



Contribution of Laser in Periodontal Treatment: Systematic Review

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Abstract

Objectives: The aim of this systematic review is to evaluate, through scientific evidence, the contribution of laser treatment as an adjunct to periodontal therapy to short-term clinical outcomes, with follow-up periods of up to six months. **Materials and methods:** A systematic review of the literature was conducted, including all publications from January 2020 to September 2024 across three databases (PubMed, ScienceDirect, and Google Scholar). The articles that did not meet the inclusion criteria or that met any exclusion criteria were excluded. **Results:** Three studies showed a significant difference in periodontal pocket depth and clinical attachment loss (CAL) between the test group (treated with the diode laser) and the control group ($P < 0.005$). However, four studies showed that patients treated with a combination of initial periodontal treatment and photodynamic therapy had a reduction in bacterial recolonization of the periodontal pockets within the same group before periodontal treatment and at the end of treatment after the addition of the diode laser therapy. These studies did not prove any significant difference between the test and control groups. **Conclusions:** The evaluation of the contribution of the laser diode adjunction to periodontal treatment in this systematic review presented certain limitations. These limitations were related to the use of different therapeutic protocols, the parameters assessed after treatment differ between studies, and the short follow-up periods of patients after treatment. Therefore, the available evidence allows conclusions to be drawn only regarding short-term outcomes and does not permit assessment of long-term stability. Further studies with longer follow-up periods are needed to evaluate the durability of the observed treatment outcomes.

Subject Areas

Dentistry

Keywords

Chronic Periodontitis, Microbiology, Laser Therapy, Photochemotherapy, Periodontal Debridement

1. Introduction

For decades, periodontal disease has been a major challenge to oral health and quality of life [1]. Periodontitis is defined as the progressive destruction of dental supporting tissues. Its main feature is the loss of periodontal tissue support, manifested by clinical attachment loss, bone loss measured on radiography, periodontal pocket formation, and gingival bleeding [2].

The management of periodontitis is based on controlling the bacterial load through non-surgical and surgical treatments aimed at eliminating these pathogenic factors, restoring function, and regenerating or repairing the supporting tissues lost as a result of inflammation [2]. However, it is well known that debridement alone is generally incomplete due to limited access to certain areas of the periodontium [3].

In this situation, various complementary techniques have been recommended, such as laser radiation [4].

To reinforce the effects of conventional periodontal treatment, lasers have been used as an adjunctive therapy for their disinfection potential (photochemical effect) and anti-inflammatory effects [1]. Although some studies have reported the clinical efficacy of different types of lasers in periodontal treatment, controversy persists [4].

The aim of this systematic review is to evaluate, through scientific evidence, the contribution of laser treatment to periodontal therapy in stabilizing long-term outcomes.

2. Materials and Methods

The protocol of this systematic review was designed according to the Preferred Reporting Items for Systematic review and Meta-Analyses (PRISMA statement) [5]. An electronic literature search was conducted from the following databases: PubMed, Google Scholar and Science direct. The search focused on studies published from January 2020 to September 2024. The search strategy used Mesh keywords and search equations using “Boolean” operators «AND» and «OR». The keywords used and the corresponding search equations were as follows: Chronic periodontitis, microbiology, laser therapy, photochemotherapy, periodontal debridement, (“Chronic Periodontitis/microbiology” [Mesh]) AND “Lasers, Semiconductor/therapeutic use” [Mesh], OR (“Periodontal Debridement” [Mesh]) AND “Laser Therapy” [Mesh], OR (“Chronic Periodontitis/microbiology” [Mesh]) AND “Photochemotherapy/methods” [Mesh], OR (“Chronic Periodontitis” [Mesh]) AND “Laser Therapy” [Mesh].

The study selection process was based on predefined inclusion and exclusion criteria. Eligible studies included clinical studies evaluating adjunctive diode laser treatment in patients aged ≥ 18 years diagnosed with periodontitis, published in English or French, and providing sufficient information regarding the study design, sample size, treatment protocol, materials, equipment, and relevant clinical and/or microbiological outcomes. Randomized clinical trials and other eligible clinical studies were considered, whereas (single case reports/case series) were excluded. Studies involving animals, patients with systemic pathologies, incomplete data, book chapters, narrative reviews, systematic reviews, and meta-analyses were excluded.

Titles and abstracts were independently screened by two reviewers, followed by independent full-text assessment of potentially eligible studies. Data extraction was also performed independently by the two reviewers using a predefined data extraction form. The extracted variables included author, year of publication, participants' age, study design, sample size, type of periodontal treatment, type of laser used, laser parameters, duration of follow-up, and clinical and microbiological periodontal outcomes. No disagreements occurred between the two reviewers during the screening, eligibility assessment, or data extraction processes. The extracted data were organized in a summary table for qualitative synthesis. The unit of analysis was recorded for each study, and outcomes reported at the patient, tooth, or periodontal pocket level were extracted according to the methodology of the original study. Split-mouth studies were included when they met the predefined eligibility criteria, and within-patient comparisons between test and control sites were retained as reported by the original authors. Clinical parameters included periodontal probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BOP), while microbiological parameters included changes in the bacterial load of periodontal pathogens, particularly bacteria belonging to the red and orange complexes, such as *Aggregatibacter actinomycetemcomitans* (Aa), *Porphyromonas gingivalis* (Pg), and *Treponema denticola* (Td).

