The ICLS protocol, proposed by Lang et al., Is used for periodontal disease. We can see a summary diagram in **Fig. 5**.

Non-Surgical Treatment

Mechanical therapy

Unlike periodontal lesions that can affect only one side of a tooth, peri-implant injuries tend to be circumferential. The clinician must therefore have tools that allow access to the entire implant surface affected by the lesion.

Antiseptic therapy

Topical antiseptic and antibiotic therapy should be preferred in peri-implantitis cases, where it is necessary to have a higher concentration of antiseptic or antibiotic in the pocket. It uses slow release systems (chlorhexidine chips, minocycline microspheres (Arestin) Doxycycline Polymers (Atridox)) [6].

Antibiotic therapy

The mechanical treatment may be associated with local release antibiotics, such as slow-release tetracycline impregnated fibers and doxycycline-containing gels (Atridox, Zila LNC., Fort Collins, CO, USA) or minocycline microspheres (Arestin, OraPharma LNC., Horsham PA, USA).

Aero-abrasive therapy

A new therapy used to control subgingival infection is Perio-Flow® (EMS, Nyon, Switzerland), which uses abrasive suspension particles. This treatment, which gives results comparable to those of the treatment of subgingival pockets, allows operating safely [7].

Surgical Treatment

The surgical approach is the treatment of choice for peri-implantitis due to the complexity of the lesion and the compromised implant surface. Nonsurgical treatment of peri-implantitis is often insufficient. However, it is an essential prerequisite before surgery. The main goal of the surgery is to create access for debridement and decontamination of the contaminated implant surface.

Decontamination with a laser, the use of abrasive systems or implantoplasty of the exposed part of the implant can be considered as complementary

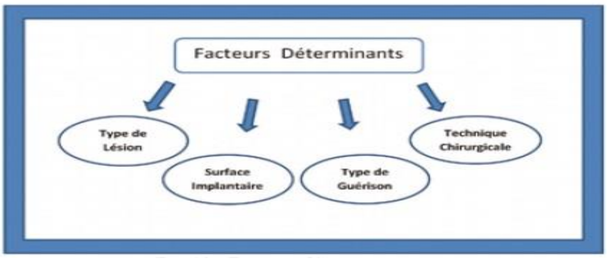

Fig. 6. Determining factors. ASSISTED LASER TREATMENT

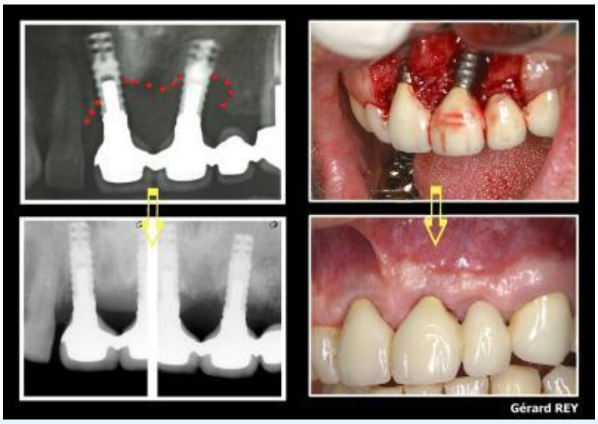

Fig. 7. Bone and gingival healing after laser assisted peri-implantitis treatment. (Case of Dr. Gérard Rey)

techniques to regenerative or resuscitative surgery. They achieve significantly better results than conventional treatment alone. Peri-implant bone surgery can be a respiratory, conservative or regenerative agent. The peri-implant resection surgery consists of an osteotomy of the infra-osseous defect to remove the pocket and the grinding and polishing of the surface of the exposed implant, which is no longer osteo-integrated, using diamond burs and rubber cups to make it similar to the original neck of the implant.

Peri-implant conservative surgery uses an access flap that allows removal of granulation tissue from the infra-bone and supra-bone portions of the defect and smoothing of the exposed surface of the implant above the limit bone.

Peri-implant regenerative surgery, which follows the principles of periodontal surgery, consists of removal of the granulation tissue present in the supraosseous and infra-osseous defects, sanding of the exposed surface of the implant and regeneration treatment. Peri-implant infra-osseous defects with the use of grafts, membranes or grafts + membranes. Depending on the different clinical situations, you can opt for surgical resection or regeneration. In non-aesthetic areas, surgical resection and apical repositioning can be used to reduce the probing depth and improve access to daily oral hygiene. The following table summarizes the key factors: (**Fig. 6**).

