

American Academy of Periodontology Best Evidence Consensus Statement on the Efficacy of Laser Therapy Used Alone or as an Adjunct to Non-Surgical and Surgical Treatment of Periodontitis and Peri-Implant Diseases

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American Academy of Periodontology Best Evidence Consensus Statement on the Efficacy of Laser Therapy Used Alone or as an Adjunct to Non-Surgical and Surgical Treatment of Periodontitis and Peri-Implant Diseases

The American Academy of Periodontology (AAP) recently embarked on a Best Evidence Consensus (BEC) model of scientific inquiry to address questions of clinical importance in the treatment of periodontal and peri-implant diseases. For each focused question addressed below, there is a critical mass of evidence. However, standing alone, that evidence is, in the judgment of the Expert Panel convened by the AAP, insufficient to support broad conclusions and/or clinical practice guidelines.

The members of the expert panel have extensive knowledge of laser therapy and experience in applying lasers to a broad range of clinical scenarios relevant to the management of periodontitis and peri-implant diseases. The Panel performed systematic reviews on the subject, debated the merits of published data and experiential information, developed a consensus report, and provided “clinical bottom lines” based on the best evidence available.

The Panel recognizes the limitations imposed on assessing the potential clinical applications of laser-assisted therapy in the treatment of periodontitis and peri-implant diseases. The challenge in analyzing current evidence in these two clinical areas stems from several factors, including the diversity of lasers, the variety of energy settings employed, and the differing modes of delivery, which together give many combinations of factors that may result in different clinical outcomes for patients. The Expert Panel looks forward to future clinical studies that will provide unequivocal answers to the role that the differing lasers can play in treating both periodontitis and peri-implant diseases.

Summary of Focused Clinical Question 1:

In patients with moderate to severe periodontitis, do lasers used alone or as an adjunct to conventional forms of periodontal therapy provide better clinical outcomes than scaling and root planing alone?

Evidence Search Strategy

A literature search of randomized controlled clinical trials (RCT) that evaluated scaling and root planing versus laser therapy alone or laser therapy plus scaling and root planing with or without surgical access in the treatment of patients with moderate to severe periodontitis was conducted using the MEDLINE, EMBASE, and CENTRAL databases. A total of 475 articles published through March 2016 were identified. Of these, 28 met the selection criteria for review. These criteria required human clinical trials of ≥ 3 months duration with at least 10 adult subjects presenting with mean probing depths of ≥ 5 mm (See Chambrone et al. 2018¹ for detailed information on the literature review and results.)

Evidence-Based Conclusions

Current evidence suggests that, as an adjunct to conventional periodontal therapy, appropriate laser therapy may provide a modest additional benefit (< 1 mm) in clinical improvements in probing depth and clinical attachment level compared to traditional forms of periodontal therapy in the treatment of moderate to severe chronic and aggressive forms of periodontitis. Although not conclusive, some evidence suggests that adjunctive use of Er:YAG or Nd:YAG lasers was superior to conventional periodontal therapy alone in deep periodontal pockets of 7 mm or greater probing depths.

At the same time, current evidence is inadequate to conclude that laser therapy alone is either superior or comparable to conventional periodontal therapy in terms of clinical improvement in probing depth and clinical attachment level in the treatment of moderate to severe chronic and aggressive forms of periodontitis.

For residual probing depths of at least 5 mm following conventional active periodontitis therapy and regular periodontal maintenance care for at least one year, current evidence is inadequate to conclude that laser therapy as an adjunct or alone provides any

additional improvement in probing depth or clinical attachment level compared to conventional periodontal therapy.¹

Summary of Focused Clinical Question 2:

In patients with peri-implant mucositis or peri-implantitis, do lasers used alone or as an adjunct to conventional forms of therapy provide better clinical outcomes than scaling and root planing alone?

Evidence Search Strategy

A literature search of prospective and retrospective human case series, controlled clinical trials or randomized controlled clinical trials was conducted using three electronic databases and a hand search of peer-reviewed journals for relevant articles published in English between January 1980 and June 2016. Human clinical trials of ≥ 10 patients with peri-implant diseases, treated with surgical/non-surgical approaches and laser therapy, and with a follow-up period of ≥ 6 months, were included. The search yielded 237 articles for evaluation, and a total of 22 articles were selected, 13 with lasers used as an adjunct to non-surgical intervention and 9 with lasers used with surgery. Among the selected 22 studies, only 3 included patients with peri-implant mucositis; the other 19 included patients with peri-implantitis. The outcomes of using lasers as the sole method of therapy could not be evaluated since no controlled studies were identified. Therefore, all results represented outcomes of applying lasers as an adjunct to surgical/non-surgical treatment. (See systematic review² for detailed information on the literature review and results.)

