Treatment of Peri-implantitis Lesions with an Er:YAG laser.

A prospective, randomized, controlled clinical trial

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INTRODUCTION

Today, oral rehabilitation by means of endosseus dental implants has gained importance in clinical practice. Various surface characteristics ranging from relatively smooth machined surfaces to more roughened surfaces created by coatings, blasting by various substances, by acid treatments, or by combinations of the treatments are available (Cochran 1999). Results from animal and in vitro experiments provide clear evidence that rough implant surfaces have increased bone-to-implant contact and require greater forces to break the bone-implant interface compared to more smooth surfaces (Carlsson et al. 1988; Deporter et al. 1990). Although the clinical results during the first decade are promising, about 10% of the osseointegrated implants are lost after loading (Adell et al. 1990). Several factors have been implicated in the pathogenesis of implant failures. One of them is related to the presence of pathogens around the collar of the dental implants (Mombelli et al. 1988; Becker et al. 1990; Alcoforado et al. 1991). This presence may lead to an inflammation of the peri-implant mucosa, and, if left untreated, the inflammation spreads apically and results in bone resorption, which has been named peri-implantitis (Mombelli et al. 1987; Mombelli & Lang 1994). Therefore, the principal objective of treatment is the complete removal of all calcified and bacterial deposits from the implant surfaces in order to stop disease progression. Ideally, the bone-to-implant contacts should increase and the implant undergo re-osseointegration.

Both mechanical and chemical methods have been recommended for cleaning and decontamination of implant surfaces (Parham et al. 1989; Fox et al. 1990; Mombelli & Lang 1992; Ruhling et al. 1994; Ericsson et al. 1996; Schenk et al. 1997; Augthun et al. 1998). Among the mechanical methods, metal curets and ultrasonic scalers induce surface alterations in implants and their use is therefore contraindicated (Augthun et al. 1998; Thomson-Neal et al. 1989). The application of plastic curets is insufficient in the elimination of bacteria on roughened implant surfaces (Augthun et al. 1998; Fox et al. 1990). Air-powder-flow may be used for implant surface decontamination (Parham et al. 1989; Augthun et al. 1998).
However, there are limitations in their application because they can be associated with an increased risk of emphysema (Van de Velde et al. 1991). Among the chemical methods, adjunctive subgingival irrigation with local disinfectants or local antibiotic therapy had a beneficial effect in patients suffering from peri-implantitis (Mombelli & Lang 1992; Schenk et al. 1997). Furthermore, surgical therapy in combination with systemic antibiotics resulted in a resolution of the peri-implantitis lesion (Ericsson et al. 1996; Persson et al. 1996). In addition to these conventional tools, the use of lasers has been proposed for cleaning and for the detoxification of implant surfaces (Oyster et al. 1995; Romanos et al. 2000; Kreisler et al. 2002a, b). The results from recently published studies have indicated that among all lasers used in the field of dentistry only the CO₂ (carbon-dioxide) laser, the diode laser and the Er:YAG (erbium-doped: yttrium, aluminium and garnet) laser may be useful for the instrumentation of implant surfaces because of their bactericidal effects and because the implant body temperature does not increase significantly after laser irradiation (Oyster et al. 1995; Ando et al. 1996; Kato et al. 1998; Romanos et al. 2000; Kreisler et al. 2002a, b, c; Schwarz et al. 2003). In contrast, the use of a Nd:YAG laser (neodymium-doped: yttrium, aluminium and garnet) resulted in extensive melting and damage of the porous titanium surface and coating (Pick & Colvard 1993; Romanos et al. 2000). Close attention has been paid to the clinical applicability of the Er:YAG laser with its wavelength of 2.94 µm in the near infrared spectrum. This wavelength is well absorbed by water because the peak is close to the absorption coefficient of water. Recently, the Er:YAG laser has been reported to be the most promising laser for periodontal treatment (Aoki et al. 1994; Ando et al. 1996; Folwaczny et al. 2001; Schwarz et al. 2001a, b). Its excellent ability to effectively ablate hard tissue and dental calculus without producing major thermal side-effects to adjacent tissue has been demonstrated in numerous studies (Aoki et al. 1994; Folwaczny et al. 2001; Schwarz et al. 2001a). Moreover, the results from a controlled clinical trial have indicated that non-surgical periodontal treatment with an Er:YAG laser leads to a significant gain of clinical attachment.
level (Schwarz et al. 2001b). So far, there are only few data available describing the effects of an Er:YAG laser on the surface characteristics of differently coated titanium discs (Rechmann et al. 2000; Kreisler et al. 2002a; Schwarz et al. 2003). In a recent study, Kreisler et al. (2002a) reported surface alterations, such as melting and glazing, at energy densities of 8.9 Jcm$^{-2}$ in plasma-sprayed surfaces, 11.2 Jcm$^{-2}$ in sand-blasted and acid etched surfaces, 17.8 Jcm$^{-2}$ in hydroxyapatite-coated surfaces and 28 Jcm$^{-2}$ in smooth titanium surfaces. The laser was used in non-contact mode without water cooling and the angle of irradiation was 90°. In a similar study, first micro-morphological changes in sand-blasted and acid etched and titanium plasma sprayed titanium surfaces occurred at an average energy density of 7 Jcm$^{-2}$ (Rechmann et al. 2000). Furthermore, the results from a recent study provide clear evidence that an Er:YAG laser, used with a special application tip (15.3 Jcm$^{-2}$), does not damage differently coated titanium surfaces and subsequently does not influence the new attachment rate of human osteoblast-like cells (Schwarz et al. 2003). Based on these facts, clinical studies are justified to evaluate the applicability and efficiency of the Er:YAG laser in the treatment of peri-implantitis.
OBJECTIVES