Each type of laser is characterized by the specific and unique wavelength of the radiation it emits. Ordinary light consists of a beam of incoherent rays, of different

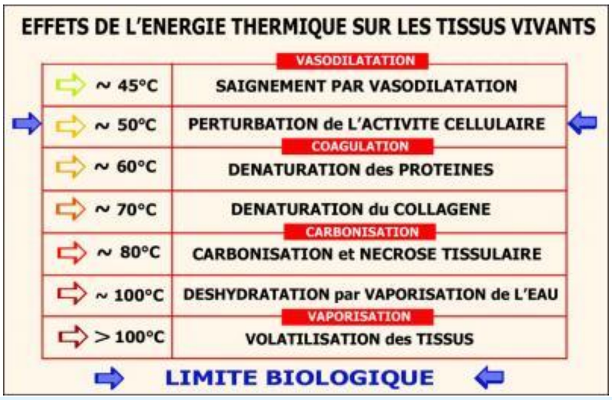

Fig. 8. Effects of thermal energy

wavelengths, while in the laser beam each emitted ray has the same wavelength and consists of phase photons and coherent. Most medical lasers have their wavelengths in the near-infrared range, i.e. above 775 nm. They remain invisible to the human eye, which can only perceive light between 375 and 775 nm. Each wavelength is found to be variously absorbed in the various constituents of matter. The choice of the wavelength, and therefore of the laser, will be predominant according to the therapeutic objectives and the tissues to be treated. Er: YAG or CO2 laser beams are strongly absorbed by water and hydroxyapatite. Their penetration into soft tissue or bone containing it will therefore be very low (2 microns for the Er: YAG laser, 20 microns for the CO2 laser). Their effects will therefore focus on the surface of these tissues and they will not be able to cause effect in depth. On the contrary, Diode or Nd: YAG laser rays, which are very little absorbed by water and hydroxyapatite, will penetrate deeply into the soft tissues or bones containing them. They will have little visible effects on the surface but will have effects in the depth of the tissues. It is precisely on these effects that laser therapy in periodontics is based. The laser beam of Nd: YAP is considered a penetrating laser even though its absorption in water is much greater than that of Nd: YAG or diode lasers. The Er: YAG laser beam, highly absorbed by water and hydroxyapatite, penetrates little into the tooth, which contains a lot of it. It makes it possible to obtain an ablation effect on the hard tissues, by using water to remove the tissue by phenomena of explosion of water molecules contained in situ. If the tissue is dehydrated the action will be less effective. Conversely, the diode laser beam penetrates very deeply into the dental tissue, up to the level of the pulp, which can receive thermal effects that may be harmful to the tissues. These effects will have to be mastered to avoid any deep lesion.

Thus we will distinguish two laser families: Penetrating lasers and absorbed lasers. Differences between absorbed and penetrating lasers on the target surfaces:

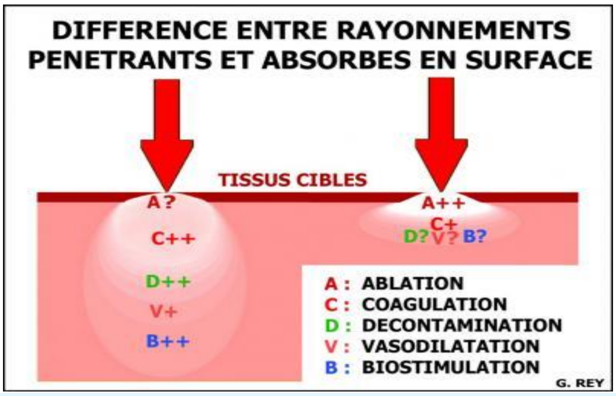

Fig. 9. Differences in the effects of radiation

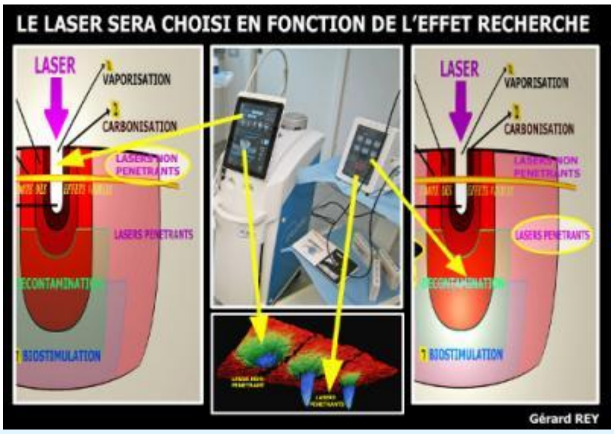

Fig. 10. Choice of the Laser according to the desired effect

* Both types of laser have superficial photo ablative effects.

* Absorbed lasers can have thermal effects but cannot reach depth; they do not have large photo-dynamic effects.

* Penetrating lasers can have thermal effects (high, medium, low), photo-dynamics (or decontaminants) and bio-stimulation effects.

