Treating Peri-implantitis in a Predictable Way: Review of Literature and An Er: YAG Laser Based Case Report

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Abstract

Treatment options for peri-implantitis varies and often unpredictable. The current article delineates treatment modalities available for peri-implantitis and discusses evidence of their long-term predictable outcome. In addition, evidence of adjunctive use of laser therapy in dentistry is discussed. Finally, a peri-implantitis case which was treated with erbium-doped yttrium aluminium garnet (Er: YAG) laser and a regenerative procedure is presented, including long term follow-up. In the case, treatment included intra-sulcular incisions with full thickness flap, mechanical debridement of the osseous defect and decontamination of implant` surfaces with Er: YAG. Bone regeneration was done using biphasic calcium phosphate bone substitute and a resorbable collagen membrane. The outcome of the case show radiographic bone formation, healthy clinical periodontal pockets and no bleeding. The case presents the advantage of adjunctive usage of Er: YAG as a disinfecting agent which provides optimal environment for regeneration in peri-implantitis cases.

Key Words: Dental implants, Laser, Peri-implantitis

Introduction

Dental implants have been recognized for more than 30 years as a predictable, long-term option in the treatment of edentulous areas [1,2]. One of most grave complications related to dental implant is peri-implantitis. This condition is defined as a localized inflammatory lesion involving bone loss around an osseointegrated implant [3]. It is believed that the onset of peri-implant disease occurs following formation of dysbiotic biofilm on implant surfaces, which leads to chronic inflammation and bone loss [4,5]. As such, most treatment modalities are founded on anti-microbial concepts, aiming to clear the pathological biofilm at the infected dental implant.

Evidence based practice for predictable treatment modality for peri-implantitis

Treatment modalities for peri-implantitis include non-surgical and surgical approaches. Most of these modalities aim to eliminate plaque and calculus, and achieve decontamination of the infected implant` surfaces.

Non-surgical approach is similar to the principals of periodontal non-surgical treatment. Fundamentally, these approaches include mechanical debridement with or without the use of adjunctive chemical agents. The mechanical debridement is done with ultrasonic devises, air abrasion systems and various hand instruments like curettes. In an effort to refrain from damaging implant` surfaces, new generation hand curettes have been introduces, and include titanium, plastic and Teflon curettes. Nonetheless, in 2014, Faggion et al. in a systematic review showed that non-surgical treatment based solely on mechanical debridement showed the least favorable clinical improvement [6].

Adjunctive approaches to the mechanical debridement show some evidence of superior results compared with mechanical treatment alone. Tang et al. showed that the additional use of 25% metronidazole gel improved clinical parameters compared with mechanical debridement [7]. Similar effect was observed by Büchter et al. using 8.5% doxycycline hyclate slow release devise (Atridox) [8]. Both Karring et al. in 2005 and Renvert et al. in 2009 found that the Vector system lead to additional improvement in clinical parameters compared with mechanical debridement [9,10]. Glycine-based powder air polishing system were also found beneficial over mechanical treatment alone [11,12]. Machtei et al. found that the addition of chlorhexidine slow release devise (PerioChip®) had a significant superior results compared with mechanical debridement alone [13]. Still, Faggion et al., in their systematic review, concluded that the differences between non-surgical treatments options were small and that there is insufficient evidence to support that any specific non-surgical treatment approach is superior to debridement alone.

Surgical treatments include a number of approaches, such as open flap debridement, pocket reduction/elimination, soft tissue augmentation and regenerative treatment. Similar to the non-surgical approaches, the surgical treatments are often accompanied by a chemical treatment. A systematic review by Chan et al. discussed surgical approaches and their outcome [14], and found that open flap approach leads to mean reduction of 2.38 mm in pocket depth following surgery while resective approach led to less favorable outcome with a mean pocket reduction of 2.04. Regenerative approach with grafting and barrier membranes led to the most promising results with a mean improvement of 3.16 mm in pocket depth. Nevertheless, similar to non-surgical treatment approach, Chan et al. [14] concluded that there is a lack of high-quality comparative studies to support a favorable modality.

