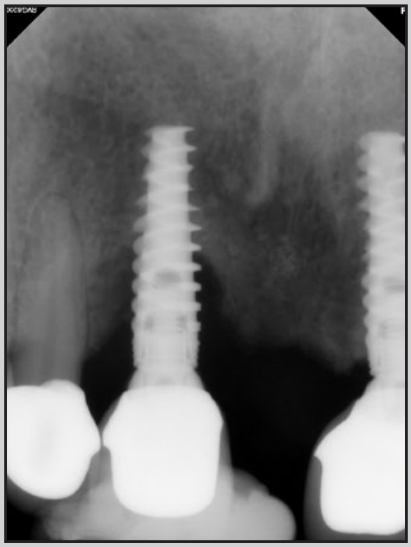
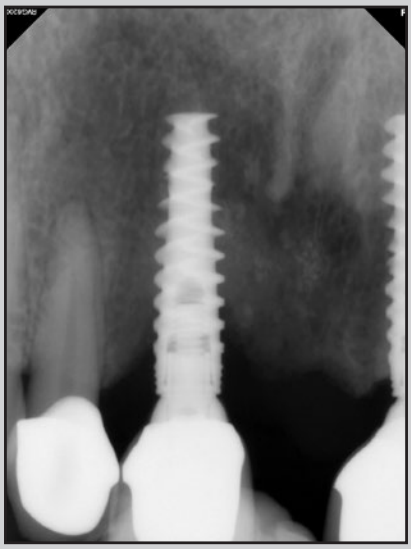
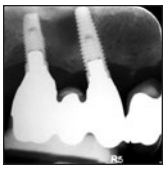




Laser-Assisted Therapy for the Treatment of Peri-implantitis. Part I. Clinical Outcomes



Gabriel Strauss, DMD[1]
David Goteiner, DDS, FACD, FICD[2]
Kevin Murawski, DMD[3]
Steven R. Singer, DDS[4]*/Howard J. Drew, DMD*[5]
Andrew Sullivan, DDS[5]

The purpose of this 12-month randomized, controlled clinical trial was to evaluate the efficacy of a monotherapy protocol with the neodymium-doped yttrium aluminum garnet (Nd:YAG) laser for treatment of peri-implantitis. Twenty patients with 36 implants exhibiting probing pocket depths (PPDs) > 4 mm and evidence of radiographic bone loss (RBL) were randomly divided into two groups. The test group was treated with the Nd:YAG laser, and the control group was managed with mechanical debridement only. Peri-implant clinical parameters were recorded at baseline and at 12 months after treatment. PPD, RBL, and bleeding on probing showed improvements after 12 months in the test and control groups. The laser therapy provided additional benefits of greater reduction in PPDs and increased bone level with no adverse outcomes. The results demonstrated that laser therapy could be a valuable modality for the treatment of peri-implantitis.
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[1]Private Practice, New York, New York, USA; Private Practice, Tenafly, New Jersey, USA.
[2]Private Practice, Chester, New Jersey, USA; Department of Periodontics, Rutgers School of Dental Medicine, Newark, New Jersey, USA.
[3]Private Practice, Lawrenceville, New Jersey, USA.
[4]Department of Diagnostic Sciences, Rutgers School of Dental Medicine, Newark, New Jersey, USA.
[5]Department of Periodontics, Rutgers School of Dental Medicine, Newark, New Jersey, USA.

Correspondence to: Dr Gabriel Strauss, Department of Periodontics, Rutgers School of Dental Medicine, 110 Bergen St, D882-B, Newark, NJ 07101, USA. Fax: 973-972-3884. Email: gabriel.m.strauss@gmail.com

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Peri-implantitis is a multifactorial disease, occurring at the interface of dental implants and the surrounding alveolar bone. Although it has long been recognized, its pathophysiology is not yet completely understood. Initially, it was thought that peri-implantitis was similar to periodontitis and could be treated in the same manner.[1] More recent studies have shown that additional risk factors may be present, including poor planning or placement of the dental implant as well as bone trauma during implant placement or prosthetic loading.[2,3]

The prevalence of peri-implantitis varies among studies, from 10% to 92% of implants, from 12% to 100% of patients, and from 5 to 10 years after implant placement.[4–7] Others report that the incidence is significantly less, at 1% to 2%, after normal bone remodeling during the first year[3] and anything greater is due to poor-quality implant systems, poor clinical skills, and/or poor patient selection.[8]

Many different treatment options have been suggested, including bone grafts, implantoplasty, implant removal and replacement, and laser therapy. Each treatment option has both advantages and disadvantages. Bone grafting requires complete visualization of the affected implant, complete removal of granulomatous tissue, bone

grafting, membrane use, and typically burying of the dental implant during healing. Implantoplasty can cause iatrogenic destruction or fracture of the implant and lodging of titanium particles in underlying tissue. Removal of the existing dental implant may cause further destruction to surrounding bone, making it inadequate for replacement. Laser therapy is a minimally invasive procedure and has the ability to treat beyond the standard surgical field. High-power lasers are used in laser medicine to cut or destroy tissue, whereas the application of low-power lasers relieves pain or stimulates and enhances cell function. This study is the first randomized, controlled study performed to examine the efficacy of the neodymium-doped yttrium aluminum garnet (Nd:YAG) laser therapy for the treatment of peri-implantitis in which the single variable is low-level laser therapy.