3. Results

The articles selection followed several steps which are presented in the flow diagram below, suggested by "the PRISMA Statement" [5] [Figure 1]. The electronic search in PubMed, Science direct, and Google scholar provided 1504 articles published between January 2020 and September 2024. After reading all the abstracts and eliminating duplicates, 41 articles were selected for full-text review. Following full-text assessment, 18 studies were selected that met the inclusion criteria for this Systematic Review, while 23 studies were excluded for the following reasons: single case report, animal studies involving rats, dogs or other animal models, and *in vitro* studies.

3.1. Study Characteristics

The search yielded 18 studies, of which 13 were randomized. All studies were

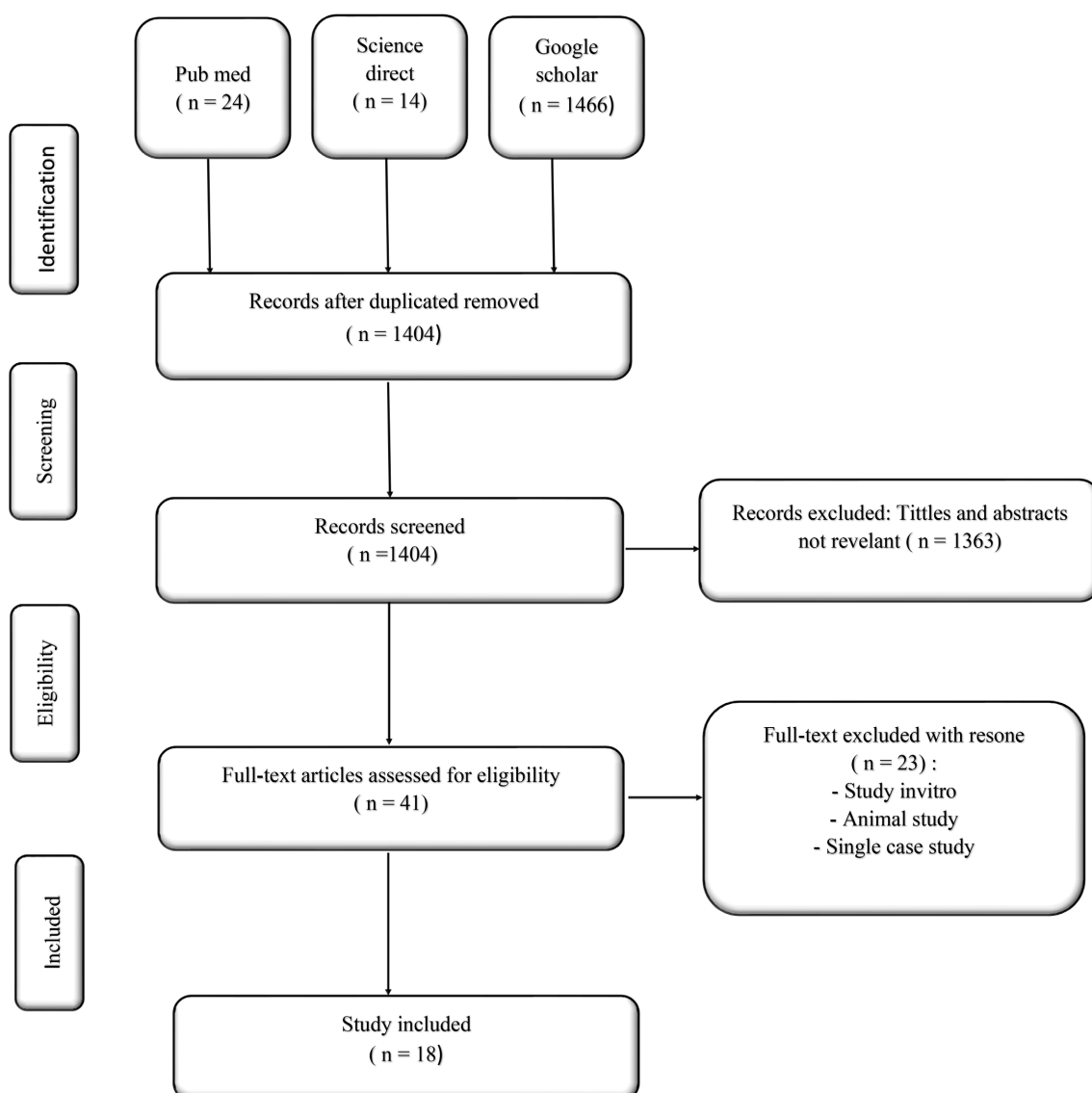


Figure 1. Prisma Flow diagram of article screening and selection process.

prospective except one, which was retrospective.