Finally and in accordance with Cochrane publication from 2011 regarding the available evidence of peri-implantitis treatments, concluded that there is insufficient quality and quantity of data regarding long term treatment outcome prognosis [15].

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The use of light to treat peri-implantitis

In 1917, Albert Einstein wrote: "a special kind of light could be created under the right conditions - a light nobody had seen before. The light would be a single color, it would not scatter the way normal light does and it would be very intense". Later on, this light was named "Light Amplification by Stimulated Emission of Radiation" (i.e., LASER). The rapid development of laser technology combined with an understanding of laser-tissue interaction increased the spectrum of possible laser applications in dentistry.

A wide variety of laser system has been introduced in dentistry, including radiation emitted from blue spectral range to mid-infrared region. The laser core is constituted of a material positioned inside highly reflective optical cavities which allow the amplification of light deriving from the energy source of the device [16]. The lasers are named according to their active medium and wavelength.

In order to achieve maximum efficacy, it is important to know what kind of laser is suited to a specific indication. Lasers can be divided into two groups: the soft tissue laser which include diode and CO_2 laser; hard tissue laser which include neodymium-doped yttrium aluminum garnet (Nd: YAG), erbium-doped yttrium aluminium garnet laser (Er: YAG), and erbium, chromium:yttrium, scandium, gallium, garnet (Erbium, chromium:YSGG).

Diode laser emit light in range of 700-1,000 nm in the near infrared region of the spectrum. Today Diode lasers machines are available at four different wavelengths: 810-830 nm, 940 nm, 980 nm and 1064 nm. The Diode wavelengths is highly absorbed by hemoglobin, melanin and pigmented tissue and have high tissue penetration abilities. These lasers are indicated for cutting and coagulating gingival, mucosa tissue and can also be used for sulcular debridement. Diode laser machines are small in size which makes them convenient and portable.

Carbon dioxide laser (CO_2) is the most powerful gas laser in dentistry. A light wavelength of this laser is 9600 nm and 10600 nm, and as such is located at the end of the mid-infrared light spectrum. This laser is strongly absorbed in water and hydroxyapatite, and is ideal for soft tissue surgery. This laser can easily cut soft tissue and promote coagulation.

Nd: YAG holmium-doped yttrium aluminum garnet, is the first laser the build for dentistry. This laser has a solid active medium with a wavelength of 1064 nm, located at the invisible near-infrared portion of the electromagnetic spectrum. The laser is highly absorbed by melanin and to lesser extent by hemoglobin. Importantly, Nd: YAG laser lead to heat formation during its activity which may increase temperature at the dental pulp [17].

Erbium family laser in dentistry was approved by the DFA at 1997. Erbium lasers have an active medium of a solid crystal emitting light at mid infrared wavelength. These lasers have two wavelengths – 2780 nm for Erbium, chromium:YSGG laser, and 2940 nm for Er: YAG. Erbium lasers have high absorption in water and in hydroxyapatite, leading to the vaporization of the water within the mineral substrate. This causes a massive volume expansion characterized as `explosion` bursts [18]. This trait enables easy caries removal [19] mainly due to high water content in dental caries which, in a way, makes this laser selective for diseased tissue [20]. Natural progression and the versatility of this technology led to the extension Er: YAG treatment modalities and now include also endodontic and osseous surgical procedures.

In dental surgical procedures, the use of laser assist in obtaining better visualization of the surgical site by decreasing bleeding [21], which in turn also reduces treatment duration [22]. Furthermore, the laser enables sterile conditions during and after surgery, which significantly reduces the occurrence of complications and infections [23].

