Review

The Effect of Laser Therapy as an Adjunct to Non-Surgical Periodontal Treatment in Subjects With Chronic Periodontitis: A Systematic Review

Marcus R. Karlsson,* Christina I. Diogo Löfgren,* and Henrik M. Jansson*

Background: The objective of this study was to systematically review the evidence on the effectiveness of laser therapy as an adjunct to non-surgical periodontal treatment in adults with chronic periodontitis.

Methods: A search was conducted for randomized controlled trials comparing the outcome of periodontitis with laser as an adjunct to scaling and root planing in the treatment of chronic periodontal disease. The electronic databases, PubMed and Cochrane Central Register of Controlled Trials, were used as data sources. Screening, data abstraction, and quality assessment were conducted independently by three reviewers (MK, HJ, and CDL). The primary outcome measures evaluated were changes in clinical attachment level, probing depth, and bleeding on probing.

Results: The search resulted in 25 abstracts; four randomized controlled clinical trials were included. Four different laser methods were used; consequently, it was impossible to conduct a quantitative data synthesis leading to a meta-analysis. All studies included a limited number of subjects.

Conclusions: No consistent evidence supports the efficacy of laser treatment as an adjunct to non-surgical periodontal treatment in adults with chronic periodontitis. More randomized controlled clinical trials are needed. *J Periodontol 2008;79: 2021-2028.*

KEY WORDS

Laser therapy; periodontal diseases/therapy; systematic review.

* Department of Periodontology, Center for Oral Health Sciences, Malmö University, Malmö, Sweden.

Chronic periodontitis is initiated by microbial plaque, which accumulates on the tooth surface at the gingival margin and induces an inflammatory reaction. The inflammatory response in patients with chronic periodontitis results in destruction of the periodontal tissues.[1] With a constant bacterial challenge, the periodontal tissues are continuously exposed to specific bacterial components that have the ability to alter many local cell functions.[2] The function of the inflammatory process is to protect the host and limit the effect of the biofilm. Some tissue destruction occurs as part of this process. The extent and severity of damage vary among individuals and over time, and may involve attachment loss. This variation in disease expression is the result of the interaction of host genetics and environmental and microbial factors.[3]

The pathogenesis and severity of periodontal disease differ among individuals,[4] which means that some individuals or subgroups of the population are at higher risk for developing periodontal disease. Several studies[5-9] showed that 35% of an adult population in different Western countries will develop periodontal disease, and 10% to 15% will develop severe periodontitis.

The primary goal of periodontal therapy is to arrest the inflammatory disease

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process. Non-surgical and surgical therapies have been performed to reduce the microorganisms.[10-15] Different local or systemic antibiotic regimens have been advocated in the treatment of periodontitis, but in most cases they have limited effects.[16-18] The increasing risk for developing antibiotic resistance should also be emphasized. For this reason, laser therapy, used as an adjunct to or as conventional therapy, has been proposed as a novel treatment option in controlling the subgingival microorganisms. Variables, including clinical attachment level (CAL) and probing depth (PD) measurements and the presence of bleeding on probing (BOP), are commonly used to assess and monitor the periodontal status.

The aim of this systematic review was to evaluate the effect of laser therapy as an adjunct to non-surgical periodontal treatment in terms of changes in CAL (ΔCAL), PD (ΔPD), and BOP (ΔBOP) in subjects with chronic periodontitis.

MATERIALS AND METHODS

The systematic approach of the literature review was adapted according to Goodman[19] and consisted of the following steps: specify the problem, formulate a plan to conduct the literature search with specified indexing terms, retrieve publications, and interpret the evidence from the literature retrieved.

Specification of the Problem

The following question was developed to specify the problem: In subjects with chronic periodontitis, does periodontal therapy with subgingival laser as an adjunct to scaling and root planing (SRP) improve the treatment results compared to treatment with SRP alone?

Outcome Variables

The primary outcome variables assessed were ΔCAL, ΔPD, and ΔBOP. Adverse reactions to treatment was another outcome variable of interest.

