



Nd:YAG Laser in Periodontal Therapy: Biological Effects, Clinical Outcomes, and Safety

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Abstract

Because neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers interact with hemoglobin and pigmented tissues to support hemostasis and pocket decontamination, they are used as adjuncts in periodontal care. This narrative review prioritizes patient-relevant benefits and risks over technical specifications while synthesizing evidence on biological effects, clinical outcomes, and safety. Although there is conflicting evidence regarding regeneration, controlled studies indicate that adjunctive Nd:YAG may offer slight additional reductions in probing depth and bleeding at deeper sites. Changes in inflammatory mediators and microbiologic shifts are examples of reported biologic signals. Protocol heterogeneity, brief follow-up, and sparse adverse-event reporting are major drawbacks. Thermal damage, improperly used root surface modification, ocular risks, and laser plume exposure are among the safety issues. It is necessary to conduct better trials with standardized results and clear harm reporting [1-3].

Keywords: Nd:YAG laser; periodontitis; non-surgical periodontal therapy; Laser-Assisted New Attachment Procedure (LANAP); safety; adverse effects.

I. Introduction

In susceptible individuals, periodontitis, a chronic biofilm-associated inflammatory disease, can contribute to a wider systemic inflammatory burden and cause progressive attachment loss. The cornerstone of care continues to be supportive periodontal therapy, risk-factor modification, and mechanical disruption of subgingival biofilm through scaling and root planing (SRP). However, some patients may experience persistent bleeding and residual deep pockets following conventional therapy, especially if the disease is advanced at baseline or if there are host-related risk factors. In order to enhance infection control, early wound stability, and patient-relevant outcomes, adjunctive approaches are regularly investigated in this context. Because of their interaction with pigmented tissues and hemoglobin, Nd:YAG (1064 nm) lasers have

been widely used in periodontal practice. This interaction can support hemostasis and pocket decontamination, but it also calls for careful consideration of safety and side effects [4-5].

With differences in indications (initial therapy versus residual pockets), co-interventions (instrumentation, surgical approaches, or laser-assisted attachment procedures), outcome definitions, follow-up duration, and harm reporting consistency, the Nd:YAG periodontal evidence base is clinically heterogeneous. We present a narrative review based on a transparent search strategy instead of a formal meta-analysis because these differences restrict direct pooling and because the aim of this manuscript is to integrate biologic plausibility, health effects, and risk considerations in a clinically readable manner. Our goal is to highlight limitations that should limit interpretation and direct future research while summarizing biologic effects, clinical outcomes, and safety signals that are most pertinent to patient care.

II. Materials and Methods

We performed focused searches in PubMed/MEDLINE and Scopus, augmented by Google Scholar and manual examination of important article reference lists, in order to find pertinent clinical studies and reviews on the application of Nd:YAG lasers in periodontology and peri-implantitis. The search terms "Nd:YAG," "periodontitis," "peri-implantitis," "laser adjunct," "LANAP," and "adverse effects" were combined to prioritize English-language human studies published after 2021 (with a few foundational papers for biologic context).

Isolated case reports and marketing materials were not included. We chose controlled clinical trials, systematic reviews, and mechanistic studies that reported biologic signals (inflammatory mediators, microbiome shifts) or clinical endpoints (probing depth, attachment level, bleeding on probing, patient-reported outcomes). By clinical application—non-surgical adjuncts, laser-assisted attachment techniques, and peri-implantitis management—data were extracted and narratively synthesized. Up until January 2026, searches were updated.



III. Biological Rationale and Reported Effects

In addition to causing coagulation and de-epithelialization in inflammatory pockets and lowering the microbial load in pigmented periodontal pathogens, Nd:YAG irradiation may also lessen bleeding and aid in the early stabilization of wounds [4,6]. Some studies report short-term changes in the structure of the subgingival community toward a more health-associated profile and changes in inflammatory mediators within gingival crevicular fluid following adjunctive laser use, in addition to direct effects on biofilm and inflamed soft tissue [7]. Although these biologic signals are believable, they do not always result in long-term attachment gain; the clinical impact is probably influenced by host risk factors, mechanical debridement quality, and baseline pocket depth.

IV. Clinical Applications and Outcomes

In clinical practice, Nd:YAG lasers are most often discussed as an adjunct rather than a replacement for mechanical debridement. Across heterogeneous clinical protocols, the most commonly reported endpoints include probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BOP), along with patient-reported discomfort and short-term inflammation control [5-8]. Overall, the recent evidence suggests that improvements are frequently driven by debridement itself, while the incremental benefit attributable to the laser is less consistent and may depend on case selection and outcome definitions [5-7]. Evidence syntheses of combined-laser protocols also highlight heterogeneity in methods and outcome reporting, which limits strong conclusions across settings [9].

As an adjunct to non-surgical periodontal therapy (NSPT), Nd:YAG has been studied in residual pockets after scaling and root planing (SRP).