In Period ontology and Implant logy the laser is used for two fundamental aspects, in bacterial infections:

a) The decontaminant effect that includes two types of complementary reactions:

1. Des reactions photochimiques dont l'accepteur d'énergie est l'oxygène (activation d'une substance par rayonnement)**.**

2. dynamic phototherapy reactions without dye (transformation of the material under the effect of a light energy allowing photo-oxidation reactions and production of singlet oxygen)

Publication history: Rey G. 2000-2001) (Rey G, Caccianiga G. 2005-2008) (Caccianiga G, Rey G. 2007-2008)

* The Biostimulant effect determines a kind of "biological doping" for the affected tissues, favoring their regeneration in case of loss of substance.

* The biostimulant effects of penetrating radiation reach greater depths than decontaminant effects.

Study: Treatment of Peri-Implantites With Ohllt Technique (Oxygen High Level Laser Therapy)

Goal

What is the effect of OHLLT therapy in the treatment of peri-implantitis patients as adjunctive therapy to non-surgically treat peri-implant disease?

Would it be possible to compare the OHLLT technique with conventional therapy (ultrasonic or manual equipment) in removing bacteria from peri-implant pockets?

The purpose of this study is to evaluate the bactericidal efficacy of high power laser radiation associated with the use of stabilized hydrogen peroxide against bacteria commonly found in peri-implant active pockets.

Material and Methods

Study program

Study design: case-control study.

Duration of the study: 6 months.

Criteria for inclusion of the population study

- Gender: male and female
- Age: 35 years old minimum
- Presence of chronic or acute periodontitis and peri-implantitis that has not undergone surgical periodontal treatment in the last 12 months in the affected site.
- Each patient should have peri-implant pockets> 4 mm with bleeding sounding
- The patient must, after being made aware of the nature of the treatment to which he will be subjected, sign the informed consent.

Exclusion criteria

- Patients who have demonstrated a lack of respect for the protocols.
- HIV seropositive patients.
- Multiple sclerosis patients.
- Patients with active or past addiction to alcohol or drugs.
- Patients with psychiatric or emotional problems, as they may invalidate informed consent or not be able to perform instructions for home care maneuvers.

Ohllt Technology

OHLLT Technology (Oxygen High Level Laser Therapy) is a treatment that involves the combination of a penetrating laser with a solution of H2O2 modified and stabilized with glycerol-phosphate (10-volume H2O2 derivative, thus free of cytotoxic actions).

The laser energy activates the modified H2O2 solution by releasing singlet oxygen free radicals that have antibacterial activity on the Gram + and Gram- specific groups of periodontal disease. The laser must be capable of producing sufficiently high peak power peaks (2.5 W) to be effective on the seeds while

Fig. 11. Choosing an average Photo-Dynamic setting. (Diode Wiser Icon Setting)

delivering a reduced average power (<0.8 watt) to avoid tissue damage.

Diode lasers on the market can be of different types according to their impulse characteristics:

- Lasers using high power but with long rest periods to avoid thermal damage.
- Lasers that use low power with extended application times and little interruption.

The first type has a good bactericidal effect but a weak biostimulant effect, the second type has a good bio stimulant effect, but an ineffective bactericidal effect.

- The 980 nm diode laser software used in the OHLLT technology has both high power peaks (which are fundamental for eliminating bacteria) and very short microsecond times of application. Average power less than 0.8 Watt (reduced thermal effect).

This new type of software-assisted diode laser can guarantee the triad of effects obtained (vasodilatation, good decontamination and bio-stimulation), by extending the Maximum Efficiency Volume (MEV) where these desired effects are superimposed on any the thickness of the target tissues.

This is what should be sought whenever we irradiate tissue with periodontal disease or peri-implantitis.

The OHLLT is characterized by:

- High peak power (2.5 watts): allowing the destruction of microorganisms (decontaminating effect)
- Reduced average power (0.5 to 0.8 watts) by reduced emission times: To reduce the high thermal effects (harmful to the tissues) and to favor the slight thermal effects (increase of the vasodilatation). This increases blood flow to the treated site, promotes healing and regeneration (increased intake of growth factors, oxygen, inflammatory cells and stem cells).
- High frequency (10,000 Hz) activation and high release of singlet oxygen (up to 10,000 times per second), increasing antibacterial activity.
- Maximum depth of penetration: with the OHLLT one uses a photo-sensitizer rich in oxygen but transparent, non-chromophore, which thus allows the penetration of the laser in depth.
- Removal of silver stabilizer H_2O_2 compounds replaced with glycerol phosphate.

The photochemical effect of this photodynamic therapy consists of the activation of a substance (in this case, hydrogen peroxide) by a mono-chromatic radiation (a laser beam characterized by a single wavelength).