The high potency of leasers may involve grave side effects, which should be taken into consideration. While ND: YAG is effective at producing coagulation and hemostasis, this laser has a potential to damage soft and hard tissues as well as implant surface due to its ability to highly penetrate tissue [24]. Carbon Dioxide Laser device currently have minimal depth penetration and therefore reduce lateral thermal damage, which makes this laser safe around implants [25]. CO_2 laser forms a thin carbon layer upon exposed to bone tissue, resulting in a protective surface that will no longer absorb energy. This trait makes this laser safe with insignificant potential damage to bone [26].

Er: YAG are highly absorbed in water and hydroxyapatite. This laser is suitable for ablation the tooth structure and bone without charring or carbonization. This trait also makes Er: YAG safe to use around implants [27]. The Er: YAG laser efficiently debride inflamed granulation tissue around implants without the need to use hand curettes (which can harm the implant's surface), and leaves the bony surface bleeding for healing [28]. Moreover, Er: YAG have excellent bactericidal properties by causing ruptures in bacteria cell membranes. Together with its ability to remove soft tissue remnants on implants surfaces [27], the uses of these lasers are highly suitable for the peri-implantitits treatment.

Preclinical and clinical studies support the use the Er: YAG laser as a tool for debridement/decontamination on implant` surfaces [29]. Moreover, Er: YAG light enables better access to all parts of the implant surface, compared with manual curettes or ultrasonic tips, and have a clear advantage in reaching all parts of screw-type implants [30,31].

Case Presentation

The concept of decontamination of peri-implantitis with Er: YAG is presented in the following case.

A 67-year-old male presented complaints of pain and swelling in the first right upper premolar area. Clinical examination revealed sensitivity to palpitation in the buccal aspect adjacent to the first right upper premolar (implant site). The mucosa around the implant was inflamed with deep probing pockets of up to 10 mm and bleeding on probing. Radiographic examination showed three neighboring implants on the right quadrant, of which the middle implant was the symptomatic one. The patient was referred to a CBCT scan, which showed extensive bone loss on the first right upper premolar (*Figure 1*), corroborating the clinical pocket depth measurement.

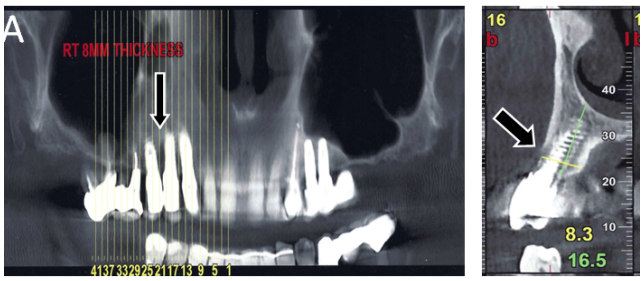

Figure 1. *Pre-operative CBCT. (a) panoramic view, (b) mid-axial view. Arrow indicates the bone loss areas.*

Treatment Protocol included a 2-stage approach: (a) non-surgical pre-treatment stage, and (b) surgical approach treatment with Er: YAG laser (Light instrument, Yokneam, Israel) at a wavelength of 2940 nm, equipped with a 17-mm 1000-µm plane-ended sapphire tip, Pulse length 158 µs, pulse energy 50 mJ and frequency 10 Hz for 60 s.

The first stage of the treatment included oral hygiene instructions and the use of antiseptic mouthwash for 2 weeks (chlorhexidine 0.12%, 3 times/day) followed by non-surgical debridement using ultrasonic device using Teflon tip (Sonicflex, KaVo, Bieberach, Germany).

The second stage of the treatment was done 12 weeks after the first stage. The treatment was done under local anesthetic (2% lidocaine with 1/20,000 adrenaline). Peri-implant intra-sulcular incisions were made and a full-thickness access flap was elevated. The peri-implantitis site elevation exhibited localized circumferential bone loss at the first right upper premolar implant (*Figure 2*).