The included studies evaluated the effect of diode laser therapy following non-surgical periodontal treatment. This assessment was based on the improvements of clinical parameters in all the included studies, except for the study conducted by El Mobadder *et al.* in 2022, which focused on the evaluation of microbiological parameters only [6]. Only 5 studies obtained evaluated microbiological parameters associated with clinical parameters in periodontitis. 12 studies subdivided their study populations into 2 groups: a control group that received initial periodontal treatment only, and a test group receiving the diode laser therapy combined with initial periodontal treatment [Table 1]. On the other hand, 6 studies divided their study populations into 3 or 4 groups: a control group that received initial periodontal treatment only, a test group receiving the diode laser therapy combined with initial periodontal treatment, and another group evaluating the

combination of a biochemical adjuvant with laser diode therapy or the biochemical adjunct with initial treatment only [Table 1].

All included studies had short-term follow-up periods ranging from 2 weeks to 6 months.

3.2. Risk of Bias in Included Studies

The quality assessment showed that 11 studies were rated with low risk of bias [8] [10]-[12] [14] [16] [18]-[20] [22] [23]. The assessment of risk of bias is summarized in Table 2.

Table 1. Characteristics of the included studies.

Reference	Study design		Intervention			
	Type of study	Population	Age(y)	Follow-up	Before l'intervention	Intervention
C. Yang <i>et al.</i> 2022 [7]	Prospective	92 patients -GRP test1 -GRP test 2 -GRP control	47.3	3 months 6 months	Grp test1: SRP Grp test 2: SRP Grp control: SRP	Cross-section -Grp test1: minocycline hydrochloride -Grp test 2: PDT -Grp control
S. K. Anwar <i>et al.</i> 2024 [8]	Prospective	50 patients -Grp test -Grp control	17 - 35	6 months	-Grp test: SRP -Grp control: SRP	Cross-section -Grp test: PDT -Grp control: ATB
N. Derikvand <i>et al.</i> 2020 [9]	Prospective	50 patients -Grp test -Grp control	35 - 50	-1.5 months -3 months	-Grp test: SRP -Grp control: SRP	Cross section -Grp test: PDT + methylene blue -Grp control
J. W. Lu <i>et al.</i> 2023 [10]	Prospective	154 pockets -Grp test -Grp control	—	-3 months -6 months	-Grp test: SRP -Grp control: SRP	-Grp test: SRP + PDT -Grp control: SRP
F. H. Niazi <i>et al.</i> 2020 [11]	Prospective	73 patients -Grp test 1 -Grp control -Grp test 2	—	-3 months -6 months	-Grp test 1: SRP -Grp control: SRP - Grp test 2: SRP	-Grp test 1: Laser diode -Grp control: - Grp test 2: SP gel
S. Gottumukkala <i>et al.</i> 2024 [12]	Prospective	20 patients -Grp test1 -Grp test2	42.20	-3 months -6 months	-Grp test: SRP -Grp test: SRP	Cross-section -Grp test: PDT -Grp test: LANAP
A. El Sharaki <i>et al.</i> 2024 [13]	Prospective	60 patients -Grp control -Grp test	20 - 40	-3 months -6 months	-Grp control: SRP -Grp test: SRP	-Grp control: ATB -Grp test: laser
B. Poormoradi <i>et al.</i> 2024 [14]	Prospective	32 patients -Grp control -Grp test	38.24	-1 month -2 months	-Grp control: SRP -Grp test: SRP	Cross section -Grp control -Grp test: laser
T. Kamble <i>et al.</i> 2024 [15]	Prospective	33 patients -Grp control -Grp test 1 -Grp test 2		-3 months	-Grp control: SRP -Grp test1: SRP -Grp test2: SRP	-Grp control -Grp: PDT -Grp: doxycycline