Formulation of a Plan, Literature Search, and Retrieval

To be included in this review, publications were sought that analyzed the outcome of periodontal therapy with laser as an adjunct to SRP compared to SRP alone in subjects with chronic periodontitis.

The search was limited to publications with an abstract and with an Entrez date in the period from January 1, 1966 to February 29, 2008. Further limits were that subjects had to be >19 years old; publications were indexed as "humans," "randomized controlled trial," and "English"; and studies had follow-up periods >12 weeks.

The first step of the search was to use Medical Subject Headings (MeSH) terms to search the electronic databases PubMed and the Cochrane Central Register of Controlled Trials. The following elements were defined on the basis of MeSH prior to the formal literature search:

Periodontal diseases: includes alveolar bone loss, furcation defects, gingival diseases, periodontal attachment loss, periodontal cyst, periodontitis, tooth loss, tooth migration, tooth mobility. Year introduced: 1965.

Dental scaling: removal of dental plaque and dental calculus from the surface of a tooth, from the surface of a tooth apical to the gingival margin accumulated in periodontal pockets, or from the surface coronal to the gingival margin. Year when change in definition was made (year introduced): 1991 (1972).

Laser therapy: the use of photothermal effects of Light Amplification by Stimulated Emission of Radiation (LASER) to coagulate, incise, vaporize, resect, dissect, or resurface tissue. Year introduced: 2008.

Lasers: An optical source that emits photons in a coherent beam. LASER is brought about using devices that transform light of varying frequencies into a single intense, nearly non-divergent beam of monochromatic radiation. Lasers operate in the infrared, visible, ultraviolet, or x-ray regions of the spectrum. Year when change in definition was made (year introduced): 1965 (1963).

The decision to include the article was made by reading the title and the abstract. All authors independently screened titles and abstracts of the search results for possible inclusion. When an abstract was considered by at least one author to be relevant, the full text of all studies of possible relevance was obtained for independent assessment against the stated inclusion criteria. Any disagreement was resolved by discussion among the reviewers.

The methodologic quality assessment and data extraction of the included studies were independently conducted by the authors with the aid of a protocol[20] (Fig. 1). Again, any disagreement was resolved by discussion among the three reviewers.

The second step was to hand-search the reference lists of the original studies that were found to be relevant in the first step (Fig. 2). Titles containing words suggesting treatment of chronic periodontitis with laser as an adjunct to SRP were sought.

RESULTS

Characteristics of the Publications

The search resulted in the identification of 25 publications. Independent initial screening of the titles and abstract resulted in the further consideration of 21 publications. Eight publications were excluded for the following reasons: not evaluating patients with chronic periodontitis,[21-24] evaluating surgical periodontal treatment,[25-27] and no evaluation of clinical variables.[28]

The remaining publications were obtained and analyzed in full text. Thirteen additional publications were excluded for the following reasons: not evaluating patients with chronic periodontis,[29] not evaluating

Author:……Title ……. Journal……Year……Volume …….. Page……	
Question	**Comments**
I. Are the results reliable?	
1. Was the assignment of patients to treatment randomized?	□ Yes □ No
2. Was there a control group?	□ Yes □ No
3. What was the sample size?	Total: Women: Men:
4. Were the groups similar at the start of the trial?	□ Yes □ No
5. Were patients analyzed in the groups to which they were randomized?	□ Yes □ No
6. Were patients and researchers masked to treatment?	□ Yes □ No
7. Aside from the experimental intervention, were the groups treated equally?	□ Yes □ No
II. What results did the study show?	
1. What was the patient diagnosis, and which examination was it based on?	□ Chronic periodontitis □ Other □ Clinical examination □ Radiographic □ Clinical + radiographic
2. Which type of laser was used?	
3. Was the number of teeth reported?	□ Yes □ No
4. Results ΔCAL = …… ΔBOP = …… ΔPD = …… Microbial sampling (Y/N)…….	
5. How were the results of the treatment analyzed?	
III. Do the results lead to better treatment for my patients?	
1. Can the results be applied to my patients?	□ Yes □ No
IV. Will the study be included in the systematic review?	□ Yes □ No; why?

