A Comparative Clinical Study of Er:YAG Laser and Hand Instruments in the Treatment of Moderate Chronic Periodontitis

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Abstract

Introduction: Moderate chronic periodontitis is the most common periodontal disease. The treatment of this condition should aim at achieving a biocompatible root surface and decontamination of the pocket, thereby restoring the health status.

Aim: In the present study, the aim was to examine the clinical effectiveness of fibreless Er:YAG laser used for scaling and root planing and to compare it with a conventional treatment with Gracey curettes.

Materials and methods: The study included 909 periodontal pockets which were treated in a split-mouth design with either Gracey curettes or with Er:YAG laser (1.5 W). Probing pocket depth (PPD), gingival recession (GR), clinical attachment level (CAL), bleeding on probing (BoP), and plaque index were recorded.

Results: There was a considerable decrease of PPD, CAL, BoP, and plaque presence values at 1 and 3 months after therapy in both treatment groups. Sites treated with Er:YAG laser demonstrated mean CAL gain of about 1.00 mm and 0.44 mm at the first and third month, respectively. In the control group, there was also significant gain of CAL of about 1.33 mm at the first and 0.30 mm at the third month. Significant difference was observed in all parameters between both groups in favour of the laser treatment.

Conclusions: The results of the present study suggest that the Er:YAG laser shows clinical effectiveness in the treatment of moderate chronic periodontitis. It can be used as a single treatment modality for subgingival scaling and root planing resulting in greater improvements in all recorded data in contrast to conventional treatment.

Keywords
clinical effectiveness, Er:YAG, laser, scaling and root planing, periodontitis

INTRODUCTION

Conservative therapy of chronic periodontal disease consists of mechanical supra- and subgingival tooth debridement, combined with patient’s oral care measures. Understanding the etiology and pathogenesis of plaque-induced periodontitis, the main goal of periodontal therapy is to reduce the bacterial load and change the microbial complex in the biofilm towards a flora more associated with health. The reduction of subgingival bacteria usually leads to reduction of inflammation and relative stability of the periodontal attachment levels. The removal of calculus and contaminated root cementum and creation of a clean,
smooth and biologically compatible root surface is the most important condition for the treatment outcome. The golden standard of care in root surface debridement is scaling and root planing (SRP) using hand instruments, though with some limitations.\(^7\) Subgingival SRP performed with hand instruments is a difficult and time-consuming procedure. The clinical effectiveness decreases with increasing probing depth, especially when probing depth exceeds 5 mm.\(^3,4\) Ultrasonic scaling creates deep grooves on the cementum surface which enables faster recolonization by subgingival bacteria.\(^5,6\) Despite the instrument choice (hand or power-driven), some areas are difficult to reach and debride properly – inter-proximal areas, cementum-enamel junction, root concavities and furcation areas. The plaque and calculus left there compromise the treatment outcome. In addition, some patients do not feel comfortable with the mechanical procedure, the need of anesthesia, the noise or vibrations of the ultrasonic devices.\(^7\)

With the introduction of lasers in dentistry, the laser-supported periodontal therapy became an alternative or an adjunctive therapy to mechanical SRP. Many lasers have been demonstrated to have a beneficial effect in the periodontal treatment. The adjunct use of diode or Nd:YAG lasers show significant improvement in clinical and microbiological parameters compared to SRP alone.\(^8-10\) Erbium lasers – Er:YAG (2940 nm) and Er;Cr:YSGG (2780 nm) are likely the most suitable lasers for periodontal therapy.\(^11,12\) They can be used both on hard and soft tissues, with minimal heat-related side effects. An Er:YAG laser has the ability to remove subgingival calculus with minimal removal of root substance\(^13,14\) and without thermal alteration\(^15,16\). The laser beam can easily reach areas difficult to scale, because the access is not mechanically limited in the pocket. A high bactericidal effect of Er:YAG laser against periodontopathic bacteria was reported by Ando et al.\(^17\), as well as the effective ability to remove cementum bound endotoxin, an important factor in the pathogenesis of periodontal disease\(^18\). Removal of epithelium lining and granulation tissue from pockets, faster healing response, decreased pain, and increased patient acceptance are other advantages of Er:YAG lasers.

Some clinical trials evaluate the effectiveness of laser treatment alone or as an adjunct to SRP, regarding changes in clinical parameters. Schwarz et al. reported significant improvement in clinical attachment level, pocket depth reduction, bleeding on probing, plaque index (Sillness-Loe) and gingival index (Loe-Sillness) within groups, as well as significant differences between the groups for all clinical parameters at short-\(^19\) and long-term intervals\(^20\). However, three studies did not report a significant difference between Er:YAG laser and SRP groups in CAL gain, PD reduction, or GR changes.\(^21-23\)

Soo et al.\(^24\) also reported statistically significant improvement in clinical parameters after SRP carried out with ultrasonic scaler and Gracey curettes, compared to Er:YAG laser treatment.