In a double-blind split-mouth randomized controlled trial, Nd:YAG-assisted NSPT produced greater probing depth reduction than NSPT alone, but the difference appeared largely attributable to increased gingival recession rather than additional attachment gain [5]. This distinction matters clinically because ‘better numbers’ can reflect tissue position changes rather than a stronger biologic repair process [5,7].

In peri-implant disease, lasers have been used for decontamination in non-surgical and surgical settings, sometimes combined with other wavelengths. A systematic review focused on radiographic outcomes found that laser approaches may reduce inflammation-related clinical measures in some studies, but the evidence base remains limited by variability in designs and reporting [10]. In a randomized clinical trial of surgical peri-implantitis therapy using a combined Er:YAG and Nd:YAG approach, both groups improved, and the laser group showed a greater reduction in BOP-positive sites at six months; however, biomarkers linked to bone loss did not show a clear between-group difference [11].

From a biologic perspective, proposed benefits include short-term bacterial load reduction and modulation of inflamed epithelium, with downstream effects on early healing signals. Even so, contemporary overviews of systematic evidence repeatedly emphasize short follow-up, inconsistent protocols, and limited long-term outcomes—so claims about durable regeneration or a disease ‘reset’ should be avoided [4,6-7]. Accordingly, Nd:YAG is best framed as a potentially useful adjunct in selected scenarios, with expected benefits being modest and context-dependent [4,7]. No high-quality long-term RCTs focusing on hard-tissue regeneration endpoints are currently available, and the overall risk of bias across the available trials is at least moderate (Table 1).

Table 1. Nd:YAG applications and outcomes

Application	Comparator	Most consistent outcomes	Main risks
Adjunct to NSPT (residual deep pockets)	SRP alone / sham	Small additional PD/BOP improvements at deeper sites [6,12]	Thermal injury; plume/eye hazards [1,4]
LANAP-type procedures	Optimized NSPT	Clinical index improvements; incremental benefit uncertain [13,17]	Protocol variability; AE under-reported [12]
Combined laser approaches	NSPT without lasers	Signals of added PD/CAL benefits; evidence limited [6,12]	Heterogeneity; short follow-up [6,12]
Peri-implantitis adjuncts	Mechanical/chemical decon.	BOP improvements in some trials; radiographic effects unclear [10-11]	Heat/surface effects; training needed [4,15]



V. Advantages, Limitations, and Risks

Improved hemostasis, targeted soft-tissue decontamination in bleeding and pigmented sites, and the potential for short-term inflammatory modulation that could supplement traditional therapy in certain patients are some potential benefits [6,11-12]. Although patient-reported outcomes are not always measured, some patients also express great satisfaction with minimally invasive procedures [13]. Broader narrative discussions in the periodontal literature similarly caution that clinical benefits vary widely and depend on indication, study design, and maintenance intensity [8].

Significant protocol variability, brief follow-up in numerous trials, and the challenge of separating laser effects from the caliber of mechanical debridement and maintenance are some of the limitations. Systematic review summaries point to a variety of methodologic limitations, such as small sample sizes and heterogeneity, as well as

inconsistent outcomes across laser modalities [12]. Unless backed by solid histologic or verified radiographic endpoints, claims of regeneration should be interpreted with caution.

Risk management and safety are crucial. If energy delivery is not regulated, Nd:YAG can penetrate relatively deeply and is linked to the risk of unintentional deep heating, which could cause soft-tissue necrosis or delayed healing [4-5,14]. The necessity of clinician training and protocol discipline is further supported by older foundational studies that show that under certain irradiation conditions, root surface alteration and thermal effects are possible [15-16]. Controlled laser zones and protective eyewear tailored to a particular wavelength are standard requirements because lasers are known to cause ocular injury [4]. In order to minimize exposure to aerosols and particulate matter, laser plumes should be controlled with high-volume evacuation and suitable filtration [1,4] (Table 2).

Table 2. Biologic effects and safety considerations

Domain	Reported effect	Limitations / safety notes
Biofilm	Short-term reduction of pigmented pathogens [17]	Durability depends on maintenance; protocols vary
Inflammation	Lower BOP; mediator changes in some studies [6-7]	Does not prove regeneration; follow-up often short
Healing	Hemostasis and early stabilization [4-5]	Over-treatment may delay healing or cause necrosis [4-5]
Thermal/surface	Potential heat and surface alteration if misused [15-16]	Training, eye protection, plume control essential [1,4]

VI. Conclusion

In certain periodontal conditions, Nd:YAG lasers can produce clinically meaningful soft-tissue effects, especially hemostasis and adjunctive decontamination. According to available data, further clinical benefits over excellent conventional therapy are typically minor and might be more noticeable in deeper bleeding sites. Disciplined indication, training, and explicit harm mitigation are the most practical messages for clinicians, not parameter selection. To determine when Nd:YAG significantly enhances patient-centered periodontal outcomes, future studies should standardize results, incorporate longer follow-up, and openly report adverse events.

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