The Clinical and Microbial Evaluation of Nd:YAG Laser in Periodontal Pocket Healing

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Purpose: Despite the large number of publications, there is still controversy among clinicians regarding the application of dental lasers for the treatment of chronic periodontitis. This study was therefore conducted to compare clinical and microbial results of nonsurgical periodontal therapy alone or associated with Nd:YAG laser in periodontal pocket healing.

Materials and Methods: Forty-eight periodontal pockets in 6 patients suffering from generalized chronic periodontitis were selected. They were treated with nonsurgical periodontal therapy (supra- and subgingival ultrasonic scaling, hand scaling and root planing). The pockets were randomly divided into two groups. For 24 pockets, Nd:YAG laser (Fidelis plus, Fotona, 300 μm fiber, 2 W, 20 Hz, 1 min, 2 times for each site and about 8×10^5 J per cm^2) was applied; in the control group, no laser was applied. Clinical parameters evaluated during this study were: periodontal pocket depth, modified gingival index, bleeding on probing, clinical attachment level, and gingival recession. Microbiological samples from pockets were also examined for Porphyromonas gingivalis and Prevotella intermedia. All patients were followed up for a period of two months.

Results: There was significant improvement in all parameters after treatment in both groups, but after one or two months, the laser-treated group showed statistically better results than the control group. Microbial evaluation showed that the laser-treated group had a greater reduction of Prevotella intermedia.

Conclusion: This clinical trial indicated that Nd:YAG laser application together with conventional methods provide better clinical and microbial results than those obtained by conventional method alone.

Keywords: nonsurgical periodontal therapy, Nd:YAG laser, clinical parameters, microbial evaluation.

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The elimination of calcified deposits, microorganisms, and microbial by-products from the periodontally diseased root by scaling and root planing is considered necessary to produce a biologically acceptable root surface.[1] Some studies have suggested that lasers may function as an alternative or adjunct therapy in the control and treatment of periodontally diseased root surfaces.[2,3]

Different aspects of Nd:YAG laser as an adjunct in periodontal therapy after completing scaling and root planing have been studied in recent years, with controversial results. Some studies demonstrated good results for Nd:YAG laser application in combination with nonsurgical periodontal therapy,[4,5] but in others, Nd:YAG laser application did not improve the clinical results.[6]

A major aspect of laser use within the diseased pocket has been to remove soft tissue lining as well as to reduce bacterial contamination; this has been cited in many papers.[3,5]

The current study was conducted to compare clinical and microbial results of nonsurgical periodontal therapy alone or in association with Nd:YAG laser in periodontal pocket healing.

MATERIALS AND METHODS

Six non-smokers suffering from generalized chronic periodontitis were selected. They had no systemic diseases, had not taken antibiotics in the last three months before the study, had not received periodontal treatment in the three months prior to this trial, and showed good co-operation. Bleeding on probing was obvious.

Oral health education was presented to patients two weeks before starting the study. Practical instruction in tooth brushing according to the modified Bass method was given and it was recommended for 5 min twice per day. Instruction in tooth-flossing procedures was also provided, and it was recommended every night before retiring. All the patients had the same oral hygiene program in this study.

Each of these 6 patients had 8 periodontal pockets with a depth of 5 to 6 mm, meaning a total of 48 pockets were included in this trial. A Michigan O probe (Hu-Friedy; Chicago, IL, USA) was used for this measurement. All the patients received nonsurgical periodontal treatment (supra- and subgingival ultrasonic scaling, hand scaling, curettage and root planing). After treatment, all the patients rinsed their mouths with chlorhexidine 0/2% solution for 1 min.

The pockets were randomly divided into case and control groups. Each group consisted of 24 pockets, and in each patient, 4 pockets were laser treated and 4 were not. The selected pockets were at single-rooted teeth for better access and comparability.

Nd:YAG laser (Fidelis plus, Fotona; Ljubljana, Slovenia, 300-µm fiber, 2 W, 20 Hz, 1 min) was applied in the case group immediately after nonsurgical periodontal treatment. Laser was not applied in the control group.

The 300-µm fiber was inserted into pocket parallel to the tooth's long axis, close to but not contacting the bottom of the pocket.[7] The fiber should never be placed at the base of the pocket[8] because this risks damaging the healthy portion of the periodontium at the base of the pocket. In an ideal situation, the pocket is explored with a probe and depths recorded. The fiber is measured to 1 mm short of the greatest depth to avoid contact with the base of the pocket. The laser light was applied with movement of the fiber from the bottom of the sulcus to the cervical part, oriented towards the soft tissue side in order to remove soft tissue lining and reduce bacterial contamination. This was done in a sweeping motion around the tooth.