The interaction between the photo-sensitizing substance and the laser beam produces photochemical reactions, in which the energy acceptor is oxygen. Stabilized hydrogen peroxide contains oxygen and its photoactivation allows a singlet oxygen production which is a radical oxygen (a free radical is a highly reactive chemical species that has unpaired electrons in its outer layer).

Discovered in 1924, singlet oxygen is 1000 times more active than basic oxygen. It is a universal intermediate in the physical, clinical and biological processes of molecular reactions.

This liquid is a normal product of aerobic metabolism in humans, it penetrates the mucous membranes and decomposes very rapidly into oxygen and water under the action of peroxidases of aerobic living organisms.

Free radicals of oxygen are naturally produced in our organism: the neutrophils PN stimulated by antibodies release singlet oxygen which destroys the bacterial cells by various mechanisms:

- Oxidation of the lipid membranes of the bacteria causing their death.
- DNA denaturation of microorganisms
- Destruction of their lysosome membrane
- Modification of mitochondrial function
- Implosion of microbes inside the pockets

This PDT under hydrogen peroxide is today very widely used in many medical fields.

The decontaminant power of this dye-free PDT was discovered in Periodontology and Implant ology in the 1990s and first described in 2000 (Rey G 2000).

The mechanisms of destruction of the infectious cells during the photodynamic therapy21 follow the same pattern of action by the production of singlet oxygen from free radicals according to the principle:

- Tissue oxygenation obtained by prior deposition of 3% hydrogen peroxide.
- Laser irradiation and interaction with H_2O_2 contained in tissues. Clear, colorless oxygenated water does not reduce the penetration of laser radiation.
- Release of molecules of H_2O and O_2 (fundamental oxygen or dioxygen), with two unpaired electrons in parallel orbits.
- New laser irradiation that allows the passage of an electron to a higher spin spin-back orbit that allows the release of singlet oxygen (diamagnetic O_2) which has a double bond between oxygen atoms (O = O.).

- The life span of singlet oxygen in our tissues is of the order of a microsecond before this molecule, highly reactive and highly unstable, isomerizes in triplet oxygen (paramagnetic oxygen) a lifetime of the order of the millisecond.

This triplet oxygen then becomes a basic oxygen molecule (dioxygen) available for new excitation[22].

- This brevity of existence is compensated by a very high frequency of lasers used diodes (6000 Hz or more).
- Reaction of the singlet oxygen on the bacteria causing their destruction according to the aforementioned mechanisms.

The treatment of peri-implantitis will exploit different types of action for the control of plaque and calculus:

- Mechanical action (removal of scale with ultrasound and / or curettes).
- Chemical action (solution of povidone-iodine (Betadine), conveyed by ultrasound, in diluted solutions 1/5)
- Mechanical and chemical action of aero-polishing with high-abrasive bicarbonate powder, with the aim of a better elimination of bacterial biofilms on implant surfaces, especially for nano-treated ones.
- Physical action of the photo-dynamic therapy: effective to eliminate even the most aggressive bacteria.
- The combination of these three phases of the therapy allows us a large disinfection and broad spectrum over the entire surface of the implant.

A comparative study of the effects of laser alone and in combination with H2O2 came to these results [8]:

- Hydrogen peroxide alone has little effect on the elimination of microorganisms.
- Hydrogen peroxide alone is effective only against Prevotella intermedia and Aggregatibacter but not on the rest of the microorganisms.
- The laser used alone gives poor results in the elimination of bacterial species involved in periodontal disease.
- The laser itself is only effective on Aggregatibacter.
- The laser in combination with hydrogen peroxide has a much more effective antibacterial action on most microorganisms involved in periodontal disease.

Ohllt Technology Protocol for the Treatment of Peri-Implantitis

The OHLLT Technology Protocol (Laser Decontamination + Stabilized Hydrogen Peroxide) is an alternative solution to eliminate bacteria in complex cases that are most refractory to conventional therapies.

There are two types of treatment possible: blind and surgical.