Continued

A. Singh <i>et al.</i> 2024 [16]	Prospective	45 patients -Grp test 1 -Grp control -Grp test 2	-3 months -6 months	-Grp control: SRP+ OFD -Grp test 2: SRP+ OFD	-Grp test 1: PDT -Grp control -Grp test 2: PDT
M. Alghafri <i>et al.</i> 2024 [17]	Prospective	22 patients -Grp control -Grp test	-3 months -6 months	-Grp control: SRP -Grp test: SRP	-Grp: control -Grp: SRP + PDT
S. Elmeligy <i>et al.</i> 2024 [18]	Prospective	24 patients -Grp control -Grp test 1 -Grp test 2	40.12 -2 weeks -4 weeks -6 weeks	-Grp control: SRP -Grp test 1: SRP -Grp test 2: SRP	-Grp control -Grp test 1: PDT -Grp test 2: Erythritol air polishing
A. Sayed-Monir <i>et al.</i> 2023 [19]	Prospective	12 patients -Grp control -Grp test	20 - 56 2 months	-Grp control: SRP -Grp test: SRP	-Grp control -Grp test: laser
M. El Mobadder <i>et al.</i> 2023 [20]	Prospective	32 patients - Grp control -Grp test	43 3 months	-Grp control: SRP -Grp test: SRP	-Grp control -Grp test: PDT
M. El Mobadder <i>et al.</i> 2022 [21]		30 patients -Grp control -Grp test	-3 months -6 months	-Grp control: SRP -Grp test: SRP	-Grp control -Grp test: laser +NaCl
M. El Mobadder <i>et al.</i> 2022 [6]	Retrospective	120 patients -Grp control -Grp test 1 -Grp test 2 -Grp test 3	6 months	-Grp control: SRP -Grp test 1: SRP -Grp test 2: SRP -Grp test 3: SRP	-GRP control -Grp test 1: laser -Grp test 2: H ₂ O ₂ -Grp test 3: H ₂ O ₂ + laser
M. R Mokhtari <i>et al.</i> 2021 [22]	Prospective	36 patients -Grp control -Grp test	≥18 6 weeks 18 weeks	-Grp control: SRP -Grp test: SRP	Cross section -Grp control -Grp test: laser
S. M. Staden <i>et al.</i> 2020 [23]	Prospective	25 patients -Grp control -Grp test	45 ± 6 6 weeks	-Grp control: SPR -GRP test: SPR	Cross study -Grp control -Grp test: laser

Grp: group, y: year, SRP scaling root planning, PDT: photo-dynamic therapy, SP gel: Salvadora Persica gel, LANAP: laser assisted new attachment procedure, OFD: open flap debridement, ATB: antibiotics.

Table 2. Risk of bias assessment.

	Randomization	Allocation concealment	Examiner blinding	Completion of follow-up	Risk of bias
C. Yang <i>et al.</i> 2022 [7]	Yes	No	No	No (2 patients were lost)	High
S. K. Anwar <i>et al.</i> 2024 [8]	Yes	Yes	Yes	Yes	Low
N. Derikvand <i>et al.</i> 2020 [9]	No	No	Yes	Yes	High
J. Wei Lu <i>et al.</i> 2023 [10]	Yes	No	Yes	Yes	Low
F. H. Niazi <i>et al.</i> 2020 [11]	Yes	No	Yes	Yes	Low
S. Gottumukkala <i>et al.</i> 2024 [12]	Yes	Yes	Yes	No (2 patients were lost)	Low
A. El Sharaki <i>et al.</i> 2024 [13]	No	No	No	yes	High

Continued

B. Poormoradi <i>et al.</i> 2024 [14]	Yes	Yes	Yes	Yes	Low
T. Kamble <i>et al.</i> 2024 [15]	No	No	No	Yes	High
A. Singh <i>et al.</i> 2024 [16]	Yes	Yes	No	Yes	Low
M. Alghafri <i>et al.</i> 2024 [17]	Yes	Yes	No	No (2 patients were lost)	High
S. Elmeligy <i>et al.</i> 2024 [18]	Yes	Yes	Yes	Yes	Low
A. Sayed-Monir <i>et al.</i> 2023 [19]	Yes	No	Yes	Yes	Low
M. El Mobadder <i>et al.</i> 2023 [20]	Yes	Yes	No	Yes	Low
M. El Mobadder <i>et al.</i> 2022 [21]	No	No	No	Yes	High
M. El Mobadder <i>et al.</i> 2022 [6]	No	No	Yes	Yes	High
M. R Mokhtari <i>et al.</i> 2021 [22]	Yes	Yes	Yes	Yes	Low
S. M. Staden <i>et al.</i> 2020 [23]	Yes	Yes	Yes	Yes	Low

Regarding treatment outcomes, 5 included studies reported statistically significant improvements in one or more periodontal parameters following treatment with adjunctive diode laser therapy. However, these findings represent within-group changes and should be distinguished from between-group comparisons. In the majority of the included studies, no statistically significant difference was demonstrated between the diode laser groups and the control groups receiving conventional periodontal treatment alone [Table 3]. Overall, 13 studies did not demonstrate a statistically significant additional benefit of diode laser therapy compared with the respective control treatment [Table 3].

Among these studies, four compared diode laser therapy with or in combination with biochemical adjuncts used alongside periodontal treatment, including hydrogen peroxide (H₂O₂), erythritol, doxycycline, and *Salvadora persica* (SP) gel [Table 3]. These comparisons further reflected differences in treatment protocols and adjunctive interventions across the included studies.

Table 3. Treatment outcomes.