The conclusion of the systematic review and meta-analysis, published by Sgolastra et al. and Cobb\(^25,26\), did not find evidence for the greater effectiveness of Er:YAG laser compared to SRP in chronic periodontitis treatment, but as the authors, the results should be interpreted with caution and future clinical trials are needed to assess the scientific evidence of Er:YAG laser effectiveness.

**AIM**

The aim of the present study was to investigate and compare the clinical effectiveness of a fibreless Er:YAG laser with the conventional scaling and root planing with hand instruments.

**MATERIALS AND METHODS**

This was a single-blinded, randomized, controlled, split-mouth clinical trial. Patients were recruited from those admitted for periodontal treatment in the Department of Periodontology and Oral Diseases in the Faculty of Dental Medicine at the Medical University of Plovdiv, Bulgaria from November 2011 to May 2012. Ethical approval was obtained from the Ethical Committee of the Medical University (No 3/2011). Each patient signed an informed consent prior to their entering the study.

**Inclusion criteria**

All participants were diagnosed as having moderate chronic periodontitis defined as a probing depth of up to 6 mm, attachment loss of up to 4 mm, bleeding on probing, and radiographic evidence of bone loss.\(^1\)

**Exclusion criteria**

Patients were excluded from the study if they had a systemic disease that could potentially influence the outcome of the therapy; if they were taking antibiotics or steroids at least 6 months prior to the treatment; had any periodontal treatment in the last 6 months or were pregnant. Smoking patients were included in the study as the statistical analysis revealed that there is no correlation between clinical parameters and smoking in the present investigation.

**Oral hygiene program**

Each patient received individual oral hygiene instructions according to their requirements at the beginning and at every treatment visit.

Prior to scaling and root planing, supragingival cleaning of plaque and calculus was performed with an ultrasonic system (Piezon Master 400, EMS, Nyon, Switzerland) with a tip A for supragingival cleaning and polishing with rubber cups and brushes.

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Treatments

Twenty patients (6 men and 14 women), aged 47.4±8.65 years, with a total of 366 teeth and 909 sites were included in the study.

Using a split-mouth design, 2 quadrants (one quadrant from each jaw) were randomly allocated into the test group (TG) or the control group (CG). The test quadrants received laser treatment with Er:YAG laser, whereas the control quadrants received SRP with an ultrasonic scaler and hand curettes. All procedures were performed without local anesthesia.

Test quadrants (TG)

Teeth in the test quadrants were debrided using a calibrated Er:YAG laser (Lite Touch, Light Instruments Ltd, Yokneam, Israel) emitting light with a wavelength of 2940 nm. The laser parameters were set according to the manufacturer's instructions: 1.5 W energy, chisel tip for scaling and root planing (100 mJ and 15 Hz) and a sapphire tip 0.6 mm for pocket debridement (50 mJ and 30 Hz). The chisel tip used in the contact mode was inserted in the pocket at an angle of 10-15 degrees to the root surface, always in motion, with coronal to apical movements until the bottom of the pocket was reached. Scaling and root planing ended when the operator felt a smooth root surface. Pocket debridement was performed after scaling and root planing with a tip 0.6 mm in diameter and a length of 17 mm, working in a non-contact mode, around the root surface.

Control quadrants (CG)

Subgingival SRP was performed with a set of 7 new Gracey curettes (Hu-Friedy, USA). The endpoint was the feeling of a clean, hard, smooth root surface, using a periodontal explorer.

Periodontal pockets were rinsed at the end of the session with 0.9% NaCl solution only.

Clinical assessments

Clinical data, including plaque index (PI), bleeding on probing (BoP), pocket depth (PD), gingival recession (GR), and clinical attachment level (CAL) score were collected before treatment (at baseline) and at follow-up examinations 1 and 3 months after the treatment. All clinical measurements were performed with a Florida Probe and entered directly into an electronic periodontal chart (Florida Probe®, Florida Probe Corporation, Gainesville, USA).

The variables were recorded as follows:

PI – presence or absence of plaque in 4 points around the tooth – mesial, vestibular, distal, and lingual;
BoP – presence or absence of bleeding on probing in 6 points around the tooth – disto-vestibular, mid-vestibular, mesio-vestibular, mesio-lingual, mid-lingual, disto-lingual;
PDD – the distance in millimetres from the gingival margin to the bottom of the pocket was taken at six points around each tooth like BI;
GR – the distance in millimetres from cementum-enamel junction to the gingival margin in millimetres like BoP and PPD;
CAL – the distance in millimetres from cementum-enamel junction to the bottom of the pocket in six points like BI, PPD and GR.