Evidence-Based Conclusions

Data on adjunctive laser treatment for peri-implant mucositis are scarce. No substantial current evidence conclusively supports their use in the treatment of peri-implant mucositis. Some evidence suggests clinical benefits with adjunctive laser use in the non-surgical treatment of peri-implantitis in the short term. However, no substantial evidence suggests long-term benefits. Such evidence includes successfully reaching certain definitive endpoints of care such as bleeding on probing reduction while failing to alter others such as pocket depth reductions, gain in attachment or radiographic improvement. Limited evidence presented benefits that could be arguable (i.e., potential bacteria reduction) for adjunctive laser use with surgical treatment of peri-implantitis. However, no long-term benefits of adjunctive laser therapy for peri-implantitis have been reported, and long-term benefits must be interpreted with caution due to the critical role of maintenance care on long-term treatment outcomes for peri-implantitis.

Summary of Focused Clinical Question 3:

In patients with moderate to severe periodontitis or peri-implantitis, does antimicrobial photodynamic therapy (aPDT) as an adjunct to conventional forms of therapy provide better clinical outcomes than scaling and root planing alone?

Evidence Search Strategy

MEDLINE, EMBASE and CENTRAL databases were searched for articles published up to and including March 2017 that presented original data from randomized clinical trials (RCTs) with a follow-up duration ≥ 3 months that evaluated scaling and root planing or implant surface scaling versus scaling and root planing or implant surface scaling plus aPDT for the treatment of adult patients (≥ 18 years old) with moderate to severe chronic/aggressive periodontitis or peri-implantitis, respectively, were considered eligible for inclusion.⁴

A total of 730 articles published through March 2017 were identified and 28 were selected for review based on their meeting the selection criteria. (See systematic review⁴ for detailed information on the literature review and results.)

Evidence-Based Conclusions

Antimicrobial photodynamic therapy (aPDT) is laser treatment used in conjunction with a photosensitizer intended to reduce periodontal pathogenic bacteria. Current evidence supports that appropriate antimicrobial photodynamic therapy as an adjunct to conventional therapy may provide modest (<1 mm) improvements in probing depths and clinical attachment levels when compared to conventional periodontal therapy for periodontitis. However, the difference in clinical outcomes suggested by the current evidence does not support clinical relevance for the combined therapy. More information is needed to provide a reliable estimate of the effect on clinical outcomes. Insufficient evidence was available to draw conclusions relative to the adjunctive effect of antimicrobial photodynamic therapy in treatment of peri-implantitis.

Expert Opinion of the Panel on Laser Therapy

The BEC panel on laser therapy acknowledges the difficulty in drawing specific conclusions from the data of the randomized controlled trials referenced in the systematic reviews that it considered. This difficulty is due to several factors. These include the heterogeneity among the studies, the potential for study bias, and the wide diversity in the types of lasers, energy settings, and modes of delivery utilized among the studies reviewed.

The panel further recognizes that there are several applications of laser therapy for which there is limited and/or controversial and/or contradictory evidence. As a result, the panel spent considerable time in discussion to arrive at a consensus on the current status of laser therapy as well as recommendations for future research and training. The following sections summarize the consensus of the expert opinion of the panel.

Potential Benefits of Laser Therapy in the Treatment of Periodontitis and Peri-Implant Diseases

- As an adjunct, appropriate laser-assisted therapy may provide modest additional benefit compared to traditional forms of periodontal therapy based on randomized controlled clinical trials (RCT's). However, anecdotal evidence such as case reports suggest that there may be instances that adjunctive laser use may provide results that are potentially clinically meaningful. Clinicians should be cautious in setting patient expectations for outcomes that have not yet been rigorously evaluated with standardized protocols in RCT's.
- Human histologic evidence is consistent with the potential for periodontal regeneration following laser-assisted therapy in patients with moderate to severe periodontitis.⁵⁻⁷ In the two clinical reports that used the Nd:YAG laser,^{5, 6} the protocol followed was specific with regards to steps and laser settings. In an earlier report⁷ the observation of periodontal regeneration involved use of a carbon dioxide laser and a clinical protocol that differed from other reports.^{5, 6}
- Antimicrobial photodynamic therapy (aPDT) may be promising in applications to improve clinical outcomes for periodontitis and may have potential benefits for the treatment of peri-implant diseases. Appropriate laser-assisted therapy plus aPDT may add value in the management of residual periodontal probing depths ≥ 5 mm following basic non-surgical therapy. However, properly controlled studies are needed before firm conclusions can be reached on several aPDT uses of potential clinical value.
- Clinical observations suggest that appropriate laser-assisted therapy may offer case management advantages for certain patients in that it could provide less patient bleeding, assist in disease site disinfection, may be useful as an alternative nonsurgical or palliative therapeutic approach for medically compromised patients or advanced age patients where conventional surgical therapy may pose a risk or be impractical. Appropriate laser-assisted therapy may be a useful alternative for some patients on anticoagulation therapies when either the patient is taking agents with no reversing agent or where the International Normalized Ratio (INR) cannot be adjusted to a level that does not pose a risk for significant bleeding. Further study is needed before firm conclusions on selection of laser-assisted therapy can be targeted to these specific patient groups.

