

ORIGINAL ARTICLE

## KTP laser therapy as an adjunctive to scaling and root planing in treatment of chronic periodontitis

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### Abstract

**Objective.** The main goal of periodontal treatment is to control infection and, thereby, curb disease progression. Recent studies have suggested that the use of a laser as an adjunct to scaling and root planing (SRP) might improve the effectiveness of conventional periodontal treatment. The aim of this study was to evaluate and compare the clinical effects of potassium-titanyl-phosphate (KTP) laser therapy in the treatment of chronic periodontitis in combination with traditional SRP. **Materials and methods.** Twenty-four patients with untreated chronic periodontitis were treated using a split-mouth study design in which each side was randomly treated by SRP alone (control group) or KTP laser (0.8W, time on 50 ms, time off 50 ms, 30 s, 532 nm) followed by SRP (test group). In the distribution of the teeth (total = 124 teeth) in the patients, 106 (86%) were molars and 18 (14%) were premolars. The selected teeth were probed with a pressure-controlled probe, guided by stents. Clinical periodontal parameters including plaque index (PI), bleeding on probing (BOP), probing pocket depth (PPD) and probing attachment level (PAL) were recorded at baseline and at 2 and 12 months following therapy. **Results.** Statistical analysis demonstrated no differences between groups at baseline for all parameters ( $p > 0.05$ ). BOP and PPD reductions and PAL gains were statistically significant both between baseline and 2 months and between baseline and 12 months in both groups ( $p < 0.05$ ). The test group showed a greater reduction in PPD compared to the control group ( $p < 0.05$ ). In addition, the test group showed a greater probing attachment gain compared to the control group ( $p < 0.05$ ). **Conclusions.** In patients with chronic periodontitis, clinical outcomes of conventional periodontal treatment can be improved by using an adjunctive KTP laser.

**Key Words:** *chronic periodontitis, non-surgical periodontal debridement, laser therapy, lasers and potassium titanyl phosphate (KTP) laser*

### Introduction

Periodontal disease is a common inflammatory disease caused by bacterial biofilm of periodonto-pathogenic species in the subgingival oral compartment, leading to a loss of the supporting hard and soft tissues of the teeth (i.e. periodontal ligament and alveolar bone) [1]. The main goal of periodontal therapy is to remove soft and hard supra-gingival and sub-gingival deposits from the root surface to curb disease progression. Mechanical biofilm removal (SRP), using hand and power-driven instruments, has become a well-documented and effective treatment modality [2,3]. The previous studies have reported that substantial improvements of periodontal condition measured by a reduction in the probing pocket depth and gains in the clinical attachment level

were a common outcome of SRP [2–4]. However, traditional mechanical therapy alone may fail to eliminate the sub-gingival periodonto-pathogenic bacteria located in areas such as multi-rooted teeth, furcation sites, interproximal areas, and deep pockets inaccessible to periodontal instruments [3,4]. Thus, laser therapy may represent a potential benefit in the treatment of periodontal diseases by reducing and eradicating periodonto-pathogenic species in these areas [5–7].

In recent years, the use of laser therapy has been reported as an alternative or adjunctive therapy to mechanical approaches for periodontal therapy. Lasers shown to be useful include the Nd:YAG (neodymium-doped: yttrium, aluminium and garnet), the Er:YAG (erbium-doped: yttrium, aluminium and garnet), the CO<sub>2</sub> (carbon dioxide), the He-Ne

(Helium/neon), the KTP (potassium-titanyl-phosphate) and diode laser [5–11]. Various advantageous characteristics of lasers, such as sterilization effects, accelerate wound healing, positive effect on inflammatory process, hemostatic effects and enhanced visual control, selective calculus ablation or bactericidal effects against periodonto-pathic pathogens might lead to improved treatment outcomes [5–7]. For these reasons, the use of laser therapy within the periodontal pocket has become a topic of much interest and is a promising field in non-surgical periodontal therapy.

The application of KTP laser in periodontal pockets as an adjunctive to SRP has been suggested [10, 11] and first tested in a clinical trial [10], but there is still a lack of clear evidence for its effect on treatment of periodontal diseases. In the highlights of the current literature, the authors of the present study hypothesized that KTP laser therapy after full-mouth SRP might be sufficient to improve in the clinical periodontal parameters. Therefore, the aim of this study was to evaluate and compare the clinical effects of KTP laser therapy in the treatment of chronic periodontitis in combination with traditional SRP.