Any debris accumulated on the fiber was removed with a wet sponge. A best-practice approach would be to test fire the laser between successive treatments to ensure good beam emission. The laser treatment was performed twice for each tooth. After treating each site, the fiber was placed in a disinfecting solution for 5 s and dried according to the Rochdand Calas protocol for preventing infection carried by optic fibers.[9]

The clinical parameters evaluated during this study were: periodontal pocket depth, modified gingival index,[10] bleeding on probing, clinical attachment level, and gingival recession. These parameters were measured before treatment, and 1 day, 1 month and 2 months after treatment.

Microbiological samples from pockets were also examined for Porphyromonas gingivalis and Prevotella intermedia, as they are two important pathogens in chronic periodontitis. Before treatment and after two months, microbial samples were collected by inserting sterilized paper cones into the pockets for 15 s. Samples were transferred to Stuart transport medium (suitable for anaerobic bacteria). In less than 3 hours, the samples were brought to the laboratory and cultured on pre-prepared anaerobic plates. Two kinds of nonspecific and specific anaerobic environments were used. In the first, all anaerobes could be grown; in the second, antibiotics added to the culture material made it possible to grow only some bacterial species. The shapes of colonies between bacterial strains were also different. In four samples, problems arose with the microbial evaluation; these were excluded from the study. Thus, microbial evaluation was done of 44 samples (22 cases, 22 controls).

All the patients had the same oral hygiene program after treatment, and they rinsed their mouths with chlorhexidine 0/2% solution twice per day for one week.The pain after treatment was low, and there was no need for analgesics.

Table 1 The p-values of tests comparing clinical parameters between two groups at four evaluation times

Clinical parameters	Before treatment	One day after treatment	One month after treatment	Two months after treatment
Clinical attachment level	0.848	0.978	0.031	0.047
Gingival bleeding index	0.552	0.999	0.002	0.006
Modified gingival index	0.223	0.003	0.439	0.032
Gingival recession	0.273	0.852	0.393	0.845
Periodontal pocket depth	0.798	0.845	0.004	0.001

Table 2 The results of the number of negative and positive microbial cultures in two groups at two evaluation times for Porphyromonas gingivalis

Group results	Before treatment		After two months	
	Laser	Control	Laser	Control
Negative culture	3	4	20	16
Positive culture	19	18	2	6
Total number of samples	22	22	22	22

All the patients were followed up for a period of two months.

The statistical tests used were the t-test, chi-square test, and Mann-Whitney U-test, with significance set at $p < 0.05$. The results were statistically analyzed with SPSS version 10.

RESULTS

Clinical Parameters

The results of the statistical analyses are summarized in Table 1. There was significant improvement in all parameters after treatment in both groups. Between the two groups, however, the laser-treated group showed better results. The t-test showed that the laser-treated group had better clinical attachment levels after one month ($p = 0.031$) and two months ($p = 0.047$) in comparison with the control group. In terms of bleeding on probing, the chi-square test demonstrated that the laser-treated group had significantly less bleeding after one month ($p = 0.002$) and two months ($p = 0.006$). In the evaluation of pocket depth (t-test), the laser-treated group had better results after one month ($p = 0.004$) and two months ($p = 0.001$) than did the control group. The modified gingival index had significantly lower values in the laser group after one day ($p = 0.003$) or two months ($p = 0.032$) (Mann-Whitney). There was no significant difference between the two groups for gingival recession (t-test).

Microbial Evaluation

The results of the number of negative (no growth of bacteria examined) and positive (some colony growth) microbial cultures for two bacterial species are given in Tables 2 and 3 by group and evaluation times.

In each group, the difference between the number of negative and positive culture results for each bacterial species before treatment and two months later was

Table 3 The results of the number of negative and positive microbial cultures in two groups at two evaluation times for Prevotella intermedia

Group results	Before treatment Laser	Before treatment Control	After two months Laser	After two months Control
Negative culture	2	4	21	15
Positive culture	20	18	1	7
Total number of samples	22	22	22	22

Table 4 The McNemar test p-values for the difference in each group between the number of negative and positive culture results for each bacterium at two evaluation times

	Before treatment and after two months	
Group	Porphyromonas gingivalis	Prevotella intermedia
Laser treated	< 0.001	< 0.001
Control	< 0.001	0.001

evaluated by the McNemar test. In both groups, the number of samples with positive and negative cultures was significantly reduced after treatment (Table 4).