Limitations of Laser Therapy in the Treatment of Periodontitis and Peri-Implant Diseases

- The evidence is limited and contradictory with respect to whether patient pain and discomfort are reduced with laser-assisted therapy in place of scaling and root planing.
- Human histological evidence suggests that regeneration is possible following the treatment of periodontitis. The extent and consistency by which repara-

tive/regenerative responses occur following laser-assisted therapy for moderate to severe periodontitis have yet to be established.

- The treatment of peri-implantitis requires removal and control of bacterial accumulations on implant surfaces, control of inflammation in the surrounding tissues, and may involve efforts to regenerate bone supporting the implant. Evidence is equivocal with regard to a regenerative endpoint being achieved in humans following laser use. Insufficient evidence is available to project what surface alterations to the dental implant might occur when using lasers according to a recommended and validated protocol and how this may impact the clinical outcomes.
- There is insufficient evidence to support laser use as a monotherapy in the maintenance of failing implants. Likewise, few controlled clinical trials are available to assess the clinical outcomes in peri-implantitis following conventional therapy.
- Long-term outcomes have not been well-established following laser therapy and regular maintenance care for the treatment of periodontal and peri-implant diseases. An assessment of long-term outcomes would not only attest to the immediate benefit of the care, but also to the creation of a suitable environment that can be maintained in health by the patient through professionally administered supportive periodontal and peri-implant care.

Potential Risks of Laser Therapy in the Treatment of Periodontitis and Peri-Implant Diseases

- No current evidence supports the use of lasers being extended to healthy sites in an effort to suppress potential reservoirs of bacteria. Expert opinion suggests that use of lasers on healthy sites could cause harm rather than benefit.
- If lasers are not used according to proper protocols, damage can occur to the teeth, dental implant and/or surrounding tissues. Overheating of the tooth or implant surface and/or body is likely to be impacted by the type of laser and protocol employed.

Future Research Recommendations for Laser Applications

- Various issues in laser research reduce the ability to determine optimal treatment outcomes. To produce more conclusive results, clinical protocols must be simplified and standardized and evaluated in controlled clinical trials.
- Current evidence suggests that antimicrobial photodynamic therapy (aPDT) may be promising in applications to improve clinical parameters for periodontitis. Research in this area should include development of photosensitizers, used with specific laser wavelengths, aimed at selectively targeting periodontal pathogenic microorganisms.

- Adequately sized randomized controlled clinical trials should compare laser therapy to conventional periodontal therapy, including minimally invasive and regenerative treatments for defect elimination/resolution, attachment level gain, and/or furcation closure.
- Considering laser physics and laser-tissue interactions, studies are needed to determine which factors are associated with success (e.g., phenotype, defect type, defect morphology, etc.) for different laser wavelengths and protocols.
- Studies are necessary to clarify the effects of laser treatment on specific therapeutic or biological endpoints, such as periodontal pathogenic bacterial suppression/elimination, regeneration, and/or bio-stimulation of the repair process.
- Studies should be conducted to determine whether laser therapy can reduce the need for systemic antibiotics and/or invasive interventions in medically compromised patients.
- Funding sources should be available to support high quality and unbiased clinical research on laser technology. Laser equipment and protocols should be available to researchers to allow unbiased and unrestricted research and publication.
- There should be greater emphasis on determining patient preference and patient-centered outcomes in prospective clinical trials comparing laser-assisted therapy to conventional periodontal or peri-implant therapies.
- Studies are also needed to assess and develop laser therapy approaches that provide the best cost-to-benefit ratio.
- All clinical trials evaluating the application of lasers in periodontal therapy should be reported to a clinical trials registry and results database (see World Health Organization, International Clinical Trial Registry Platform Search Portal). The Food and Drug Administration (FDA) requires registration of clinical trials (clinicaltrials.gov) that meet FDAAA 801 definition of an “applicable clinical trial.”
- Laser treatments should be compared to other methods of treatment for peri-implant mucositis.
- While a split mouth design would be optimal to provide controlled comparison of laser-assisted therapy and standard alternatives for peri-implantitis, it may not be possible to have such controls in all patients. Systematic reviews/meta-analyses should explicitly address controls and adjust the potential impact from individual studies to appropriately represent the strength of the evidence.
- Research is needed to determine the effect of laser energy and wavelength on implant surfaces and whether those effects turn out to be positive or negative.
- There is a need to evaluate the histologic patterns of healing (re-osseointegration, healing, scar formation) after laser treatment of implant surfaces.