## Materials and methods

This was a single-center, randomized-controlled, split-mouth, double-blind clinical trial of 12-month duration. The study protocol was approved by the local ethical committee and conducted according to the principles outlined in the Declaration of Helsinki on experimentation involving human subjects. All participants provided written informed consent.

### Selection of patient

The study population consisted of 24 patients with untreated chronic periodontitis who visited the periodontology department of Atatürk University, Erzurum, Turkey. Criteria for subject selection were: (1) no systemic diseases or conditions; (2) not using any medication; (3) no use of smoking; (4) at least 30 years of age; (5) no receive periodontal therapy in the last 6 months; (6) a minimum of five natural teeth in every quadrant; (7) presence of four or more non-adjacent teeth with PPD of  $\geq 4$  mm; (8) presence of BOP and radiographic evidence of alveolar bone loss; and (9) no presence of carious lesions or restorations on the selected teeth.

### Sample size

The sample size was calculated using  $\alpha = 0.05$  and the power  $(1 - \beta) = 80\%$ . For the variability ( $\sigma = SD$ ), the value of 0.5 mm was used considering clinical attachment gain as a variable outcome. The minimum clinically significant value ( $\delta$ ) considered was 0.5 mm. On the basis of these data, the number of patients

required to be enrolled to conduct this study has been calculated as 24 [12].

### Study design

The study was performed according to a split-mouth design, and each patient was entered into a clinical protocol consisting of two different modalities: the teeth on test sides received SRP and KTP laser therapy (test group), whereas control sides were treated with SRP alone (control group). The assignment of the test or control sides for the respective treatments was randomly determined by a coin toss prior to initiating treatment (Figure 1).

Alginate molds of dental arches were made to prepare individual acrylic occlusal stents for standardizing the clinical measurements during clinical trial. The treatment was carried out in two sessions, with intervals of 7 days between sessions. The clinical periodontal parameters were assessed before SRP (baseline) and at 2-month (Short-term) and 12-month (Long-term) after the conclusion of treatment. The patients did not know what kind of therapy each tooth was receiving. In addition, the SRP and laser therapies were performed by one researcher (SS) and the clinical measurements were assessed by another researcher (AD).

On the first session, after the assessment of the clinical periodontal parameters, each patient received initial periodontal therapy consisting of thorough oral hygiene instructions and full-mouth supra- and sub-gingival SRP with ultrasonic instruments (EMS Mini-Piezon, Nyon, Switzerland). The tip of ultrasonic instrument was applied parallel to the tooth surface to remove the supra- and sub-gingival debris and there was no intention to traumatize the soft tissues. SRP with ultrasonic instruments was performed until the researcher considered the teeth surfaces to be appropriately debrided and planed. Following SRP, all supra-gingival teeth surfaces were polished with a rubber cup and point in combination with a dental paste (Detartrine, Septodont, Cedex, France).

### Examiner calibration

The researcher charged with clinical assessments was calibrated for intra-examiner repeatability prior to the start of the trial. Thirteen patients with a total of 42 periodontal pockets were enrolled for this purpose. Duplicate measurements of PPD were collected with an interval of 48 h between the first and the second recording. Calibration was accepted if measurements at baseline and at 48 h were within a millimeter (mm) at  $\geq 99\%$  of the time.

### Clinical parameters

The following clinical periodontal parameters were assessed baseline and at 2- and 12-months after