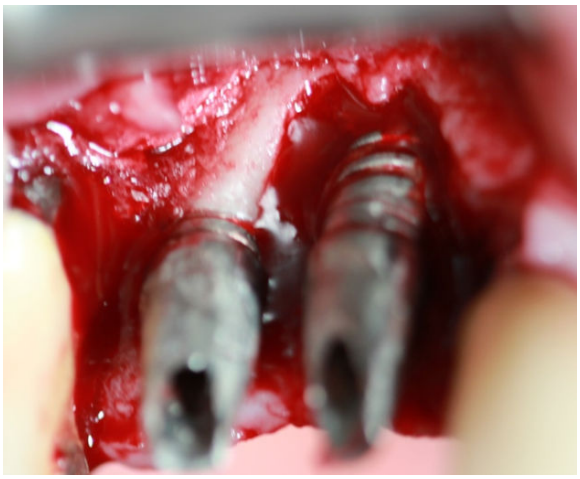

Figure 2. *Implant and alveolar bone shape following flap elevation.*

Er: YAG laser with external water irrigation was then applied with a near contact to the implant surface (*Figure 3*). The exposure of laser led to exfoliation of granulation tissue from the implant and from the bony defect, and enabled disinfection of implant`s exposed surfaces.

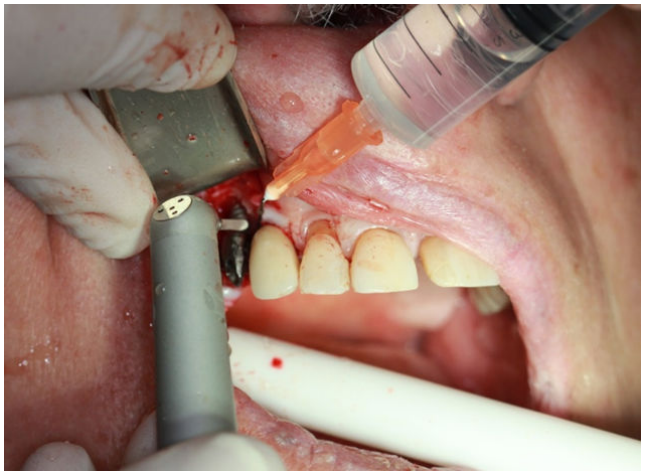

Figure 3. *Er: YAG decontamination approach using cylindrical tip and external irrigation.*

Synthetic bone substitute (biphasic calcium phosphate, BCP, Biomatlante, Nantes, France) was used to fill the crater-shaped bony defect and a resorbable membrane (biogide, Geistlich, NJ) was adapted to the site (*Figure 4*). The flap was sutures with 4-0 silk sutures and a supportive maintenance program in 3 months intervals was set for the patient.

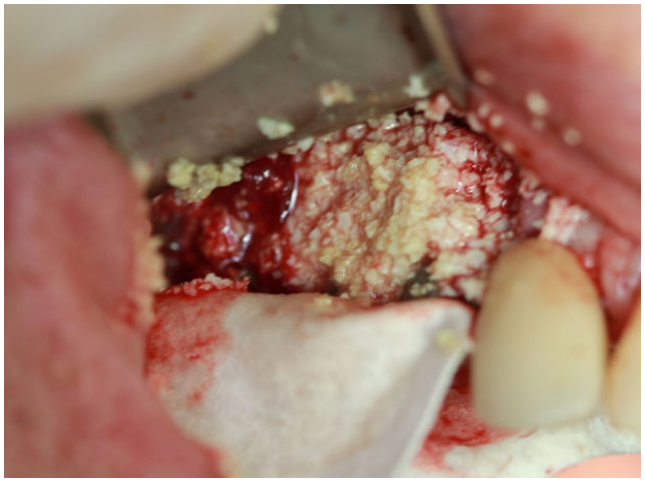

Figure 4. *Bone substitute material was used to fill the bony defect, and a resorbable membrane was used to cover the bone material.*

Three years later (after surgery), probing depth was 3 mm with no signs of bleeding or inflammation (*Figure 5*). Radiologic examination in new CBCT indicate stable bone formation around the implant (*Figure 5*).