Materials and Methods

Enrollment

The study was approved by the Institutional Review Board at Rutgers University. Twenty subjects with a total of 36 implants were selected from patients seen in the Rutgers School of Dental Medicine Postdoctoral Periodontics Clinic. All patients enrolled in the study were medically healthy (American Society of Anesthesiologists Class I). A thorough medical history, periodontal exam, and radiographic exam were completed at the initial visit. Patients were selected based on the following inclusion criteria: at least 18 years old at the time of the study, being in good health, and having no metabolic diseases. Eligibility was based on a diagnosis of peri-implantitis on at least one implant, at least 2 mm of keratinized attached gingiva, and no periodontitis. A history of periodontal therapy did not exclude the subjects. Peri-implantitis was clinically defined as a probing pocket depth (PPD) > 4 mm with suppuration (SUP) and/or bleeding on probing (BOP), and radiographically defined as evidence of alveolar bone loss from the time the definitive prosthesis was placed.[9]

Patients were excluded based on the following criteria: under 18 years old, active periodontal disease, and significant medical history including, but not limited to, diabetes, tobacco use, pregnancy, treatment for osteoporosis, or other metabolic diseases.

A written informed consent was obtained from each subject prior to enrollment in the study. Patients were alternately assigned to the test or control group based on time of registration into the study (ie, first patient assigned to the test group, second patient assigned to the control group, repeated).

Data Collection

The following data was collected at baseline: PPD, periapical radiographs using a phosphor storage plate on a custom jig, segmental CBCT scan, Plaque Index,[10] Gingival Index,[11] BOP and SUP,[12] and gingival recession (GR). PPD was measured at six points on each implant or tooth with a UNC15 probe (Hu-Friedy). Radiographic jigs were fabricated for each treated implant, using vinyl polysiloxane bite registration material (Blu-Mousse) on anterior or posterior bite blocks. A small field-of-view (FOV) CBCT (CS 9000, Carestream) was taken in the Department of Radiology. A single researcher (G.S.) performed all clinical measurements.

Therapy

All patients were instructed in oral hygiene and treated with mechanical debridement (except for the experimental site) 1 week prior to beginning the study. Implant treatment was performed by two experienced periodontists (D.G. and N.L.). No two interproximal surfaces were treated simultaneously to limit the heat and energy, in terms of joules, delivered to an area. After anesthetic infiltration (Septocaine 4% with epinephrine 1:100,000, Septodont) without papillary infiltration, the test group underwent peri-implant therapy with an Nd:YAG laser (Perio-Lase MVP-7, Millennium Technologies) using an established protocol. The laser was used on a setting that delivered 3.6 watts at 20 mHz. Total joules delivered varied, but the rate was set at 4 J/mm probing depth. Ablation of the lesion was carried at a 100-μsecond pulse, intermittently using an air/water syringe to cool the tissue. The laser tip was kept parallel to the implant surface and moved laterally and apically to

remove the diseased pocket epithelium. The implant was then debrided with piezo-ultrasonic instrumentation (Piezon 250, EMS), using a 1:3 ratio of chlorhexidine to sterile water as an irrigating solution, to remove calculus or any residual cement. Bone stimulation was then completed with the piezo tip to induce bleeding. The Nd:YAG laser was then passed along the implant surface a second time on a setting of 550-μsecond pulse duration from the alveolar crest to the gingival margin. The tissue was then bathed at 100 μseconds at 3 watts for 300 J, and occlusal adjustment was completed to minimize nonaxial occlusal forces. The control group received the same protocol without laser therapy, to test the laser as the only variable between the two groups.

Postoperative instructions were the same for both groups; ibuprofen (800 mg) tid for 3 days and azithromycin (500 mg) once daily for 10 days were prescribed. Patients were instructed to not brush the treated area for 1 week. Supragingival debridement and occlusal adjustment were performed at 2 weeks and 4 weeks. After day 1, periodontal supportive therapy was performed every 3 months for 1 year. During this period, the sites were not probed or subgingivally debrided. At 12 months, all clinical and radiographic measurements were repeated.

