Laser Multi-Wavelength Approach for the Treatment of Peri-Implantitis: A Case Report

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INTRODUCTION

Clinical observations of peri-implantitis have significantly increased in recent years, likely because of the large number of patients demanding mouth rehabilitation, implant-prosthetic treatments, and procedures to assure implant maintenance.[1]

Statistics are difficult to analyze because the standard deviations are very high, likely because of self-declaration by dental practitioners. The prevalence of peri-implantitis varies from 7% to 28% and increases with follow-up.[2,3] In fact, after 10 years, 10%–50% of implants develop peri-implantitis. Moreover, risk factors such as patient history (previous aggressive periodontitis and previous implant failures), technical misconduct, and incorrect material choice have not been systematically evaluated.

Peri-implantitis is considered a progressive and irreversible disease in the absence of treatment, and it concerns both soft and hard tissues.[4] Peri-implantitis is characterized by inflammation and destruction of tissues surrounding the implant itself, resulting in bone resorption, reduction or absence of osseointegration, pocket formation, and suppuration from multimicrobial infection.[5] Consequently, titanium surfaces start to be damaged by bacterial contamination and can no longer fix the hydroxyl groups of the glycoproteins, partially responsible for osseointegration.[6]

Peri-implantitis has great similarities with periodontitis. In fact, the initial lesion (when not the consequence of occlusal overloads or incorrect mechanical adaptation) generally starts as mucositis.[7] Early diagnosis is a key factor for successful treatment because this represents the proper time to stop the progression of the lesion with an effective treatment, which mainly comprises eliminating the biofilm at the level of the implant neck or healing screw.[8]

In the case of advanced peri-implantitis, the treatment must immediately start when diagnosed, usually by the presence of infection, edema, loss of stability, and pathologic pocket depth. After a first nonsurgical phase of initial decontamination with antibiotics, if the clinician decides to preserve the implant, an access flap is prepared depending on the mucosal conditions and morphology of the bone defect. This surgical phase depends on the number of remaining bone walls and the necessity of bone regeneration with the help of modern biological means, with membranes such as plasma-rich fibrin (PRF), platelet-rich plasma (PRP), allogenic bone grafts, cellular derivatives, and other filling materials.[9,10]

Unfortunately, these standard treatments are not always able to solve all the encountered problems because of numerous parameters that make the prognosis very uncertain. The difficulties concerning the decontamination itself are linked to bacterial resistance, elimination of granulation tissue, necessity of minimally invasive osteotomy, and possible damage on the implant surfaces.

The use of laser technology has been proposed for many years by several authors for the treatment of this kind of disease: Natto et al,[11] in a systematic review of the literature, concluded that CO_2 laser is safe and makes it possible to enhance bone regeneration; the diode laser (980 nm) seems to be effective in its bactericidal effect without changing the implant surface pattern; the Er, Cr:YSGG laser may create bone regeneration around a failing implant; and the Er:YAG laser exhibits a strong bactericidal effect against periodontopathic bacteria. Moreover, Tang et al,[12] investigated the effect of diode laser (810 nm) at low energy on normal human oral keratinocytes and fibroblast cells and concluded that the use of low-dose laser therapy itself (photobiomodulation [PBM]) can provide additional therapeutic benefits for effective clinical management of periodontal or peri-implant disease.

Another approach, photodynamic therapy (PDT), consisting of the association of a low-energy laser irradiation with proper cromophore delivery, was proposed for bacteria decontamination in peri-implantitis: some authors demonstrated its antimicrobial effectiveness with in vitro studies,[13] and other in vivo researches demonstrated that PDT has significant benefits in peri-implantitis treatment by reducing bacterial count.[14]

The aim of this preliminary clinical proposal was to suggest a new way to treat peri-implantitis based on the integrated use of a high-power laser, PBM, and PDT and to show, with the help of a clinical case, all the treatment steps, considering the irradiated tissue characteristics and the treatment objectives.

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CASE REPORT

Patient PV, a 56-year-old man, came to our clinic complaining of a problem with 2 crowns over implants (teeth 18 and 19).