Comparison	Pocket depth		Clinical attachment loss		Bleeding on probing		Microbiological tests	
	Outcomes	P Value	Outcomes	P Value	Outcomes	P Value	Outcomes	P Value
C. Yang <i>et al.</i> 2022 [7] 6 months								
Grp test1	3.82 ± 0.95		6.46 ± 0.79					
Grp test 2: PDT	3.52 ± 0.97	0.042	5.99 ± 0.94	0.028				
Grp contrôle	4.79 ± 1.24		6.10 ± 0.94					
S. K. Anwar <i>et al.</i> 2024 [8] 3 months								
							Pg: 54.49 ± 93.63 (10 ³)	
Grp test	4.52 ± 1.96	0.082	4.84 ± 3.05	0.078			Aa: 2.05 ± 3.95 (10 ³)	Pg: 0.701
Grp control	3.88 ± 2.05		3.48 ± 3.04				Pg: 23.96 ± 39.15 (10 ³)	Aa: 0.181
							Aa: 4.08 ± 4.76 (10 ³)	

Continued

N. Derikvand *et al.* 2020 [9] 6 months

Grp test	2.64 ± 0.75	0.019
Grp control	3.20 ± 0.87	

J. Wei Lu *et al.* 2023 [10] 24 weeks

Grp test	3.06 ± 0.86	2.58 ± 0.94	15.49%
Grp control	4.46 ± 1.57	3.03 ± 1.25	64.29%

F. H. Niazi *et al.* 2020 [11] 6 months

GRP test 1: laser	4.02 ± 0.48	0.002	3.00 ± 0.94
GRP test 2: SP gel	4.93 ± 0.85		3.65 ± 1.07
GRP contrôle	5.00 ± 0.75		4.03 ± 0.77

S. Gottumukkala *et al.* 2024 [12] 6 months

GRP test 1: PDT	3.21 ± 0.46	0.641	2.03 ± 0.54	0.2
GRP test 2: LANAP	3.52 ± 0.50		3.22 ± 0.62	

A. El Sharaki 2024 [13] 6 months

GRP test: laser	3.1 ± 0.5	3.9 ± 0.7	24.8 ± 8.7
GRP controle: ATB	3.6 ± 0.6		30.5 ± 9.6

B. Poormoradi *et al.* 2024 [14] 8 weeks

GRP test: laser	1.92 ± 0.65	0.326	0.17 ± 0.07	0.552	0.06 ± 0.07
GRP controle	2.21 ± 0.82		0.26 ± 1.15		0.12 ± 0.13

T. Kamble *et al.* 2024 [15] 3 months

			4.5 ± 0.8		
GRP A: PDT	2.18 ± 0.405	0.49	0.64 ± 0.5	0.54	20 ± 6.11
GRP B: doxycycline	4.36 ± 0.50		2.18 ± 0.4		130 ± 82.14
GRP C: controle	5.27 ± 0.64		3.09 ± 0.3		193 ± 8.063

A. Singh *et al.* 2024 [16] 6 months

GRP A: PDT	3.33 ± 0.81	3.60 ± 0.73
GRP B: open flap	3.47 ± 0.51	
GRP C: PDT + open flap	3.20 ± 0.56	

M. Alghafri *et al.* 2024 [17] 6 months

GRP test: PDT	2.91 ± 0.56	0.26	3.53 ± 0.93	0.09
GRP controle	3.21 ± 0.92		2.95 ± 0.45	

S. Elmeligy *et al.* 2024 [18] 6 weeks

					Aa: 00 - 200 (min-max)
					Pg: 50 - 1000 (min-max)
GPR test 1: PDT	0.86 ± 0.38	0.004	0.83 ± 0.36	0.004	Aa: 00 - 300 (min-max) Aa: 0.816
GRP test 2: Erythritol	1.07 ± 0.37		1.05 ± 0.57		Pg: 5 - 1000 (min-max) Pg: 0.735
GRP controle	1.58 ± 0.35		1.68 ± 0.35		Aa: 00 - 100 (min-max)
					Pg: 14 - 150 (min-max)

A. Sayed-Monir *et al.* 2023 [19] 2 months

GRP controle	1.12 ± 0.38	0.06	0.88 ± 0.31	0.07	3.03 ± 2.49	0.06
GRP test: laser	1.21 ± 0.27		1.14 ± 0.21		5.16 ± 2.44	

Continued**M. El Mobadder 2023 [20] 3 months**

GRP controle	4.85 ± 0.42	5.99 ± 1.08
GRP test	3.79 ± 0.35	5.01 ± 0.81

M. El Mobadder 2022 [21] 6 months

GRP controle	5.28 ± 0.67	6.32 ± 1.07	20.70 ± 9.44	6.2 × 10 ⁹
GRP test: laser + NaCl	4.03 ± 0.49	5.76 ± 1.03	14.32 ± 9.07	5.6 × 10 ⁸

M. El Mobadder 2022 [6] 6 months

GRP controle	-	7.26 × 10 ⁷	0.0001
GRP test1: laser	-	4.01 × 10 ⁷	
GRP test2: H ₂ O ₂	-	4.32 × 10 ⁷	
GRP test3: laser + H ₂ O ₂	-	3.21 × 10 ⁷	