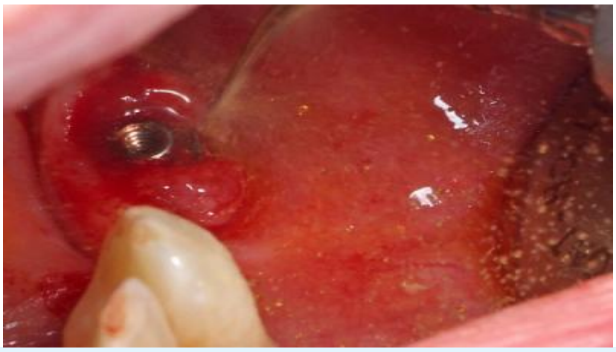

Fig. 12. Ultrasonic debridement under irrigation of 20% Povidone Iodine

Fig. 13. Air polishing with sodium bicarbonate with high abrasiveness

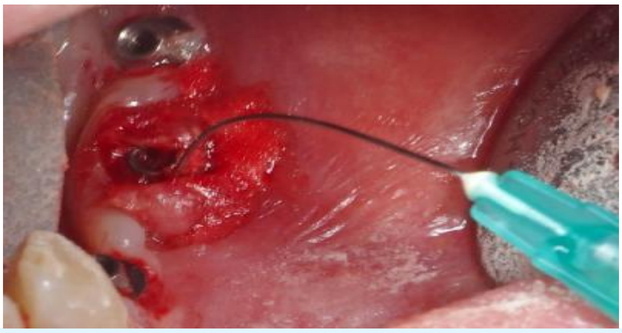

Fig. 14. Hydrogen peroxide irrigation at 3%

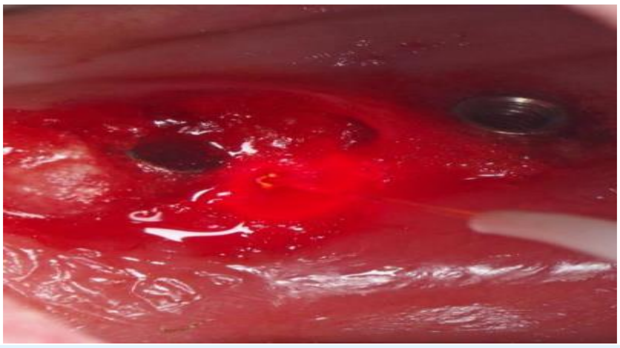

Fig. 15. Dynamic phototherapy treatment without laser Diode 980nm dye, 400μm fiber, 2.5W, 6000Hz, 50μs Tone, Toff 117μs, 75μ

- Nonsurgical treatment: Provided for sounding with a depth of less than 5 mm, (mucositis) and loss of bone support of less than 2 mm, or contraindication / impossibility of surgical treatment. (**Figs. 12** to **18**).

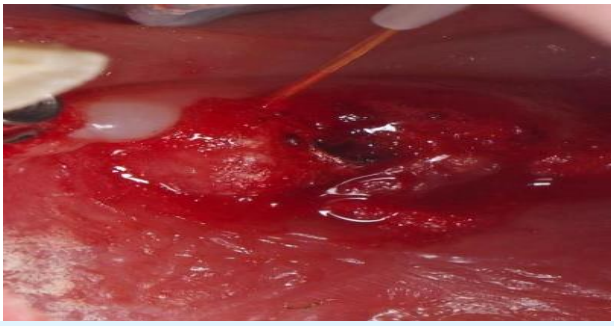

Fig. 16. Laser Coagulation Diode 980nm, 400µm fiber, 2.5W, 100Hz, Ton 5ms, Toff 5ms, 25days

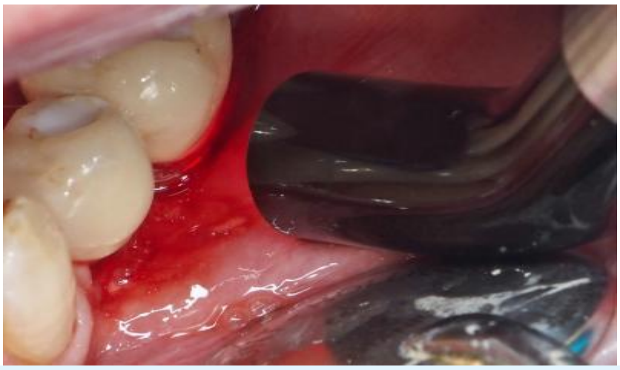

Fig. 17. Laser Biostimulation Diode 980nm, Defocusing Lentil Lens 2 W, 10000Hz, Tone 5µs, Toff 5µs, 150µ

Fig. 18. Healing 14 days after non-surgical 980 nm diode laser treatment. The sanitized clinical situation will facilitate the surgical treatment of reconstruction

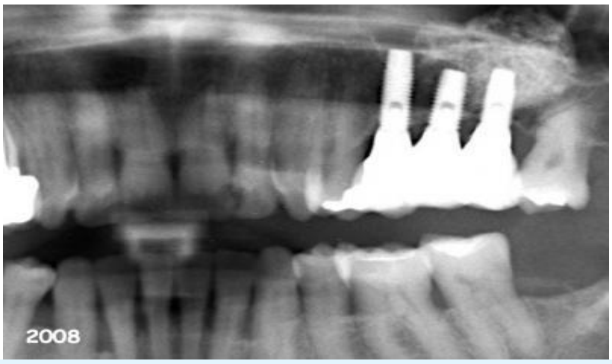

Fig. 19. Implants in position 25-26-27 without obvious radiological evidence of peri-implant disease (2008)

Surgical treatment: Probing depth greater than 5 mm and loss of bone support equal to or greater than 2 mm.

