Use of the Erbium laser in treatment of peri-implantitis

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I. Introduction

At the First European Workshop on Periodontology, peri-implantitis was defined as an inflammatory process affecting the tissues around an osseointegrated implant in function, resulting in loss of supporting bone. Peri-implant mucositis was defined as reversible inflammatory changes of the peri-implant soft tissues without any bone loss. The infectious etiology of peri-implantitis is evident. High levels of periodontal pathogens including Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis, Porphyromonas intermedia, Tannerella forsythia and Treponema denticola, have been associated with peri-implantitis.

The retrograde peri-implantitis is defined as a clinically symptomatic periapical lesion (diagnosed as aradiolucency) that develops shortly after implant insertion while the coronal portion of the implant achieves a normal bone to implant interface. The term retrograde peri-implantitis has just recently been introduced through several case reports. The retrograde peri-implantitis is often accompanied by symptoms of pain, tenderness, swelling, and/or the presence of a fistulous tract. It should be distinguished from a clinically asymptomatic, peri-apical radiolucency, which is usually caused by placing implants that are shorter than the drilled cavity or by a heat-induced aseptic bone necrosis. Retrograde peri-implantitis can result from bacterial contamination during insertion, premature loading leading to bone micro-fractures, or the presence of a pre-existing inflammation (bacteria, inflammatory cells, and/or remaining cells from a cyst, granuloma). Such lesions start at the implant apex but exhibit the capacity of spreading coronally, proximally, and facially.

The presence of bacteria on implant surfaces may result in an inflammation of the peri-implant mucosa, and, if left untreated, it may lead to a progressive destruction of the alveolar bone supporting the implant and implant failure. Therefore, the principal objective of treatment is the complete removal of all bacterial plaque biofilms and calcified calculus from the implant surfaces in order to stop disease progression. Ideally, the bone-to-implant contacts should increase and the implant undergoes re-osseointegration.

Recently, in addition to conventional tools, the Erbium laser has been proposed for treatment of peri-implant infections. As the Erbium laser can perform excellent tissue ablation with high bactericidal effect, detoxification, and removing...
plaque and calculus, they are expected to be one of the most promising new technical modalities for treatment of failing implants.

II. Materials & Methods

A. CASE 1 (Peri-implantitis)

A 56-years old male patient had been performed implantation on left maxillary central incisor with Tapered Screw-Vent implant (Zimmer, U.S.A) and immediate loading. After 3 months, it was observed an inflammatory process around the implant. At first time, non-surgical treatments was performed with the Er:YAG laser (Key3, Kavo, Germany) (Fig. 1) during 2 months, but it was continued inflammatory changes of the peri-implant soft tissues and loss of supporting bone on measurement of a probing depth and the radiograph (Fig. 2, 3). So peri-implantitis was diagnosed and surgical treatment was planned with the autogenous bone graft. Probing depth was measured from the mucosal margin to the bottom of the probeable sulcus before treatment using a periodontal probe. When a full-thickness flap was raised, the implant was surrounded by granulation tissue (Fig. 4). The Er:YAG laser (Anybeam E, B&B, Korea) (Fig. 5) with the chisel tip was performed removal of granulation tissue and irradiation on the implant surface (Fig. 6). The left maxillary tuberosity bone was harvested with bone rongeur. The autogenous bone grafts were then placed into the peri-implant bone defect (Fig. 7). The flap was closed with interrupted sutures (Fig. 8).

Fig. 1. Er:YAG laser (Key3, Kavo, Germany).

Fig. 2. Deep probing depth.

Fig. 3. Pre-operative radiograph.

Fig. 4. Full thickness flap elevation.
B. CASE 2 (Retrograde peri-implantitis)

A 52-years old male patient had been performed implantation on right and left mandibular lateral incisors with Tapered Screw-Vent implant (Zimmer, U.S.A) and immediate loading. After 4 months, a fistula was presented on buccal gingiva and the radiograph was showed a clear radiolucency around the apical part of right mandibular lateral incisor implant, while the bone apposition at the coronal part seemed intact (Fig. 9,10). At first time, non-surgical treatments was performed with the Er,Cr:YSGG laser (waterlase, Biolase, U.S.A) (Fig. 11) during 2 months, but a fistula was not disappeared. So retrograde peri-implantitis was diagnosed and surgical treatment was planned with the DFDB allograft. When a full-thickness flap was raised, a perforation of the buccal bone plate was present (Fig. 12). It was performed a trepanation of the defect with the piezoelectric device (PIEZOSurgery, Mectron Medical Technology, Italy) (Fig. 13). It was removed granulation tissue of the bony cavity walls except the implant surface with hand instruments (Fig. 14). The Er,Cr:YSGG laser (Waterlase, Biolase, USA) was performed removal of granulation tissue and irradiation on the implant surface (Fig. 15,16). PRP (platelet-riched plasma) gel was sprayed on implant surface (Fig. 17) and all defects were filled with DFDB allograft (Puros, Tutogen, USA) after making multiple perforations of the bone surface (Fig. 18,19). PRP gel membrane was covered the graft (Fig. 20). Primary wound closure was achieved with mattress and interrupted sutures (Fig. 21). Post-operative radiograph was taken immediately thereafter (Fig. 22).
Fig. 9. Fistula on buccal gingival of #42.

Fig. 10. Pre-operative radiograph.

Fig. 11. Er,Cr:YSGG laser (waterlase, Biolase, U.S.A).

Fig. 12. Full thickness flap elevation.

Fig. 13. Trepanation of the defect with piezo electric device.

Fig. 14. Mechanical curettage on bony wall.

Fig. 15. Removal of granulation tissue and implant surface detoxification with Er,Cr:YSGG laser.

Fig. 16. Complete elimination of granulation tissue.
Fig. 17. PRP spray on implant surface.