Figure 1.
The protocol used for quality assessment and data extraction of included studies. Y/N = yes/no.

laser as an adjunct to SRP,[30-38] no evaluation of clinical variables,[39,40] and follow-up <12 weeks.[41] Four publications were selected for inclusion (Fig. 2).

The manual search and screening of the reference list of included publications did not result in additional articles. Thus, four publications were included in the present systematic review.

Preliminary evaluation of the selected publications revealed considerable homogeneity with regard to the inclusion criteria; however, the lasers used in the included studies were different. Consequently, it was impossible to conduct a quantitative data synthesis leading to a meta-analysis. Therefore, the data are reported using descriptive methods. The characteristics of the four publications are summarized in Table 1.

The four publications were grouped according to direct or indirect action of the laser source.

Direct Action, Conventional Laser

Different kinds of lasers have been used in the treatment of periodontitis.[42-44]

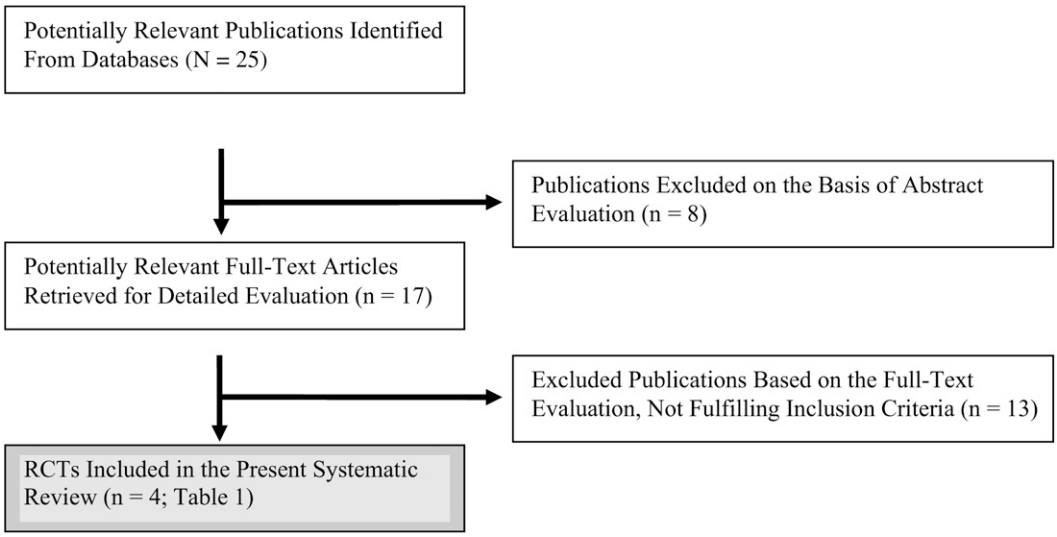

Figure 2.
Flow chart and selection process of the included publications. RCTs = randomized control trials.

Table 1.