Study Protocol

This study was conducted on a group of ten people with periodontal and peri-implant disease without

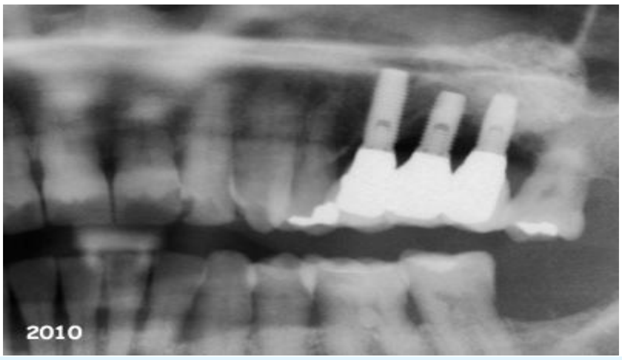

Fig. 20. Implants in position 25-26-27 With obvious radiological sign of early peri-implant disease (2010)

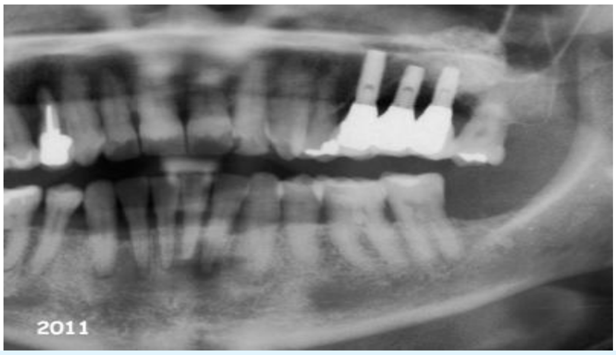

Fig. 21. Implants in position 25-26-27 With significant radiological evidence of peri-implant disease (2011)

Fig. 22. Implants in position 25-26-27 on the day of surgical treatment (2012)

systemic complications. All patients underwent treatment of periodontal and peri-implant pockets by the assisted laser therapy described in this article. (**Figs. 19-22**: Radiological evolution of peri-implantitis from 2008 to 2012).

Therapeutic Sequences

- 1st session

- Obtain informed consent.
- Collection of medical history.
- Checking inclusion and exclusion criteria for OHLLT technology

Fig. 23. Implants in position 25-26-27 clinical evaluation of bone defects by periodontal sounding, the day of surgical treatment (2012)

Fig. 24. Implants in position 25-26-27: Surgical vision of vestibular bone defects before surgical treatment

- Charting and periodontal probing of all pockets and gingival recessions
- Indices for measuring plaque and bleeding
- Motivation of the patient to purchase and use all necessary tools for the home care protocol
- Collection of gingival fluid, colonized by bacteria and containing epithelial cells, peri-implant pockets to be treated, by conical tips of sterile paper, immediately sent to the laboratory for microbiological analysis.
- Execution of immediate retro-alveolar X-rays and prescription of CBCT analysis (possibly)

- **2 ° Session (at 1 week of the first session)**

• Evaluation of microbiological data arrival of the laboratory.

• Local anesthesia with mepivacaine and vasoconstrictor (epinephrine 1: 200,000).

• Complete non-surgical periodontal treatment of the whole oral cavity using laser-assisted medical periodontology techniques (Application of povidone Iodine (Betadine) diluted 1/5 concurrently with debridement of periodontal and peri-implant pockets by ultrasound and curette, aero -polishing root surfaces with low abrasive powdered sodium bicarbonate or with glycine powder in the periodontal pockets, and with high abrasive sodium bicarbonate powder in the peri-implant pockets. Periodontal and peri-implant pockets with stabilized hydrogen peroxide solution, removal of excess solution in the oral cavity by aspiration.

The hydrogen peroxide solution is left in the bone defects for at least 3 minutes to allow oxygenation of the hard and soft tissues, then introduction of the diode laser fiber 980 nm into the periodontal and peri-implant pockets and processing with OHLLT settings and application times (described later)

- Programming the next session in a week

- **3 ° Session (at 1 week of the second session), (Fig. 23 to 26)**

• Anesthesia with articaine and vasoconstrictor (epinephrine 1: 200,000)

• Intrasulbaric incision and decoliation of a full buccal and lingual / palatal flap extending mesially and distally to the papillae of adjacent elements to the peri-implant lesion to be treated.

• Debridement of the implant surface using ultrasound under irrigation of povidone iodine (Betadine) diluted to 1/5 and curettage of the granulation tissue using curettes and gouge pliers.