Fig. 18. Cavity filling with DFDB allograft (Puros, Tutogen, USA) mixed in PRP gel.

Fig. 19. After bone graft

Fig. 20. PRP gel placement on graft.

Fig. 21. Suture.

Fig. 22. Immediate post-operative radiograph.

Fig. 23. 11 days after surgery.

Fig. 24. 50 days after surgery.
III. Result

In these cases, no complications such as abscesses, or infections were observed, and implants and grafts were stable. In case 1, there are a significant reduction of pocket depth and gain of clinical attachment level (Fig. 23, 24, 25). In case 2, a fistula was disappeared and implants osseointegrated as confirmed by post-operative radiograph (Fig. 26).

IV. Discussion

Most titanium implants feature a rough surface to increase areas of implant–bone contact and anchorage force in alveolar bone. However, surface roughness makes elimination of bacteria from implants difficult. Several treatment regimens have been proposed for cleaning and decontamination of implant surfaces in order to treat peri-implantitis. However, some of the recommended cleaning methods have been reported to change or damage the surface properties of implants [14-17].

Mechanical debridement is usually performed using specific instruments made out of materials less hard than titanium (i.e. plastic curettes, polishing with rubber cups) in order to avoid a roughening of the metallic surface which in turn may favour bacterial colonization [18-21]. Since mechanical methods alone are insufficient in the elimination of bacteria on roughened implant surfaces, adjunctive chemical agents (i.e. irrigation with local disinfectants, local or systemic antibiotic therapy) were examined clinically and proven to enhance healing following treatment [12, 22]. Bactericidal chemicals such as chlorhexidine digluconate or iodine solutions are useful adjuncts in the treatment of peri-implantitis. And therapy of peri-implantitis by local delivery of tetracycline had a positive effect on clinical and microbiological parameters. Fiber therapy seems particularly suited for the therapy of not too advanced peri-implantitis lesions assuming the typical defect morphology of a circumferential saucer. Furthermore, surgical therapy in combination with systemic antibiotics resulted in a resolution of the peri-implantitis lesion [23]. Air-powder flow may be
used for implant surface decontamination\textsuperscript{24}. However, there are limitations in its application because they can be associated with an increased risk of emphysema\textsuperscript{25}.

In addition to these conventional tools, the use of lasers has been proposed for cleaning and for the detoxification of implant surfaces. The interaction between laser light and metal surfaces is mainly determined by the degree of absorption and reflection. Each metal features a certain spectral reflection capacity, which is dependent on the specific wavelength of the laser. The reflection capacity of titanium for the Er:YAG laser with its wavelength of 2940 nm in the near infrared spectrum is 71\% and rises up to 96\% for the CO\textsubscript{2} laser at 10,000nm\textsuperscript{26}. In this situation, the implant surface does not absorb the irradiation and subsequently there is no temperature increase, which would damage the implant surface. The results from recently published studies have indicated that among all lasers used in the field of dentistry, only the carbon dioxide(CO\textsubscript{2}), the diode and the Er:YAG laser may be useful for the instrumentation of implant surfaces because the implant body temperature does not increase significantly after laser irradiation\textsuperscript{27-30}. In contrast, the use of an Nd:YAG laser resulted in extensive melting and damage of the porous titanium surface and coating\textsuperscript{27,28,32}. Therefore the carbon dioxide(CO\textsubscript{2}), the Diode and the Er:YAG lasers are recommended, since it appears that they do not exert a negative impact on the implant surface. Since, neither CO\textsubscript{2} nor diode lasers were effective in removing plaque biofilms from implant surface, both types of lasers were only used adjunctive to mechanical treatment procedures\textsuperscript{31-35}. In contrast, as described above, several investigations have reported on the promising ability of the Er:YAG laser for calculus removal from implant surface without producing major thermal side-effects to adjacent tissue\textsuperscript{36,37}.

\section*{V. Conclusion}

In recent years, the use of the Erbium laser has been expected to serve as an alternative or adjunctive treatment to conventional, mechanical periodontal therapy. Among all lasers used in the field of dentistry, the Erbium laser seems to possess characteristics most suitable for peri-implantitis, due to its ability to ablate both soft and hard tissues as well as bacterial biofilms and calculus without causing major thermal damage to the adjacent tissue and implant surface. This study demonstrates that surgical treatment involving the combined use of the mechanical instruments and the Erbium laser might to have more bactericidal, detoxification, and removing calculus and plaque effects in the peri-implantitis treatment. And it is suitable to promote re-osseointegration at contaminated implant surfaces. However it needs a careful and controlled using, because laser irradiation can result in morphological alterations of implant surfaces when defined energy settings are exceeded.

\section*{REFERENCES}


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임프란트 주위염 치료에서 Erbium laser의 활용
장호열, 이장렬, 정영균, 공화수, 김현철, 박일해, 이상철
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최근 임프란트 치료의 보편화와 환자들의 요구가 높아지고 있다. 하지만 술후관리의 부족으로 인한 실패의 증례가 늘고 있다. peri-implantitis는 진단되기 전에 임프란트 주위 조직의 염증 상태를 나타낸다. 그 중 치관부의 골유착은 정상이지만 임프란트 치근단 부위의 방사선 투과성 병소를 보이는 경우는 retrograde peri-implantitis라고 분류한다. 일반적으로 peri-implantitis의 치료를 위해 기계적, 화학적 요법 및 항생제 요법이 병용되어 사용되고 있다. 본 증례는 임프란트 표면에 변성을 초래할 수 있으므로 주의가 필요하다. 본 증례를 통해 임프란트 주위염 치료시 Er:YAG laser를 활용할 때의 장점과 잠재적 효과에 대해 고찰하고자 한다.