Details From Included Publications

	Andersen et al., 2007[47]	Kelbauskiene and Maciulskiene, 2007[42]	Ambrosini et al., 2005[43]	Neill and Mellonig, 1997[44]
Methods	RCT 3 treatment groups 12-week duration	RCT Split-mouth 12-week duration	RCT Split-mouth 12-week duration	RCT Split-mouth 24-week duration
Participants	33 individuals; all completed the study 22 females and 11 males Age: 18 to 75 years; mean age: 53 years	10 individuals; all completed the study Gender not reported Age: 30 to 60 years; mean age not reported	30 individuals; 5 dropouts, 17 females, and 13 males Age: 20 to 65 years; mean age: 42 years	10 individuals; all completed the study 7 females and 3 males Age: 33 to 53 years; mean age: 44 years
Periodontal diagnosis	Chronic periodontitis	Early to moderate periodontitis	Chronic periodontitis	Chronic periodontitis
Interventions	Initial therapy: none Group 1: photodisinfection Group 2: SRP Group 3: SRP + photodisinfection Evaluation intervals: 3, 6, and 12 weeks	Initial therapy: none Control: SRP Test: SRP + Er;Cr:YSGG laser	Initial therapy: none Control: SRP Test: SRP + Nd:YAP laser Evaluation intervals: 6 and 12 weeks	Initial therapy: none Group 1: SRP Group 2: SRP + Nd:YAG laser Group 3: plaque-control Evaluation intervals: 4, 12, and 24 weeks
Outcomes	Analyses: subject level ΔBOP: NS ΔPD: SRP: 0.74 ± 0.43 mm versus SRP + photodisinfection: 1.11 ± 0.53 mm; P <0.05 ΔCAL: SRP: 0.36 ± 0.35 mm versus SRP + photodisinfection: 0.86 ± 0.61 mm; P <0.02	Analyses: tooth level ΔPI: NS ΔBOP: NS ΔPD: lingual sites (SRP: 0.94 ± 0.12 mm versus SRP + laser: 1.96 ± 0.11 mm; P <0.001); vestibular sites (SRP: 0.99 ± 0.14 mm versus SRP + laser: 2.03 ± 0.11 mm; P <0.001)	Analyses: site level ΔPI: NS ΔBOP: NS ΔGI: NS ΔPD: NS ΔCAL: NS	Analyses: tooth and site level ΔGI: P <0.001 ΔGBI: NS ΔPD: NS ΔCAL: P <0.024 Patient- and clinician-administered surveys
Smoking	Not reported	Not reported	5 individuals were smokers	Not reported
Complications	No treatment-related adverse event was reported during the study	No treatment-related adverse event was reported during the study	Not reported	Not reported
Sample size	No power calculation described	No power calculation described	No power calculation described	No power calculation described
Randomization	Yes	Yes	Yes	Yes
Masking	No	No	Unclear	Unclear
Investigators' conclusion	SRP + photodisinfection resulted in significant improvements of the investigated variables over the use of SRP alone.	Test and control led to significant short-term improvements in all clinical parameters investigated. The combined treatment using laser as an adjunct to SRP seemed to be advantageous compared to SRP alone.	No statistically significant differences between test and control. No statistically significant difference in reduction of quantity of bacteria between test and control.	Findings suggest a longer-lasting effect for the laser therapy in altering subgingival microflora. There are several additional areas where the adjunctive use of the Nd:YAG laser may be an advantage over SRP alone. These include the analgesic effect of the Nd:YAG laser, the hemostatic effect, and the antibacterial potential of laser energy.
Conclusion	Adjunctive effect	Some adjunctive effect?	No adjunctive effect	Some adjunctive effect?

NS = not statistically significant; RCT = randomized controlled trial.

Ten individuals with early to moderate periodontitis were enrolled in a prospective, randomized, control study of split-mouth design.[42] All subjects received SRP; thereafter, two quadrants were supplemented with erbium, chromium-doped:yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) laser therapy used as an adjunct to SRP. Plaque index (PI),[45] BOP, and PD were assessed at baseline and 3 months after therapy. Three months after therapy, neither PI nor BOP revealed any statistically significant differences between the test and control. However, there were statistically significant differences between test and control in PD reduction at lingual (SRP: 0.94 ± 0.12 mm versus SRP + laser: 1.96 ± 0.11 mm; P <0.001) and vestibular sites (SRP: 0.99 ± 0.14 mm versus SRP + laser: 2.03 ± 0.11 mm; P<0.001). No power calculation for the sample size was reported in this study; however, the randomization process was described in detail. No treatment-related adverse event was reported during the study.