M. R Mokhtari *et al.* 2021 [22] 18 weeks

GRP contrôle	4.23 ± 0.84	0.2	4.42 ± 1.41	1.0	18.41 ± 12.11	0.02
GRP test: laser	3.94 ± 0.85		4.13 ± 1.42		12.11 ± 9.05	

S. M. Staden *et al.* 2020 [23] 6 weeks

GRP contrôle	0.4644	0.763	0.4648	0.586	41.64	0.005	Aa: 0.28 × 10 ⁵ Pg: 0.468 × 10 ⁵ Td: 0.4 × 10 ⁴	Aa: 0.733 Pg: 0.672 Td: 0.852
GRP test: laser	0.4984		0.5288		50.144		Aa: 0.29 × 10 ⁵ Pg: 0.440 × 10 ⁵ Td: 0.424 × 10 ⁵	

Grp: group, PDT: photo-dynamic therapy, SP gel: *Salvadora Persica* gel, LANAP: laser assisted new attachment procedure, ATB: antibiotics, Aa: *Aggregatibacter actinomycetemcomitans*, Pg: *Porphyromonas gingivalis*, Td: *Treponema denticola*, NaCl: Sodium chloride.

4. Discussion

Periodontal inflammation is initiated by the formation of a bacterial biofilm; therefore, the main aim of periodontal therapy is to eliminate these pathogens through non-surgical and surgical techniques [7] [8]. The addition of diode laser therapy to non-surgical treatment has been proposed as an adjunctive approach to target pathogenic bacteria. The laser transmits energy to the bacteria cells, causing denaturation of bacterial proteins [16]. The aim of this Review is to assess the contribution of laser therapy to periodontal treatment to clinical and microbiological outcomes:

4.1. Effect on Clinical Parameters:

In this review, three studies reported statistically significant differences between the test group, which received diode laser therapy as an adjunct to periodontal treatment, and the control group for probing pocket depth and clinical attach-

ment level (CAL) ($P < 0.005$) [11] [13] [18]. These findings suggest a potential additional short-term clinical benefit of diode laser therapy in the specific studies concerned. The observed effects have been attributed to the laser's broad antimicrobial spectrum, which targets both Gram-negative and Gram-positive bacteria (it's a non-specific destruction mechanism reducing the risk of developing bacterial resistance), as well as its ability to penetrate and disrupt the biofilm structure, potentially facilitating the elimination of residual bacteria.

However, the majority of the included studies did not demonstrate statistically significant differences between the test and control groups [7] [8] [9] [12] [14] [17] [19] [22] [23]. In several studies, improvements in periodontal parameters were observed within both treatment groups following therapy, without a statistically significant additional benefit attributable to diode laser therapy. The absence of significant between-group differences may be related to several factors, including the laser parameters applied, such as wavelength (940 nm), power (0.7 to 1 w), pulsed mode, and exposure time (10 to 15 seconds), which may not have been optimal, as well as the relatively small sample sizes, which may have limited the statistical power to detect differences between groups. In addition, the relatively short follow-up periods may not have been sufficient to assess the persistence of clinical effects.

4.2. Effect on Microbiological Parameters:

Among the studies investigating microbiological outcomes, four reported reductions in the recolonization of periodontal pockets by *A. actinomycetemcomitans* (Aa), *P. intermedia* (Pi), and *P. gingivalis* (Pg) following treatment combining initial periodontal therapy with photodynamic therapy [6] [8] [18] [23]. However, these studies did not demonstrate statistically significant differences in bacterial levels between the test and control groups. Rather, some studies reported statistically significant reductions in the levels of specific bacteria, particularly Aa and Pg, within the laser-treated groups when comparing bacterial levels before treatment with those measured after treatment. These within-group changes indicate an improvement following treatment but do not, in isolation, establish an additional effect of diode laser therapy compared with conventional periodontal treatment.

The lack of statistically significant between-group differences may be related to several study limitations, including relatively small sample sizes and the inclusion of predominantly patients with stage I and II periodontitis, which may limit the generalizability of the findings to more advanced forms of periodontal disease. Furthermore, the short follow-up periods may have limited the ability to detect sustained microbiological effects [18].

4.3. Comparison between the Effect of Diode Laser and the Effect of a Biochemical Adjuvant in Association with Periodontal Treatment

Two studies investigated the combination of laser therapy with biochemical

agents, including hydrogen peroxide (H_2O_2) and sodium hypochlorite ($NaOCl$), and reported reductions in bacterial load following the combined interventions [6] [21]. In the study involving H_2O_2 , hydroxyl radicals were proposed to exert antibacterial effects through oxidative damage to bacterial cells. Elmobader *et al.* reported a reduction in bacterial load following treatment; however, the interpretation of this finding should be based on the comparison between the test and control groups rather than on within-group changes alone [6].

Another study compared adjunctive photodynamic therapy with an SP gel (*Salvadora persica*). The photodynamic therapy group showed greater improvements in probing pocket depth reduction and clinical attachment loss compared with the SP gel group, whereas the SP gel group demonstrated a greater improvement in bleeding on probing index (BOP) [9]. The reduction in gingival bleeding observed with the SP gel may be related to its organic and inorganic constituents, including silica, calcium, sodium bicarbonate, vitamin C, and tannic acid [11].