The chi-square test was used for comparing the number of negative and positive culture results between the two groups at two evaluation times. After two months, the difference between the two groups for Porphyromonas gingivalis was not significant, but was for Prevotella intermedia, with the laser-treated group having better results ($p = 0.019$).

DISCUSSION

Various hard lasers such as Nd:YAG, CO_2, Er:YAG, excimer, argon, Nd:YAP, Alexandrite, and soft lasers such as He-Ne, Ga-Al-As have been investigated for periodontal treatment.[3] A major application of laser within the diseased pocket has been to remove soft tissue lining as well as to reduce bacterial contamination, as described by several authors.[3,5]

Some studies have suggested that lasers may function as an alternative or adjunct therapy in the control and treatment of periodontally diseased root surfaces.[2,3] In some studies, the results of laser efficacy were controversial. Cobb's review of the literature suggested that the use of Nd:YAG or Er:YAG wavelengths for treatment of chronic periodontitis may be equivalent to scaling and root planing (SRP) with respect to reduction in probing depth and subgingival bacterial populations.[11]

However, if gain in clinical attachment level is considered the gold standard for nonsurgical periodontal therapy, then the evidence supporting laser-mediated periodontal treatment over traditional therapy is minimal at best. Moreover, there is limited evidence suggesting that lasers used in an adjunctive capacity to SRP may provide some additional benefit.[11] In another study, the effects of Nd:YAG laser treatment vs scaling and root planing on crevicular IL-1 beta levels was evaluated.The level of IL-1 beta was significantly lower when scaling and root planing were performed alone in comparison with laser therapy.[6]

In this study, there was a significant difference between the laser-treated group and control after scaling and root planing for some clinical parameters. It seemed that laser combined with the conventional method produced better results than the conventional

method alone. These results were similar to those of other authors.[4,5] In the current study, the case and control groups comprised similar patients, and the systemic conditions were similar. In this study as in others,[5,18] laser was applied toward the soft tissue lining but not the cementum, based on the results of other studies which found Nd:YAG laser to achieve calculus removal comparable to conventional hand instrumentation,[2] and to be effective for removal of remaining root surface smear layer after root planing in vitro,[12] but the temperature increase was greater than clinically desirable.[3,13] Side effects of Nd:YAG laser-treated root surfaces included cementum melting and cracking,[14,15] charring and carbonization of the cementum with pit and crater formation,[16] and alteration of the chemical composition of root surfaces, decreasing the protein to mineral ratio.[3,17]

In this study, two bacterial species (Porphyromonas gingivalis and Prevotella intermedia) were chosen for microbial evaluation. They are two important and prevalent bacteria in chronic periodontitis that are associated with disease progression, and it is possible that these commensal and pathological strains compromise post-treatment clinical observations.[19] In this study, the difference between the two groups for Prevotella intermedia was significant after two months. This antibacterial efficacy of Nd:YAG laser was similar to that found in other studies,[5,18,20] but there was no significant difference after two months between the two groups for Porphyromonas gingivalis, although the numbers of negative cultures in the laser-treated group were lower in comparison with the control group. The probable causes for the lack of significant difference for Porphyromonas gingivalis between the two groups may be good scaling and root planing, no additional effect of Nd:YAG laser by applied dose for this bacterium, or as the case and the control groups were in the same patients, this bacterium may have spread from control sites to case sites during the two-month postoperative period. In an in vitro study, there was a large difference in ablation threshold between the pigmented pathogen (Porphyromonas gingivalis) and the blood agar for pulsed Nd:YAG laser, thus the pulsed Nd:YAG laser may selectively destroy pigmented pathogens and leave the surrounding tissue intact.[21]

It is possible that the fluence used in this study was inadequate for complete elimination of Porphyromonas gingivalis. Perhaps if laser were applied in combination with a suitable antibiotic, the antibacterial effects might be sufficient, as suggested by other authors.[4]

Benefits such as bleeding control during surgery and less pain and thermal tooth sensivity after treatment were reported for laser application in some studies.[18] Others have described another benefit of laser application in periodontal pocket healing: laser de-epithelialization for enhanced guided tissue regeneration. This means that laser usage blocks the down-growth of epithelium into the healing periodontal wound after surgery and prevents formation of a long junctional epithelial attachment.[22]

CONCLUSION

Within the limitations of this study, the results indicate that Nd:YAG laser application together with conventional methods provides better clinical and microbial results than those obtained by conventional methods alone, although the selection of single-root sites may limit result applicability for multiroot sites.

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