Another study[43] of split-mouth design compared the results of neodymium-doped:yttrium, aluminum, and perovskite (Nd:YAP) laser therapy used as an adjunct to SRP (test) to SRP alone (control). Thirty patients with chronic periodontitis were enrolled; five persons did not complete treatment or did not return for evaluation after 3 months. PI, gingival index (GI),[45] BOP, PD, and CAL were assessed at baseline and 3 months postoperatively. There was no statistically significant difference in clinical data between test and control groups 3 months after treatment. No power calculation for the sample size was reported in this study; however, the randomization process was described in detail. No treatment-related adverse event was reported during the study.

The efficacy of a low-powered pulsed neodymium-doped:yttrium, aluminum, and garnet (Nd:YAG) laser used as an adjunct to SRP was evaluated over a 24-week period.[44] Ten patients with moderate to advanced chronic periodontitis, defined as PD >4 mm with radiographic bone loss, were enrolled; none withdrew. In all patients, each quadrant was randomly assigned to one of the following three experimental groups: SRP alone, SRP and Nd:YAG laser therapy, and plaque control only. Patients with four affected quadrants received laser treatment in the remaining quadrant. Clinical variables, such as GI, gingival bleeding index (GBI),[46] PD, and CAL, were assessed 1, 3, and 6 months following therapy. At each follow-up visit, the patients were questioned regarding their compliance with the prescribed regimen and the incidence of adverse effects. The control group, who only received plaque control, received appropriate treatment after the 6-month follow-up. At the 6-month follow-up, statistically significant improvements were shown for GI (P<0.001) and CAL (P<0.024) in the laser-treated group compared to controls. Significant differences in the efficacy of bacterial reduction were also reported for the groups treated with SRP alone and SRP and laser over controls.

Indirect Photo Sensitizer and Laser

The clinical effect of a photodisinfection treatment was evaluated over a 12-week period in 33 subjects with chronic periodontitis.[47] All subjects were randomly treated in one of three study groups with photodisinfection alone (group 1) using a diode laser and photosensitizer combination, SRP alone (group 2), or SRP and photodisinfection combined (group 3). Clinical variables, such as BOP, PD, and CAL, were assessed 3, 6, and 12 weeks following therapy. BOP results revealed a significant improvement in all treatment groups, but there was no statistically significant difference among the groups. At the 12-week follow-up, statistically significant improvements were reported for ΔPD (group 2: 0.74 ± 0.43 mm versus group 3: 1.11 ± 0.53 mm; P <0.05) and ΔCAL (group 2: 0.36 ± 0.35 mm versus group 3: 0.86 ± 0.61 mm; P <0.02). Plaque-control levels during the active periodontal therapy and follow-up were not reported. No power calculation for the sample size was reported, and the randomization process was described in the following way: "The first five subjects were placed in the photodisinfection only group (group 1). The subsequent 28 subjects were provided with SRP followed by opening a randomized envelope describing if the patient would get the test treatment or only receive the control treatment. Neither the patients nor the clinician were blinded."

Methodologic Quality of Included Studies

Allocation concealment. Two studies[44,47] stated that allocation procedures were implemented but did not provide details on how it was accomplished. Two studies[42,43] described the method of randomization, which was performed with the aid of numbered envelopes.

Masking of assessors. In one study,[42] treatment and measurements were performed by the same person. The final examination was performed without knowing which treatment had been applied. One study[43] was single-masked, and one study[44] was double-masked. In one study,[47] the treatment was not masked to outcome assessors. Withdrawals occurred in one study,[43] but no reasons for withdrawal were given. No trial reported on power calculation with regard to sample size.