Statistical analysis

Statistical analysis was performed with SPSS for Windows, version 17 (SPSS Inc., Chicago, IL, USA). Data were presented as mean ± Sx (SD). ANOVA and Independent Samples t tests were used to compare clinical variables (PPD, GR, CAL) in and between both groups before and after the treatment at the first and third month. Chi-square test was used to compare variables for bleeding on probing and plaque presence. Differences were considered statistically significant when the P value was <0.05.

RESULTS

The study investigated 20 patients with moderate chronic periodontitis; a total of 366 teeth (both single and multi-rooted) and 909 sites were included in the study. They were treated in a split mouth design where 176 teeth (437 sites) were allocated to the control group, and 190 teeth (472 sites) – to the test group. Variations in the clinical scores are presented hereafter.

Changes in PPD, CAL, and GR

The mean values of the basic clinical parameters and their changes at 1 and 3 months are presented in Table 1. There was statistically significant reduction in the PPD after the treatment both in control and test quadrants. PPD reduction between measurements at baseline and after 3 months was 1.77 mm for the laser group and 1.71 mm for the conventional treatment group. The difference between the groups was small, but it was statistically significant (p<0.05).

Mean GR at 1 month was significantly increased after conventional instrumentation, if compared with the baseline values. The position of the gingival margin in CG was at the same level, while in TG it was found out an additional increase of 0.05 mm.

Both treatment modalities resulted in a significant reduction of mean CAL. One month after treatment CAL reduction between groups was not statistically significant, while at the visit at 3 months, the parameter had a statistically significant reduction in the laser group.

Changes in BoP

Both treatment methods lead to a reduction in the percentage of sites with BoP (Table 2).
At baseline, 87% of the sites in the control group showed bleeding on probing and in the test group the percentage was 84% – the results were strictly comparable. Bleeding decreased significantly 1 month after treatment to 32.7% in the control and 25.6% in the test group, as the reduction in the laser group was significantly higher compared to that in the control group ($p < 0.05$). Three months after treatment, there was bleeding only in 18% of the sites, treated with the laser while in the control group the bleeding was 28%.

**DISCUSSION**

The present study found that conservative treatment of periodontally diseased teeth is effective with both treatment modalities – hand instrumentation and laser debridement. Both methods lead to statistically significant reduction of the main clinical parameters – PPD, GR, CAL, and BoP. However, there is a small but statistically signif-

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**Table 1.** Comparative analysis for GR, PPD and CAL values at baseline, 1 month and 3 months after treatment in both groups

<table>
<thead>
<tr>
<th>Examination</th>
<th>GR</th>
<th></th>
<th>PPD</th>
<th></th>
<th>CAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Curette n=437</td>
<td>Laser n=472</td>
<td>$p^{**}$</td>
<td>Curette n=437</td>
<td>Laser n=472</td>
<td>$p^{**}$</td>
</tr>
<tr>
<td>Baseline (mean±SD)</td>
<td>0.09±0.01</td>
<td>0.13±0.02</td>
<td>0.004</td>
<td>4.61±0.03</td>
<td>4.57±0.03</td>
<td>0.761</td>
</tr>
<tr>
<td>1 month (mean±SD)</td>
<td>0.22±0.02</td>
<td>0.18±0.02</td>
<td>0.042</td>
<td>3.38±0.05</td>
<td>3.14±0.05</td>
<td>0.450</td>
</tr>
<tr>
<td>$p^{*}$</td>
<td>0.001</td>
<td>0.249</td>
<td></td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>3 months (mean±SD)</td>
<td>0.22±0.03</td>
<td>0.23±0.03</td>
<td>0.664</td>
<td>2.90±0.05</td>
<td>2.80±0.04</td>
<td>0.006*</td>
</tr>
<tr>
<td>$p^{*}$</td>
<td>1.000</td>
<td>0.495</td>
<td></td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

*statistically significant difference between different examinations (at baseline, at 1 and 3 months) in one group; **statistically significant difference between both groups (control and test treatment) in one examination

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**Table 2.** Comparative analysis for sites with bleeding on probing at baseline, 1 and 3 months after treatment

<table>
<thead>
<tr>
<th>Examination</th>
<th>Bleeding on probing</th>
<th>$\chi^2$</th>
<th>$p^{**}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Curette n=437</td>
<td>Laser n=472</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>No</td>
<td>Yes</td>
<td>Total</td>
</tr>
<tr>
<td>1 month</td>
<td>57</td>
<td>380</td>
<td>437</td>
</tr>
<tr>
<td>3 months</td>
<td>313</td>
<td>124</td>
<td>437</td>
</tr>
<tr>
<td>$p^{*}$</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*statistically significant difference between different examinations (at baseline, at 1 and 3 months) in one group; **statistically significant difference between both groups (control and test treatment) in one examination