Once the diagnosis was established with radiographic findings (Figure 1) and pocket measurement using an electronic periodontal probe (Florida Perio Probe, Florida Probe, Gainesville, Fla; Figure 2), 9 main steps were included in the treatment sequence using a 2940-nm Er:YAG laser and 635-nm diode laser; the second laser was used alone for PBM treatment (and in combination with methylene blue).

The first step, with a PBM treatment performed by a 635-nm red diode laser (Lasotronix, Piaseczno, Poland), was to prepare the tissues (Figure 3) using the following settings: 0.8 cm handpiece diameter; 200 mW power; continuous wave mode; 30 seconds of irradiation on the vestibular surface and 30 seconds on the buccal surface for 60 seconds; and 23.9 J/cm^2 theoretical fluence. This was done before an incision with a cold blade was made.

Subsequently, decontamination of the soft tissue surfaces was accomplished using povidone iodine (Shijiazhuang Sdyano Fine Chemical, Shijiazhuang, Hebei, China). Local anesthesia and a cold blade (Blade 15C, Hu-Friedy, Chicago, Ill) were used for incision, and the flap was conventionally reflected once the healing screw was removed for easy access.

Decontamination of the implant surface was then performed using a 2940-nm Er:YAG laser (Lite Touch, Light Instruments, Yokneam, Israel; Figure 4) with the following settings: 100-mJ energy, 20-Hz frequency, air/water spray, 1.2-mm sapphire tip diameter, 2-minute irradiation time, 8.84 J/cm^2 per pulse theoretical fluence.

Using the same Er:YAG settings, laser irradiation of the inner surface of the flap to eliminate the granulation tissue was then performed (Figure 5). Peripheral bone remodeling by vaporizing the tissue was accomplished using the same time irradiation with higher energy (150 mJ, 13.27 J/cm^2 per pulse theoretical fluence).

PDT was then performed using toluidine blue plus a 635-nm diode laser (Figure 6) with the following parameters: 0.8-cm handpiece diameter, 200-mW power, continuous wave mode, 60-second irradiation time (30 seconds of irradiation on the vestibular surface and 30 seconds on the buccal surface), and 23.9 J/cm^2 theoretical fluence.

A bone graft was inserted (Bio-Oss, Geistlich Pharma AC, Wolhusen, Switzerland; Figure 7), and the tissue was reapproximated and sutured (Dafilon, Braun Surgical, Barcelona, Spain).

At the end of surgery, PBM was performed, using the same parameters as described above (Figure 8). The patient was instructed to maintain strict oral hygiene, and he came back to the clinic 3 and 7 days later (for the removal of the sutures), 1 month, and 3 months later. The healing screws were replaced 3 months after surgery when the healing process was complete (Figure 9). A follow-up exam was performed every 3 months, and after 12 months, the crown was placed (Figures 10–13).

DISCUSSION

The treatment proposed here was organized in different steps regarding decontamination and remodeling, and PBM was used to enhance the healing process.

This technique activates the cells based on 2 mechanisms: a direct mechanism, consisting of a photobiological action on the respiratory chain and activation of the cellular redox chains that enhances ATP production,[15] and an indirect mechanism that activates the cells through secondary messengers produced by previously activated cells. Low fluences (0.05–10 J/cm^2) and a long exposition time (30–120 seconds) are necessary for successful treatment.[16]

In this protocol proposal, we recommend to use a cold blade for flap design because laser removes part of the target tissue; the quantity corresponding at least to the diameter of its spot (from 300 μm to 1.5 mm, depending on the use of fiber or tip). The choice of using a cold blade is justified because this loss of tissue may influence the healing process after suturing, and the quality of the incision performed with a scalpel was higher than the quality of the incision obtained with a laser beam.[17]

Decontamination is the key to a successful treatment: Er:YAG laser may destroy the biofilm invading the whole surface of the exposed titanium by explosive vaporization, and the low energy used in this protocol (100-mJ setting), along with abundant air/water spray, cleans and detaches the biofilm; in fact, although lower energies are not able to completely decontaminate the implant surface, higher energies may cause the surface to be damaged.[18–21]