• Curettage of Er: YAG laser granulation tissue.

Fig. 25. Implants in position 25-26-27 on the day of surgical treatment after removal of Er: YAG 180mJ, 20 Hz, 70% H2O laser granulation tissue, (2012)

Fig. 26. Implants in position 25-26-27, the day of surgical treatment after closure of the gingival flap (2012)

Fig. 27. Implants in position 25-26-27 1 month after surgical treatment

Fig. 28. Implants in position 25-26-27 3 years after surgical treatment

- Aero-polishing of the implant surface with high abrasivity sodium bicarbonate powder
- Irrigation of peri-implant bone defects with stabilized hydrogen peroxide solution
- Suction of excess solution in the oral cavity.
- The peroxide solution is left in the bone defects for at least 3 minutes to allow oxygenation of the hard and soft tissues.
- Introduction of the laser fiber into the bone defect
- 980 nm diode laser processing by OHLLT technique (“decontamination” setting). The fluency of the laser is related to the time and the power used. The average laser power is 0.5 watts, Ton: 20 µs Toff: 80 µs, freq: 10KHz. The diameter of the laser fiber is 400 microns which corresponds to 0.0012 cm 2. The fluency is 25,000 J / cm2.

The laser is applied for 60 seconds on the vestibular wall and 60 seconds on the palatal / lingual wall with a continuous oscillating movement that goes from distal to mesial and vice versa.

- Repeat the debridement of the surface with Laser Er: YAG and / or curettes and / or ultrasound to remove any form of plaque or granulation tissue present and repeat the application of OHLLT to obtain a blood bed favorable to the regeneration of tissue.

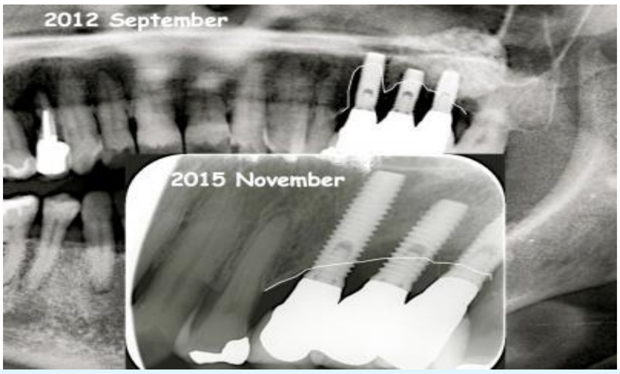

Fig. 29. Radiological control at 3 years

- Closure of the flap by suture with a silk of 4/0: a first point of internal horizontal padding makes it possible to bring the two shutters closer without creating tensions then sutures of the occlusal margins of the flaps.

In no patient was filler material applied, leaving the soft and hard tissues as the sole regenerative potential.

- **4 ° Session (at 15 days)**

- Deletion of points and control of the wound
- First treatment control with the application of photodynamic therapy to allow a new decontamination. If an area has not been completely treated, it is possible to repeat the ultrasound under irrigation of providence iodine (Betadine) without recourse to a new anesthesia.
- Treatment monitoring, every 20 days, apply the modified and stabilized hydrogen peroxide and the laser (usual settings: average power: 0.5 Watt, peak power: 2.5 Watts, frequency: 10,000 Hertz, Ton: 20 µs, Toff: 80 µs in the remaining faults, to allow a new decontamination plus a biostimulation If a zone has not been completely treated, it is possible to resume the ultrasonic treatment under irrigation of povidone iodine again (**Fig. 27**).
- At 6 months gingival fluid sampling is performed, with conical paper tips, in the treated peri-implant pockets and immediately sent to the laboratory for microbiological analysis.

All clinical parameters (probing, plaque index and bleeding index) are checked.

RESULTS

Summary of results:

The plaque index dropped by an average of 65% with a range of 86% to 23%.

The bleeding index decreased by an average of 66% with a range of 80% to 26%.

Mean borehole depth dropped by an average of 1.6 mm with a range of 2.6 mm to 0.48 mm (**Fig. 30**).