Analysis

Small–field of view (FOV) CBCT images (5 × 5 cm) were taken at days 0 and 365, using standard settings with an image resolution (voxel size) of 76 μm and an effective dose of 5 to 19 μSv. All scans were interpreted by three viewers (D.G., S.R.S., and K.M.) using CS 3D Imaging Software (Carestream). Viewers were blinded to exam dates and interventions. Scans were randomized to minimize potential bias. For each implant viewed on each scan, two measurements (at the buccal and lingual heights of the contour) were made using the onboard ruler in the imaging software. Measurements were made from the platform of the implant to the nearest bone height. The same projection was used for both buccal and lingual measurements for each implant. Brightness and contrast were adjusted to help visualize the endpoint of the implant.

The customized radiographic jig was used at baseline and at 1 year to standardize the FOV and projection geometry of the periapical radiographs. Mesial and distal bone measurements were calculated in a similar fashion to the buccal and lingual measurements.

Clinical measurements recorded at baseline and 1 year were expressed in mean ± SD values. The implant was positive for BOP/SUP if any site of the implant was positive. All analyses were performed with statistical software (SPSS version 25, IBM).

Results

Thirty-six implants were treated in the study. One patient with 2 implants was lost to follow-up due to an unrelated medical complication. A total of 34 implants were included in the data analysis (Table 1).

PPD Levels

The test group (n = 19) had a mean baseline PPD of 6.51 mm and a mean 1-year PPD of 4.61 mm (Table 2); data analysis identified that the decrease in PPD in the test group was 1.89 ± 1.33 mm. The control group (n = 15) had a pretreatment average PPD of 5.34 mm and a postoperative mean PPD of 3.99 mm; the average decrease in PPD for the control group was 1.36 mm ± 2.01 mm. Based on the Froum classification system,[9] 23 implants (67%) exhibited PPD > 6 mm and were categorized as moderate to advanced disease. Soft tissue recession of 3-mm was present on one implant posttherapy, located in the anterior maxilla, buccal to the alveolar process.

The change in PPD levels between baseline and 1 year between study groups was greater in the test group, but was not statistically significantly between the two groups (P = .380).

Radiographic Bone Levels

Initial radiographic evaluation found that 23 of the implants had bone loss of at least 25%. Radiographic bone levels (RBLs) for the test group were 4.22 mm at baseline and 3.80 mm at 1 year (Table 3). The control group had an RBL of 2.86 mm at baseline and 2.61 mm at 1 year. The average increases in bone level were 0.41 ±

Table 1 Severity of Implant Disease According to the Froum Classification[9]

	Implants, n
Clinical	
Early	11
Moderate	8
Advanced	15
Radiographic	
Early	11
Moderate	11
Advanced	12

Table 2 Mean Descriptive Statistics of Clinical Probing Pocket Depth (PPD)

	PPD, mm				
Group	Baseline	1 y	Difference	SD	*P*
Test	6.51	4.61	1.89	1.33	.354
Control	5.34	3.99	1.36	2.01	

The test group comprised 19 implants, and the control group comprised 15 implants.

Table 3 Mean Descriptive Statistics of the Radiographic Bone Levels (RBL)

	RBL, mm				
Group	Baseline	1 y	Difference	SD	*P*
Test	4.22	3.80	0.41	0.92	.582
Control	2.86	2.61	0.26	0.64	

The test group comprised 19 implants, and the control group comprised 15 implants.

0.92 mm and 0.26 ± 0.64 mm for the test and control groups, respectively. The test group showed up to 5 mm of bone gain (Figs 1 and 2).

BOP and SUP

All implants exhibited a reduction in BOP at 1 year. At baseline, implants in the test group exhibited 100% BOP and 42% SUP; at 1 year, they exhibited 10% BOP and no SUP. The control group had 80% BOP and no SUP at baseline, and 33% BOP and no suppuration at 1 year. The test group showed a greater decrease in BOP at the 1-year postoperative visit.