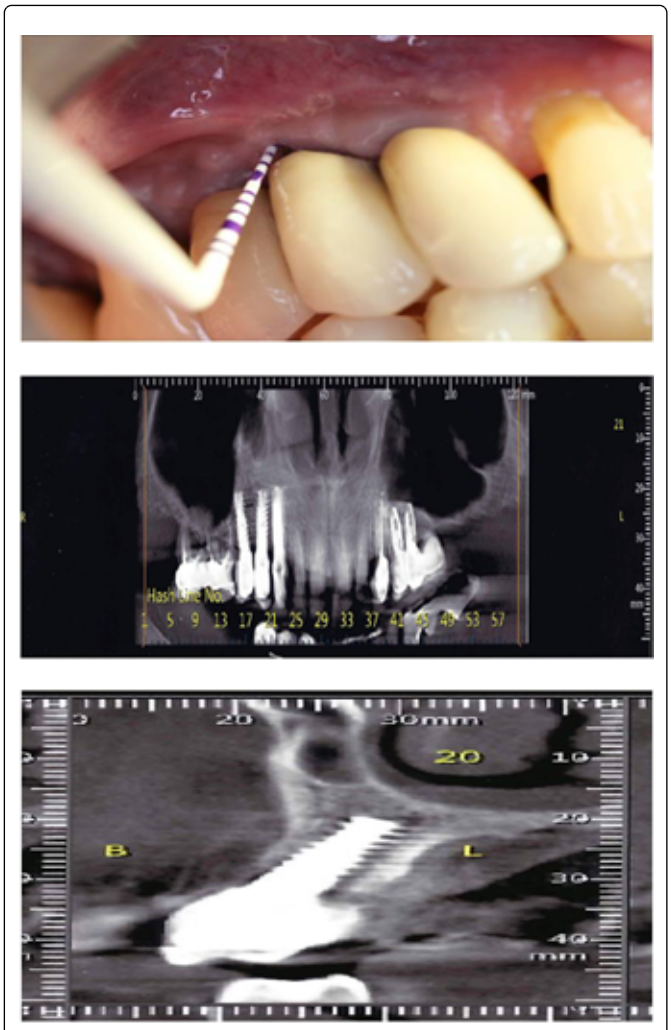

Figure 5. 3 years follow up examination. (a) Clinical photograph with periodontal probe, (b) Panoramic view on CBCT, (c) Mid-axial view on CBCT.

Discussion

In the case, treatment included intra-sulcular incisions with full thickness flap, mechanical debridement of the osseous defect and decontamination of implant` surfaces with Er: YAG. Bone regeneration was done using biphasic calcium phosphate bone substitute and a resorbable collagen membrane. The outcome of the case show radiographic bone formation, healthy clinical periodontal pockets and no bleeding. The case presents the advantage of adjunctive usage of Er: YAG as a disinfecting agent which provides optimal environment for regeneration in peri-implantitis cases.

Conclusion

The search for a predictable treatment modality for peri-implantitis mostly includes the use of conventional modalities used in the periodontal field. Unfortunately, current literature shows unpredictable outcome of most treatment modalities. This compel us to think "outside of the box" in search for an effective treatment for peri-implantitis.

The presented case displays the possibility of successful treatment of severe Peri-implantitis with a predictable long-term outcome. Together with an access flap, the use of Er: YAG laser allows effective debridement and decontamination of the exposed implant surface, and therefore provides a greater chance for effective and predictable regeneration. The clinical indices and the newly formed radiologic bone confirm the potential of Er: YAG laser in such cases.

Conflict of Interest and Source of Funding

All the authors have made a substantial contribution to the manuscript and have read and approved the final version. The authors declare that there is no conflict of interest in this study. The study was conducted with the department`s sources.

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