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**Table 3.** Comparative analysis for sites with plaque at baseline, 1 and 3 months after treatment

<table>
<thead>
<tr>
<th>Examination</th>
<th>Plaque presence</th>
<th>$\chi^2$</th>
<th>$p^{**}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Curette n=437</td>
<td>Laser n=472</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>No</td>
<td>Yes</td>
<td>Total</td>
</tr>
<tr>
<td>1 month</td>
<td>180</td>
<td>524</td>
<td>704</td>
</tr>
<tr>
<td>3 months</td>
<td>66.3</td>
<td>33.7</td>
<td>100.0</td>
</tr>
<tr>
<td>$p^{*}$</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*statistically significant difference between different examinations (at baseline, at 1 and 3 months) in one group; **statistically significant difference between both groups (control and test treatment) in one examination
icant greater reduction of those parameters in the group treated by the Er:YAG laser. Following laser treatment, we observed higher reduction of PPD and CAL 3 months after treatment than the reduction achieved by hand instrumentation which is considered as clinically insignificant. In contrast, the reduction in BoP in the test group at 3 months was greater by 10% than that in the control group (18.3% in the Er:YAG laser group vs. 28.4% in the hand instruments group). Our results are consistent with the results from clinical studies published before. Schwarz et al.19 and Crespi et al.27 found that laser treatment provides greater reduction in BoP, PPD and greater gain in CAL compared with mechanical treatment. Nonhoof et al.28 also found that after 3 months laser treatment lead to a greater CAL gain compared with the sonic, ultrasonic and hand instrumentation. Our results differ from the results reported by Soo et al.24 who found a greater improvement in clinical parameters following SRP with hand instruments over 12 weeks. Rotundo et al.33 also was not able to find additional benefits of the Er:YAG laser in periodontal treatment.

To verify the long-term results from the instrumentation in the present clinical trial, the patients were followed up for 1 year and the results will be further presented. The results of many laboratory and clinical trials demonstrate that the laser scaling and root planing can be an effective alternative or adjunctive nonsurgical periodontal treatment. The Er:YAG laser is the only one who can ablate both soft and hard tissues, so this laser system can be used for calculus removal, scaling and root planing, etching of the root surface and better healing. Moreover, although not tested in the present study, it seems that the Er:YAG laser periodontal treatment is perceived better from the patients as they experience less pain in comparison to the traditional SRP.

**REFERENCES**


**CONCLUSIONS**

The results of the present study indicate sustained stability in the Er:YAG laser treated group with greater reduction of the inflammation in comparison with the conventional treatment of moderate chronic periodontitis with hand instruments. This allows the use of fibreless Er:YAG laser treatment as effective alternative nonsurgical periodontal treatment of the most common periodontal disease – the moderate chronic periodontitis.
Сравнительное клиническое исследование Er:YAG-лазера и ручных инструментов в лечении хронического пародонтита средней степени тяжести

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Резюме

Введение: Хронический пародонтит средней степени тяжести – наиболее распространённое заболевание пародонта. Лечение этого состояния должно быть направлено на достижение биосовместимости поверхности корня и обеззараживание стенок пародонтального кармана, таким образом восстанавливая состояние здоровья.

Цель: Целью настоящего исследования было оценить клиническую эффективность оптического Er:YAG-лазера, используемого для удаления зубного камня и выравнивания корней, и сравнить его с традиционным лечением кюретами Грейси.

Материалы и методы: В исследование было включено 909 пародонтальных карманов, которые были обработаны по методу „split-mouth design“ либо кюретами Грейси, либо лазером Er:YAG (1.5 W). Были измерены глубина кармана при зондировании (ГКЗ), рецессия десны (РД), клинический уровень прикрепления (КУП), кровотечение при зондировании (КЗ) и индекс налёта.

Результаты: В обеих группах лечения было обнаружено значительное снижение значений ГКЗ, КУП, КЗ и наличия бляшек через 1 и 3 месяца после терапии. Участки, обработанные лазером Er:YAG, показали последующее увеличение КУП на 1.00 мм и 0.44 мм в первый и третий месяц, соответственно. В контрольной группе также было значительное увеличение примерно на 1.33 мм в первый месяц и на 0.30 мм в третий месяц. Значительная разница наблюдалась по всем параметрам между двумя группами в пользу лазерного лечения.

Заключение: Результаты настоящего исследования показывают, что лазеры Er:YAG обладают клинической эффективностью при лечении хронического пародонтита средней степени тяжести. Его можно использовать как самостоятельный метод лечения для удаления поддесневого камня и выравнивания корней и приводит к большему улучшению всех показателей, чем традиционное лечение.

Ключевые слова

клиническая эффективность, Er:YAG лазер, удаление зубного камня и выравнивание корней, пародонтит