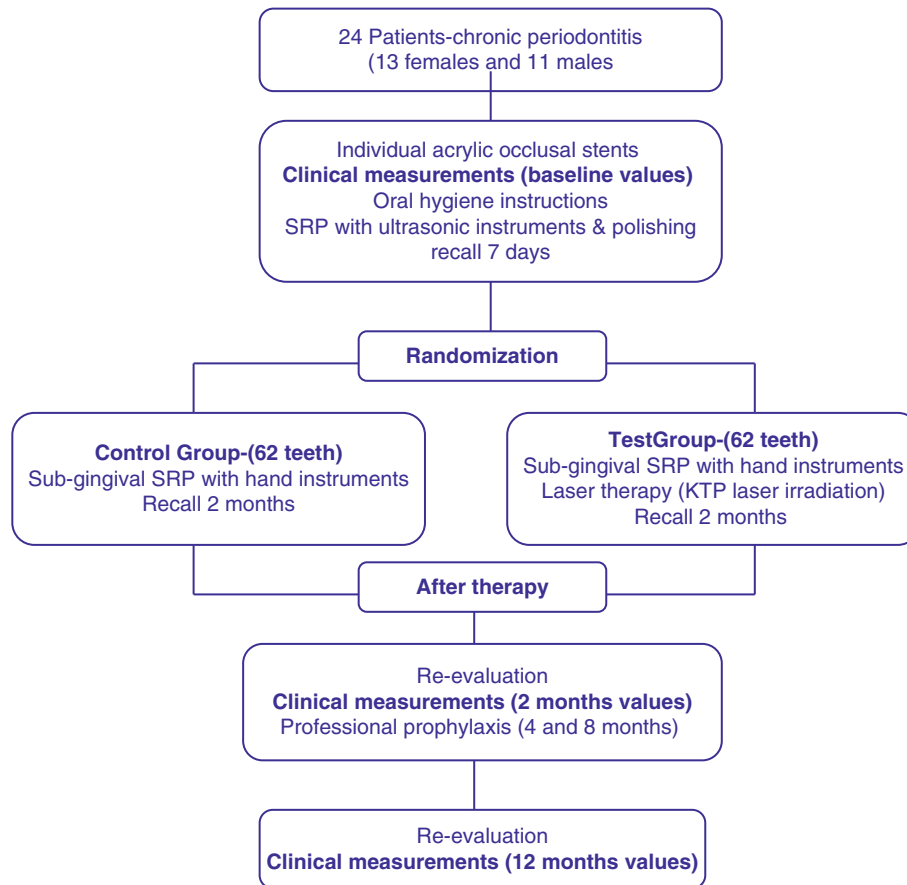


Figure 1. Diagram illustrating the study design. Clinical measurements; PI, plaque index; BOP, bleeding on probing; PPD, probing pocket depth; PAL, probing attachment level.

treatment: Plaque index (PI) [13], bleeding on probing (BOP), probing pocket depth (PPD) and probing attachment level (PAL).

*Bleeding on probing (BOP).* On the selected teeth, BOP (see below PPD) to the bottom of the pocket was determined and the percentage of BOP positive sites, bled upon within 30 s after probing with a controlled-force probe (Florida Probe, Gainesville, FL), recorded.

*Probing pocket depth (PPD) and probing attachment level (PAL).* PPDs and PALs were measured with the use of controlled-force probe (0.25 N, 127 N/cm<sup>2</sup>). PPD measurements were performed in duplicate, according to the guidelines of the Florida Probe software (FP 32 Software version 4) and subsequently the mean of the two values was calculated. PAL measurements were obtained from a groove at the occlusal stent to the bottom of the pocket by the Florida stent probe.

#### Treatment

All therapy procedures for both test and control groups were performed during the same treatment

session and by the same researcher and with the same technique.

On the second session, sub-gingival SRP was carried out using curettes (Gracey curettes, Hu Friedy, Chicago, IL) for all teeth of both groups under local anesthesia (Ultracaine DS Forte<sup>®</sup>, Hoechst Roussel, Frankfurt, Germany) and was continued until the researcher felt that the root surfaces were hard and smooth. Following hand instrumentation, the sites were rinsed with sterilized physiological saline solution. In addition, for the test group, the laser application was performed using a KTP laser device (SmartLite, DEKA, Florence, Italy) with a flexible fiber-optic tip with a diameter of 200 µm. Immediately after sub-gingival SRP, the periodontal pockets were radiated by a laser beam of 0.8 W, time on 50 ms, time off 50 ms, 30 s, 532 nm and fluence 11.7 J/cm<sup>2</sup> with sweeping motion and pulsewave (PW) mode. Two 30-s applications were made in each direction, for a total irradiation time of 60 s for each tooth. An interval of 20 s between irradiations was used for thermal relaxation of the tissue. Before activating the laser, the fiber-optic tip was placed at the base of the periodontal pocket parallel to the tooth surface. Then the laser was activated and the tip moved horizontally (back and forth) and coronally

(up and down) until it reached the gingival margin. When the lasers were in use, protective eyewear of appropriate optical density was worn by investigator and patients.

All patients were recalled for professional prophylaxis 4 and 8 months after the treatment. During the year, sub-gingival instrumentation of the all sites was not performed.

#### Statistical analysis

The means and standard deviations were calculated for all clinical parameters of both groups. The data, thus, collected were assessed using SPSS 16.0 statistical software (SPSS Inc., Chicago, IL). The Wilcoxon signed ranks test was chosen to compare test and control group differences in mean PI, BOP, PPD and PAL. The Friedman test was used to assess the differences in mean clinical parameters for the baseline and at 2 and 12 months.