The aim of this prospective, parallel group designed, controlled clinical study is to evaluate the clinical outcome following non-surgical treatment of peri-implantitis lesions using an Er:YAG laser or hand instruments (plastic curets).

MATERIALS AND METHODS

Thirty (30) patients referred for peri-implantitis treatment to the Department of Oral Surgery, Heinrich Heine University Düsseldorf, will be included. All patients participating in the study will receive oral and written explanations of the research protocol and will be asked to sign a consent form having any time the possibility of withdrawing from the study. Each of the patients will receive oral hygiene instructions and supragingival tooth cleaning as needed before.

Inclusion Criteria

- No systemic diseases which could influence the outcome of the therapy
- No systemic antibiotics during the last 6 months
- No peri-implantitis treatment during the last 12 months

Following clinical parameters will be recorded at baseline, at 3 and at 6 months by the same calibrated and blinded examiner (DR):

1. **Plaque Index** (Silness-Löe, 1964)
2. **Gingival Index** (Löe 1967)
3. **Bleeding on probing** (BOP) 30 sec. after measurement
4. **Probing pocket depth** at 6 places around the implant (recorded with a manual periodontal probe, PCP 12, Hu-Friedy, USA)

5. **Gingival recession** (distance from the implant-neck to the gingival margin)

6. **Clinical attachment level** (distance between the implant-neck and the bottom of the pocket).

Additionally to the clinical parameters, **microbiological samples** will be taken using DNA probes. The samples will be taken at baseline at 3 and 6 months from the deepest pocket of each implant. The microbiological evaluation of the DNA probes will be performed by Hain Diagnostika.

**Treatment of the lesions**

The patients will be randomly divided into 2 groups:

1. Treatment with either an Er:YAG laser – KEY3® (100 mJ, 10 pps) (15 patients) or,
2. Treatment with hand instruments – plastic curets/adjunctive subgingival irrigation with 0.2% chlorhexidine (15 patients).

In order to standardize the technique all treatments will be performed by the same experienced operator (FS). Local anesthesia will be given as needed.

No antibiotics will be given before and after the treatment. All patients will rinse 2 times per day for 2 min with 0.2% chlorhexidine during the next 3 days. Recall appointments including oral hygiene instructions and supragingival tooth cleaning will be performed every 2 weeks during the first 2 months and then monthly for the rest of experimental period of 6 months. The same clinical parameters as at baseline will be recorded at 3 months and at 6 months.
following treatment by the same blinded and calibrated examiner (DR). The microbiological evaluation will be performed at 3 and 6 months.

Pockets developing abscesses will be excluded from the study and receive further peri-implantitis treatment.