The addition of doxycycline to periodontal treatment was also compared with adjunctive diode laser therapy in one study [15]. Although the diode laser groups showed improvements in some clinical and microbiological parameters, these findings should be interpreted according to whether the differences were statistically significant between groups or represented changes occurring within the laser-treated groups. Therefore, the available evidence does not consistently demonstrate a significant additional benefit of diode laser therapy over conventional periodontal treatment or systemic doxycycline.

5. Conclusion

The results of this review indicate that adjunctive laser therapy during periodontal treatment may provide short-term improvements in some clinical periodontal parameters compared with conventional periodontal treatment alone. The diode laser may contribute to periodontal pocket decontamination and reduction of gingival inflammation. However, these findings are based exclusively on follow-up periods of six months or less and therefore provide evidence only of short-term clinical outcomes. The long-term stability of the observed benefits cannot be determined from the available evidence. Further well-designed clinical trials with longer follow-up periods are needed to assess the persistence of these effects and to establish optimal treatment protocols for the adjunctive use of diode laser therapy in periodontal practice. Based on the short-term evidence currently available, the systematic use of diode laser therapy as an adjunct to non-surgical periodontal treatment cannot be strongly recommended.

Limitations of the Study

- The studies examined in this review used different therapeutic protocols
- The parameters assessed after treatment differed between studies (some evaluated clinical parameters, others assessed biological parameters and some assessed both at the same time)

- The duration of follow-up of patients after treatment was short, and varied between studies

Therefore, it is difficult to make a precise comparison between the included studies, and to determine the contribution of diode laser therapy to the treatment of periodontal pockets as an adjuvant to conventional treatment.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Karthikeyan, J., Vijayalakshmi, R., Mahendra, J., Kanakamedala, A.K., Chellathurai, B.N.K., Selvarajan, S., *et al.* (2019) Diode Laser as an Adjunct to Kirkland Flap Surgery—A Randomized Split-Mouth Clinical and Microbiological Study. *Photobiomodulation, Photomedicine, and Laser Surgery*, **37**, 99-109. <https://doi.org/10.1089/photob.2018.4519>
- [2] Sanz, M., Herrera, D., Kebschull, M., Chapple, I., Jepsen, S., Berglundh, T., *et al.* (2020) Treatment of Stage I-III Periodontitis—The EFP S3 Level Clinical Practice Guideline. *Journal of Clinical Periodontology*, **47**, 4-60. <https://doi.org/10.1111/jcpe.13290>
- [3] Coluzzi, D., Anagnostaki, E., Mylona, V., Parker, S. and Lynch, E. (2020) Do Lasers Have an Adjunctive Role in Initial Non-Surgical Periodontal Therapy? A Systematic Review. *Dentistry Journal*, **8**, Article 93. <https://doi.org/10.3390/dj8030093>
- [4] Jiang, Y., Feng, J., Du, J., Fu, J., Liu, Y., Guo, L., *et al.* (2022) Clinical and Biochemical Effect of Laser as an Adjunct to Non-Surgical Treatment of Chronic Periodontitis. *Oral Diseases*, **28**, 1042-1057. <https://doi.org/10.1111/odi.13847>
- [5] Moher, D., Liberati, A., Tetzlaff, J. and Altman, D.G. (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine*, **6**, e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- [6] El Mobadder, M., Nammour, S., Namour, M., Namour, A. and Grzech-Leśniak, K. (2022) Disinfection Potential of 980 Nm Diode Laser and Hydrogen Peroxide (3%) in “Critical Probing Depths” Periodontal Pockets: Retrospective Study. *Life*, **12**, Article 370. <https://doi.org/10.3390/life12030370>
- [7] Yang, C., Wang, X. and Wang, Y. (2022) Effect of Diode Laser Combined with Minocycline Hydrochloride in Nonsurgical Periodontal Therapy: A Randomized Clinical Trial. *BMC Oral Health*, **22**, Article No. 71. <https://doi.org/10.1186/s12903-022-02106-4>
- [8] Anwar, S.K., Hafez, A.M. and Roshdy, Y.S. (2024) Clinical and Microbiological Efficacy of Intra-Pocket Application of Diode Laser in Grade C Periodontitis: A Randomized Controlled Clinical Trial. *BMC Oral Health*, **24**, Article No. 270. <https://doi.org/10.1186/s12903-024-04031-0>
- [9] Derikvand, N., Ghasemi, S.S., Safiaghdam, H., Piriaei, H. and Chiniforush, N. (2020) Antimicrobial Photodynamic Therapy with Diode Laser and Methylene Blue as an Adjunct to Scaling and Root Planning: A Clinical Trial. *Photodiagnosis and Photo-*