#### Results

For the current study, 24 untreated periodontitis patients were enrolled from February 2010 to November 2011 (total = 124 teeth). The mean age of the patients was  $40.6 \pm 7.01$  years (range = 31–56 years) and 13 out of 24 were females.

All participants completed the study. No adverse effects of laser therapy were observed or reported by the patients. None of the patients revealed any major periodontal inflammatory symptoms after instrumentation during the entire study. Post-operative complications such as infections, suppuration or abscesses were not observed.

The statistical analyses for the clinical parameters at baseline and at 2 and 12 months following therapy are presented in Table I. According to Table I, no statistically significant differences between groups were observed for any of the clinical parameters at baseline ( $p > 0.05$ ). At 12-month examination, there was, compared to the baseline value, statistically significant reduction of the PI scores (from  $1.42 \pm 0.50$  to  $0.88 \pm 0.34$  for the control group; from  $1.46 \pm 0.51$  to  $0.83 \pm 0.38$  for the test group;  $p < 0.05$ ), a corresponding statistically significant reduction of the BOP values (from  $88 \pm 0.34\%$  to  $54 \pm 0.51\%$  for the control group; from  $92 \pm 0.28\%$  to  $38 \pm 0.50\%$  for the test group,  $p < 0.05$ ).

At 2- and 12-month examinations, both treatments yielded significant improvements in terms of PPD decrease and PAL gain compared to baseline values ( $p < 0.05$ ). The test group showed a greater reduction in PPD and PAL gain compared to the control group ( $p < 0.05$ ). There was a statistically significant decrease of the PPD values (from  $5.67 \pm 0.96$  mm to  $3.58 \pm 0.65$  mm for the control group; from  $5.79 \pm$

Table I. Mean  $\pm$  SD values of the clinical parameters at baseline and 2 and 12 months.

Parameters	Control group	Test group
<i>PI</i>		
Baseline	$1.42 \pm 0.50$	$1.46 \pm 0.51$
2-month	$0.96 \pm 0.20$	$0.96 \pm 0.36$
12-month	$0.88 \pm 0.34^b$	$0.83 \pm 0.38^b$
<i>BOP (%)</i>		
Baseline	$88 \pm 0.34$	$92 \pm 0.28$
2-mont	$58 \pm 0.50^b$	$50 \pm 0.51^b$
12-months	$54 \pm 0.51^b$	$38 \pm 0.50^{a,b}$
<i>PPD (mm)</i>		
Baseline	$5.67 \pm 0.96$	$5.79 \pm 0.78$
2-month	$4.50 \pm 1.04^b$	$4.04 \pm 1.33^{a,b}$
12-month	$3.58 \pm 0.65^b$	$3.08 \pm 0.65^{a,b}$
<i>Difference (base–12 months)</i>	$2.08 \pm 1.02$	$2.71 \pm 0.86$
<i>PAL (mm)</i>		
Baseline	$7.38 \pm 0.77$	$7.50 \pm 0.72$
2-month	$6.91 \pm 1.25^b$	$.20 \pm 1.25^{a,b}$
12-month	$5.08 \pm 1.14^b$	$4.42 \pm 0.78^{a,b}$
<i>Difference (base–12 months)</i>	$2.29 \pm 1.16$	$3.08 \pm 1.06$

PI, plaque index; BOP, bleeding on probing; PPD, probing pocket depth; PAL, probing attachment level.

<sup>a</sup>Statistically significant difference between the groups ( $p < 0.05$ ), Wilcoxon signed-rank non-parametric test.

<sup>b</sup>Statistically significant difference from baseline ( $p < 0.05$ ), Friedman non-parametric test.

0.78 mm to  $3.08 \pm 0.65$  mm for the test group;  $p < 0.05$ ).

At 12 months, the mean PAL gain in the control and test group was  $2.29 \pm 1.16$  mm and  $3.08 \pm 1.06$  mm, respectively.

#### Discussion

The aim of this clinical trial was to evaluate and compare the clinical effects of KTP laser therapy in the treatment of chronic periodontitis in combination with traditional SRP. Data from the present study indicated that non-surgical periodontal treatment of chronic periodontitis with either KTP laser or with conventional SRP led to significant improvements in all investigated clinical parameters at 12 months following treatment. The results have also demonstrated that clinical changes occurred during the 2-months after the treatment in both the control and test groups. These results compare well with others. Romeo et al. [10] reported that there were significant improvements in the clinical periodontal parameters (BOP, PPD and CAL) at 6 weeks after the KTP laser therapy.