Discussion

A variety of treatment techniques exist for the treatment of peri-implantitis, including mechanical debridement, antimicrobial therapy,[13] photodynamic therapy,[14] and the use of other adjuncts.[15] Limited data is available with regard to laser therapy for the treatment of

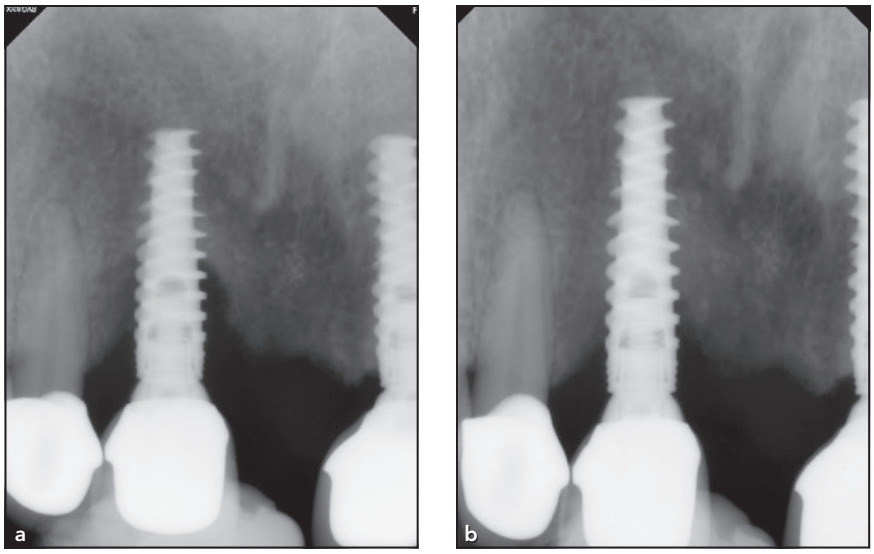

Fig 1 *Laser-treated implant in the maxillary right first molar site.* (a) *Preoperative periapical radiograph. Bone loss of 7 to 8 mm was measured around the implant.* (b) *Postoperative periapical radiograph. Bone gain of 4 to 5 mm was measured on the mesial and distal surfaces of the implant.*

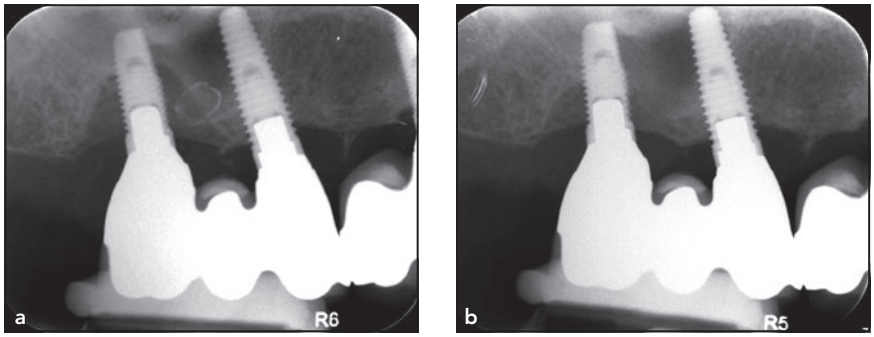

Fig 2 *Laser-treated implant in the maxillary right first molar site.* (a) *Preoperative periapical radiograph. The patient was restored with a diastema to match her previous natural dentition.* (b) *Postoperative periapical radiograph. Bone gain of 3 to 4 mm was measured 1 year after laser therapy.*

peri-implantitis. The purpose of this study was to evaluate the Nd:YAG laser as a monotherapy for peri-implantitis.

Advantages of the Nd:YAG laser include its ability to remove ulcerated epithelium without damage to healthy connective tissue,[16,17] a necessity to obtain new attachment. This will also lead to less recession.[18] The present study reported almost no recession in either group except for one implant that was out of the bony housing.

The laser-treated group showed a greater reduction in PPD and increase in RBL, similar to those shown in classic periodontal regenerative literature.[19–21] More recent regenerative implant treatment showed a reduction in pocket depth of 2 to 3 mm,[22,23] which is similar to the present test group (1.89 mm). The difference in PPD reduction between test and control groups was not statistically significant.

Adverse tissue reaction or infection was not observed following any of the treatment modalities in the study. Both tested treatments required no sutures and minimal patient time in the chair. Patients were prescribed postoperative pain medication, which was underutilized due to minimal discomfort.

The present authors measured bone levels based on radiographs and CBCT, which was deemed analogous to clinical practice. RBLs increased up to 1.3 mm in the test group and 0.8 mm in the control group. A limitation of this study is that bone level measurements were taken at four fixed points on each implant and not at the depth of the defects, as in open flap studies.

A potentially limiting factor is leaving the implant restorations in place throughout the duration of the study. The authors recommend removing the prosthesis at the time of treatment when possible.

Conclusions

The present study reports on 1-year outcomes of a randomized, controlled clinical trial on laser treatment of peri-implantitis. Both treatment groups exhibited reduced signs of inflammation at the 1-year follow-up. Laser therapy provided additional benefits over mechanical debridement, with greater reduction in PPD and an increase in RBL. As the first randomized clinical trial examining laser therapy for the treatment of peri-implantitis, future studies with larger sample sizes and longer follow-ups are encouraged.

Acknowledgments

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