One more aspect that must be discussed is related to the necessity to prescribe antibiotics. In the case of acute peri-implantitis, particularly when associated with swelling, antibiotics may be required for 1 week to 10 days, even if further investigation is needed. In fact, the literature remains controversial, and several authors believe that "no sound scientific basis is available for the use of systemic antibiotics."[22]

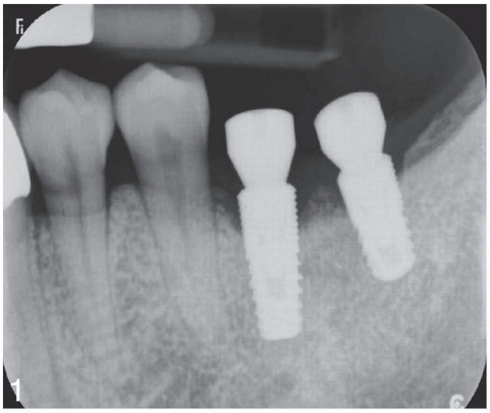
Bone remodeling using the Er:YAG laser is based on the high absorption of this wavelength in water and hydroxyapatite: it requires high energy to obtain explosive vaporization through the explosion of the water inside the cells. In this way, it is possible to selectively eliminate the granulation tissue, avoiding destruction of a large amount of bone.[23]

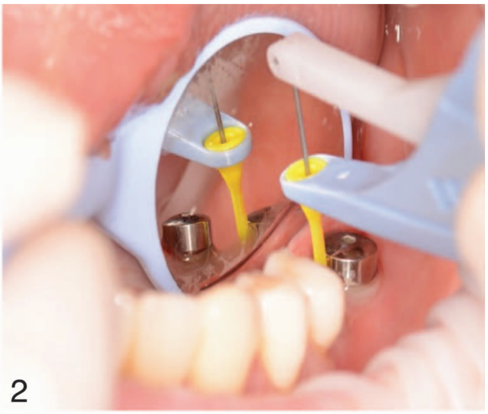
To complete the decontamination, after the biofilm destruction using the Er:YAG photoacoustic effect, our protocol uses PDT with 3 components: a photosensitizer, visible light, and oxygen. A complex interaction among them produces cytotoxic effects inside the target tissue cells, involving mitochondria apoptosis, lysosome necrosis, and cell membrane necrosis, resulting in bacterial reduction.[24]

The use of nonabsorbable membranes associated with a bone graft could be useful, as well as PRF or PRP. The choice of material depends on the clinical statement and the ability of the dental practitioner; in the case described, the choice was limited to the use of a bone graft without using other biomaterials.[25] Finally, after suturing as hermetically as possible, PBM is used to support the healing process.

Even with the limits of presenting only 1 case report, the aim of this contribution is to propose a new protocol, based on the integration of different laser wavelengths and different ways of using them; each was demonstrated as effective in several in vitro and in vivo studies.

It will be necessary to confirm the results with further research and future clinical investigation, such as randomized controlled trials and multicentric observations, to support the





Figures 1–7. Figure 1. Initial X-ray. **Figure 2.** Pocket depth measurement. **Figure 3.** Photobiomodulation. **Figure 4.** Er:YAG laser irradiation of the implant and bone recontouring. **Figure 5.** Incision and excision of granulation tissue**. Figure 6.** Performing photodynamic therapy. **Figure 7.** Bone graft placement.

Figures 8–13. Figure 8. Immediate postoperative PBM. **Figure 9.** Six-month follow-up X-ray. **Figure 10.** Twelve-month follow-up X-ray. **Figure 11.** Twelve-month follow-up with screws. **Figure 12.** Vision of crowns. **Figure 13.** Crowns placed on the abutments.

idea that a multi-wavelength laser approach can simultaneously obtain tissue decontamination and a fast healing process coupled with new bone formation.

ABBREVIATIONS

PBM: photobiomodulation
PDT: photodynamic therapy
PRF: plasma-rich fibrin
PRP: platelet-rich plasma

NOTE

The authors declare no financial conflict of interests and that no funds were received for this research.

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