DISCUSSION

The key finding of this systematic review is that there are a limited number of studies evaluating the clinical effect of laser therapy as an adjunct to SRP, which would recommend this approach over conventional

non-surgical periodontal therapy. These findings are in accordance with the study by Cobb.[48]

In the present systematic review, findings from one study[47] seemed to be better compared to SRP alone. The results of SRP are somewhat similar to those reported by Badersten et al.[12] and Nordland et al.[49] In the study by Badersten et al.,[12] SRP resulted in increased reduction in PD and CAL gain in relation to initial PD; however, they only investigated the effect of SRP on non-molar, single-rooted teeth. The study by Andersen et al.[47] only reported mean PD reduction and mean CAL change. It would have been of interest if the results had been analyzed with respect to initial PD and characteristics of the sites, i.e., non-molar, molar flat surfaces, and molar with furcation. The healing response for molar furcation sites is impaired compared to that of non-molar sites and molar flat surfaces.[49]

In the other group of studies,[42-44] laser therapy seemed to have been limited to no adjunctive effect. No statistically significant difference was observed in the study by Ambrosini et al.[43] One factor that could have influenced the outcome is that all patients received a prescription of 0.2% chlorhexidine mouthrinse to use during the initial healing phase. According to Löe and Schiott,[50] one can expect that this will influence PI and GI, as well as BOP scores indirectly.

In the study by Kelbauskiene and Maciulskiene,[42] a statistically significant difference between test and control was identified with regard to PD reduction at analyzed sites (vestibular and lingual sites). No clinical variables were reported for proximal sites. In the study by Badersten et al.,[51] the presence of proximal root concavities or furcation involvement in non-molar teeth was associated with a higher frequency of probing attachment loss. The healing response in proximal sites is not as easily achieved as at buccal and lingual sites because these surfaces are easier to clean and more accessible to subgingival instrumentation.

Statistically significant differences in GI and CAL gain were reported for the laser-treated sites compared to controls at 6 months in the study by Neill and Mellonig.[44] The investigators reported that the gains in attachment level for laser-treated sites remained stable throughout the 6 months, whereas sites treated with SRP alone demonstrated a decrease in attachment level, and control sites returned to baseline attachment level. Laser therapy seemed to have an impact on the microflora, which, compared to the use of antibiotics, has no known side effects. The minimal risk for bacterial resistance is a major advantage.

Only one study[43] mentioned the proportion of subjects who were smokers, which might influence the treatment outcome. The other studies[42,44,47] might have been conducted in non-smoking individuals. Subgroup analyses of smokers and non-smokers would have been of interest.

In general, the majority of studies, both included and excluded, had problems with statistical power because of limited sample sizes. Sixty subjects are needed in each group in a full-size study with a high chance of finding significant differences between SRP and laser therapy as an adjunct to SRP. This calculation is based on the detection of a difference of 0.5 mm in the mean PD reduction between the test and control groups, assuming that the common standard deviation is 0.6 mm, with an α error defined as 0.05 and a power level of 90%.

Furthermore, all included studies[42-44,47] had problems to describe the study population, disease severity, and with the case definitions, which clinical and radiographic variables have been used when diagnosing chronic periodontitis? The available data are too fragmented to allow the performance of a meta-analysis. None of the included studies reported to what extent the experimental sites included lesions with furcation involvement. Furcation lesions are known to respond differently to treatment than flat surface lesions[49] and should be analyzed separately. The duration of the included studies ranged from 12 to 24 weeks. A longer follow-up would have been preferred, but three studies[42,44,47] showed that the greatest clinical improvements were achieved within 3 months after SRP. However, the lasting effect of the adjunctive treatment is unknown. Additional research is needed to evaluate the long-term effects of laser therapy as an adjunct to SRP.

CONCLUSIONS

This systematic review showed that a limited number of studies have evaluated the clinical effect of laser as an adjunct to SRP. Results from new methods, such as laser as an adjunct to SRP or laser replacing SRP as the first treatment option in chronic periodontitis, should be interpreted with caution until there are several independent randomized controlled trials with sufficient statistical power.

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Correspondence: Dr. Henrik Jansson, Department of Periodontology, Center for Oral Health Sciences, Malmö University, SE-205 06 Malmö, Sweden. Fax: 46-40-6658405; e-mail: henrik.jansson@mah.se.

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