Consensus Recommendations for Laser Training

- Prior to incorporating laser therapy into clinical practice, practitioners should be trained in diagnosis, prognosis, and treatment planning for periodontal and peri-implant diseases with an understanding of where and when laser-assisted therapy may be appropriate.
- Laser safety must be emphasized in all training programs. Reference sources should include appropriate laser safety standards from the American National Standards Institute (ANSI), such as ANSI Z136.3 – Safe Use of Lasers in Health Care.
- Ideally, adequate clinician training should be obtained through a formal program prior to use of lasers to treat patients. Standards for such training programs vary by state and should be established to provide clinician certification to assure safe clinical use of lasers in the management of periodontal and peri-implant diseases. Standards for training programs should be established that address the physics of lasers, including commercially available wavelengths, energy/power levels, and delivery modes.

Consensus Conclusions

- When laser treatment is used as an adjunct to mechanical treatment, current evidence suggests similar or slightly better clinical outcomes compared with laser treatment alone. Current evidence fails to demonstrate a beneficial long-term (>48 months) effect of laser treatment used as an adjunctive therapy to non-surgical treatment in providing a more maintainable environment.
- When using a laser as an adjunct to periodontal surgery, most current evidence suggests no additional benefit beyond that seen with surgery alone. However, when lasers are used to treat peri-implantitis surgically, most studies show a reduction in bleeding on probing; however, short-term data demonstrate inconsistency with regard to pocket depth reduction, clinical attachment level gains, and bone fill.
- Antimicrobial photodynamic therapy (aPDT) is laser treatment used in conjunction with a photosensitizer intended to reduce periodontal pathogenic bacteria. Current evidence supports that antimicrobial photodynamic therapy may provide improvements in probing depth and clinical attachment level when compared to conventional periodontal therapy for periodontitis and peri-implantitis patients. However, comparative differences in clinical outcomes are modest (<1 mm), and their clinical significance is open to question. More information is needed to provide a reliable estimate of the effect on clinical outcomes.

In 2015, the American Dental Association (ADA) generated a clinical practice guideline on non-surgical treatment of periodontitis that included evidence on scaling and root planing with adjunctive therapies, including lasers.^{2,3} Although evidence assessed as the basis for this Best Evidence Consensus (Chambrone 2018 ref) was essentially the same as considered by the ADA panel, there are differences in the criteria used by the two expert panels that may have contributed to differences in the conclusions of the two groups. Whereas the BEC recommendations were based on both clinical attachment loss (CAL) and probing depth outcomes in patients with moderate to severe periodontitis, the ADA panel used only CAL outcomes and considered laser use in patients with any severity of chronic periodontitis.

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REFERENCES

1. Chambrone L, Ramos U, Reynolds MA. Infrared Laser Wavelengths for the Treatment of Moderate to Severe Periodontitis: An AAP Best-Evidence Review. *Journal of periodontology* 2017.
2. Smiley CJ, Tracy SL, Abt E, et al. Systematic review and meta-analysis on the nonsurgical treatment of chronic periodontitis by means of scaling and root planing with or without adjuncts. *J Am Dent Assoc* 2015;146:508-524 e505.
3. Smiley CJ, Tracy SL, Abt E, et al. Evidence-based clinical practice guideline on the nonsurgical treatment of chronic periodontitis by means of scaling and root planing with or without adjuncts. *J Am Dent Assoc* 2015;146:525-535.
4. Chambrone L, Wang HL, Romanos G. Antimicrobial Photodynamic Therapy for the Treatment of Periodontitis and Peri-implantitis: An AAP Best-Evidence Review *Journal of periodontology* 2017.
5. Yukna RA, Carr RL, Evans GH. Histologic evaluation of an Nd:YAG laser-assisted new attachment procedure in humans. *The International journal of periodontics & restorative dentistry* 2007;27:577-587.
6. Nevins ML, Camelo M, Schupbach P, Kim SW, Kim DM, Nevins M. Human clinical and histologic evaluation of laser-assisted new attachment procedure. *The International journal of periodontics & restorative dentistry* 2012;32:497-507.
7. Israel M, Rossmann JA, Froum SJ. Use of the carbon dioxide laser in retarding epithelial migration: a pilot histological human study utilizing case reports. *Journal of periodontology* 1995;66:197-204.

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