The following are the results obtained by microbiological analyzes performed on the samples (bacterial analysis by PCR - real time). The first sample

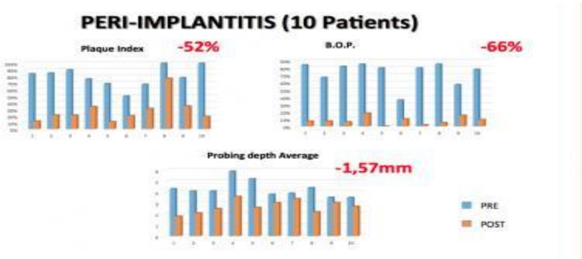

Fig. 30. Mean borehole depth dropped by an average of 1.6 mm with a range of 2.6 mm to 0.48 mm

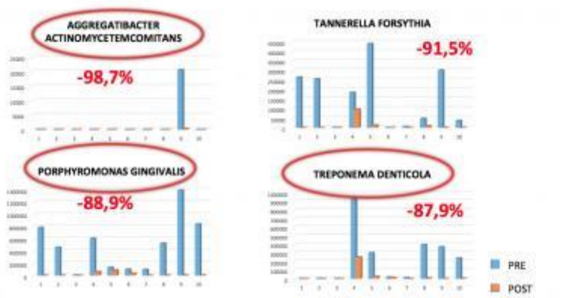

Fig. 31. The number of bacteria

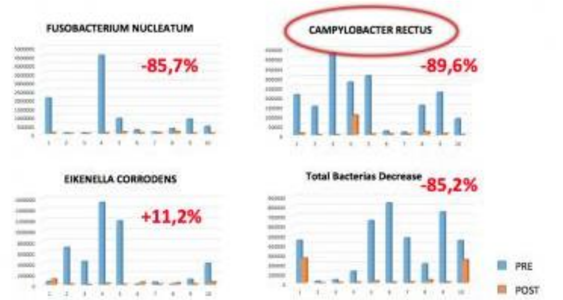

Fig. 32. The number of bacteria

was taken before treatment and the second 6 months after the end of treatment.

- The number of bacteria actinomycetemcomitans Aggregatibacter decreased on average by 98.70% (**Fig. 31**).
- The number of Porphyromonas gingival is bacteria have decreased by an average of 89% with a range of 100% to 34.55% (**Fig. 31**).
- The number of bacteria Tanner Ella forsythia has decreased on average by 92% with a range that ranges from 100% to 47.73% (**Fig. 31**).
- The number of Treponema Denticolas bacteria has decreased on average by 88% with a range that ranges from 100% to 30.77% (**Fig. 31**).
- The number of bacteria of Fusobacterium nucleatum fell on average by 85.68% with a range that ranges from 99.63% to 45.56% (**Fig. 32**).
- The number of Campylobacter rectus bacteria decreased by an average of 89.64%, with a range that ranges from 100% to 62.84% (**Fig. 32**).
- The number of Eikenella corrodens bacteria has increased on average by 38.64%, with a range of -100% to 491.07% (**Fig. 32**).
- The number of bacteria in the total load decreased on average by 85.27% with a range of 99.36% to 42.03% (**Fig. 32**).

DISCUSSION

The majority of peri-implantitis treatment methods are aimed at controlling the disease by reducing bacterial plaque on the root surface and peri-implant tissue to levels compatible with the host's immune system capacity. To control growth.

These methods can be advantageously supplemented by a laser treatment of the implant surfaces in order to eliminate the residual microbial load.(Li et al. 2016)

In our study, we can highlight how the OHLLT photodynamic therapy used as an adjunct to conventional therapy leads to a significant decrease in bacterial strains in the peri-implant space.

The above results show a significant decrease in the bacterial burden of the sites affected by the disease on which the OHLLT protocol was applied.

In particular, there is a decrease in the total bacterial load of approximately 70% due to the decontamination effect of the OHLLT. One could also refer to the bio-stimulating effect which acts as a kind of biological doping with an improvement of the plaque index close to 70%, the bleeding index of nearly 75% and the average depth survey of affected sites by approximately 1.2 mm.

This new protocol could solve the problem of refractory peri-implantitis in which aggressive bacteria, colonizing peri-implant sites, can be reduced to a greater extent than by any other type of conventional approach.

CONCLUSION

The majority of the studies analyzed show modest beneficial effects of pulsed lasers (Er: YAG or Er, Cr YSGG) compared to conventional therapies (with manual and / or ultrasound instrumentation) in the initial treatment of patients with peri-implantitis.

OHLLT photodynamic therapy, using penetrating and super-pulsed lasers (980 nm), thanks to the biological hypotheses that support it, and by the preliminary results obtained with this study, seems to be a good complement to the surgical treatment of the perioperative -implantite.

The effectiveness of the proposed protocol highlights the possibility of acting on the site in the least traumatic way possible, but with efficiency capable of offering a real improvement of the bacterial flora condition.

The reduction of inflammation of the peri-implant tissues, with a decrease in the sounding depth, the rate of bleeding and a massive reduction of the bacterial load, especially for aggressive strains very often found in affected sites, refractory to conventional protocols, are tangible elements as to the potential effectiveness of this protocol for the treatment of peri-implant disease.

It will be necessary to complete this pilot study with RCTs or other forms of research referenced in the pyramid of scientific evidence in dentistry.

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