Bacterial biofilm plays a key role in the etiology and pathogenesis of periodontitis. An essential

component of periodontitis therapy is the effective removal of bacterial biofilm from the tooth surfaces. The aim of the periodontal therapy is to create a biologically acceptable root surface by eliminating the biofilm and the metabolic products. Clinically, there is evidence that SRP with hand- and power-driven instruments provides the best results for the treatment of periodontal disease [2–4]. The conventional SRP of the root surface is considered as a pre-requisite for a long-term treatment success. However, several anatomic variations may limit the success of conventional SRP such as deep pockets, which may hinder the access of instruments into the periodontal pocket. In periodontal pockets  $\geq 3.73$  mm in depth, hand instruments cannot eliminate sub-gingival dental plaque and calculus effectively and no instruments are effective for periodontal pockets with 5.7–8.3 mm [3]. For this reason, in the past decades, several treatment alternatives have been presented. Thus, laser therapy has been proposed as an alternative or adjunct to conventional SRP, due to excellent tissue ablation, reaching sites that conventional SRP cannot, bactericidal and detoxification effects against periodontal species in deep pockets [5–7]. In the present study, therefore, teeth with PPD of  $\geq 4$  mm were chosen for the KTP laser therapy.

In the current study, the reason for choosing a split-mouth design was to facilitate the comparison of both treatment methods under very similar and optimally standardized healing and evaluation conditions by eliminating patient-specific conditions [14]. The number of affected teeth should have been equally distributed in the two groups, as the treatment time was set to 60 s per tooth. Furthermore, none of the baseline clinical parameters revealed any statistically significant differences.

As can be seen in Table I, the finding that non-surgical periodontal treatment with conventional SRP can result in statistically significant improvements in PI, PPD and PAL compared to baseline is in agreement with previously reported data [15–22]. In the present study, a mean PPD reduction of 2.08 mm and a mean PAL gain of 2.29 mm were observed in teeth with PPD of  $\geq 4$  mm. These results are in accordance with data reported in different recent meta-analyses [2,3].

One important aspect to assess the success of sub-gingival debridement is the effective reduction of periodontal inflammatory symptoms like BOP [3]. In the present study, supra- and sub-gingival debridement and oral hygiene instructions was conducted, in order to reduce gingival inflammation. The BOP value in the control and test groups showed a more favorable response at 2 and 12 months compared to the baseline. An absence of BOP, thus, demonstrated a very high probability that periodontal health can be well maintained.

The results of the current study indicated that periodontal pockets treated with a KTP laser showed an improvement in PPD and PAL measurements when they were compared with those from traditional SRP alone. At 12 months, the mean PPD reduction in the control and test group was 2.08 mm and 2.71 mm, respectively. In addition, the mean PAL gain in the control and test group was 2.29 mm and 3.08 mm, respectively. The obtained mean PPD reduction and PAL gain were higher than that from the other researchers [10]. This discrepancy might be explained by differences in duration of trial that was 6-weeks and the laser energy settings that were 0.6 W, Ton 10 ms, Toff 50 ms, fluence 19 J/cm<sup>2</sup>. In addition, the present study demonstrated that KTP laser irradiation was effective as an adjunct to conventional periodontal treatment. This was probably due to the thermal effect, which creates antimicrobial activity without damaging the dental tissues [23–31].

With respect to clinical outcome measures, there are several studies reporting the inconsistency of the efficacy of laser therapy as an alternative or adjunct to non-surgical periodontal treatment. Despite so many studies, at the moment it is not possible for a meaningful comparison to be achieved between various clinical studies or between laser and conventional SRP therapy, because of the wide variations in laser parameters such as power level (W), exposure time (s), pulsed vs continuous wave energy, energy density (J/cm<sup>2</sup>), distance from the surface and the angle between the target tissue and the fiber tip, the insufficient reporting of parameters that, in turn, do not allow calculation of energy density, the differences in the experimental design, the lack of proper controls and the differences in severity of disease and in treatment protocols [5–7].

In conclusion, within the limits of the present study, in patients with chronic periodontitis, clinical outcomes of conventional periodontal treatment can be improved by using an adjunctive KTP laser. In addition, the microbiological effects underlying the observed clinical benefits should be investigated.

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