- dynamic Therapy*, **31**, Article ID: 101818.
<https://doi.org/10.1016/j.pdpdt.2020.101818>
- [10] Lu, J.W., Huang, S.H., Lei, X.X., Deng, L. and Luo, L.J. (2023) Clinical Outcomes of Diode Laser as an Adjunct to Nonsurgical Periodontal Therapy for Residual Periodontal Pockets in Mandibular Second Molars—A Randomized Controlled Clinical Trial. *Clinical Oral Investigations*, **27**, 4493-4501.
<https://doi.org/10.1007/s00784-023-05071-6>
 - [11] Niazi, F.H., Noushad, M., Tanvir, S.B., Ali, S., Al-Khalifa, K.S., Qamar, Z., *et al.* (2020) Antimicrobial Efficacy of Indocyanine Green-Mediated Photodynamic Therapy Compared with *Salvadora Persica* Gel Application in the Treatment of Moderate and Deep Pockets in Periodontitis. *Photodiagnosis and Photodynamic Therapy*, **29**, Article ID: 101665. <https://doi.org/10.1016/j.pdpdt.2020.101665>
 - [12] Gottumukkala, S.N., Veluri, S.V., Penmetsa, G.S., KSV, R., Pasupuleti, M.K., Gera, D., *et al.* (2024) Comparative Evaluation of Indocyanine Green and 810nm Diode Laser Assisted Antimicrobial Photodynamic Therapy with 810nm Diode Laser Assisted New Attachment Procedure as Adjuncts to Scaling and Root Planning in Supportive Periodontal Therapy: A Randomized Controlled Split-Mouth Clinical Trial. *Dentistry* 3000, **12**, a001. <https://doi.org/10.5195/d3000.2024.392>
 - [13] El Sharaki, A. (2024) Comparative Study on the Efficacy of Antimicrobial Photodynamic Therapy versus Antibiotic Therapy as an Adjunct to Non-Surgical Treatment in Managing Periodontitis (Stage II, Grade B). *Al-Azhar Assiut Dental Journal*, **7**, 19-27. <https://doi.org/10.21608/aadj.2024.355431>
 - [14] Poormoradi, B., Rabinezhad, N., Mohamadpour, L., Kazemi, M. and Farhadian, M. (2024) Evaluating the Effects of Diode Laser 940 nm Adjunctive to Conventional Scaling and Root Planning for Gingival Sulcus Disinfection in Chronic Periodontitis Patients. *Avicenna Journal of Dental Research*, **16**, 35-41.
<https://doi.org/10.34172/ajdr.1778>
 - [15] Kamble, T.A., Deshpande, N.C., Shah, M., Jha, R. and Shah, A. (2024) Clinical and Microbiological Evaluation of Diode Laser and Systemic Doxycycline as an Additive to Scaling and Root Planing for Stage II and Stage III Periodontitis Patients. *Cureus*, **16**, e56509. <https://doi.org/10.7759/cureus.56509>
 - [16] Singh, A. and Jaiswal, G.R. (2024) Evaluation of Laser Assisted and Conventional Open Flap Debridement Procedure in Patients with Chronic Periodontitis—A Clinical and Microbiological Study. *African Journal of Biological Sciences*, **6**, 6161-6181.
 - [17] Alghafri, M., Fadhul, I., Shah, M., Hakam, A., Tawse-Smith, A., Alsabeeha, N.H.M., *et al.* (2024) Diode Laser as an Adjunctive Treatment for Periodontitis: A Randomized Controlled Trial. *International Journal of Dental Hygiene*, **22**, 959-970.
<https://doi.org/10.1111/idh.12809>
 - [18] Elmeligy, S.M.A., Saleh, W., Elewa, G.M., Abu El-Ezz, H.Z., Mahmoud, N.M. and Elmeadawy, S. (2024) The Efficacy of Diode Laser and Subgingival Air Polishing with Erythritol in Treatment of Periodontitis (Clinical and Microbiological Study). *BMC Oral Health*, **24**, Article No. 763. <https://doi.org/10.1186/s12903-024-04481-6>
 - [19] Seyed-Monir, A., Seyed-Monir, E. and Mihandoust, S. (2023) Evaluation of 940-Nm Diode Laser Effectiveness on Pocket Depth, Clinical Attachment Level, and Bleeding on Probing in Chronic Periodontitis: A Randomized Clinical Single-Masked Split-Mouth Study. *Dental Research Journal*, **20**, Article 113.
https://doi.org/10.4103/drj.drj_751_22
 - [20] El Mobadder, M., Nammour, S. and Grzech-Leśniak, K. (2023) Photodynamic Therapy with Tolonium Chloride and a Diode Laser (635 nm) in the Non-Surgical Man-

- agement of Periodontitis: A Clinical Study. *Journal of Clinical Medicine*, **12**, Article 5270. <https://doi.org/10.3390/jcm12165270>
- [21] El Mobadder, M., Nammour, S., Matys, J. and Grzech-Leśniak, K. (2022) Sodium Hypochlorite and Diode Laser in Non-Surgical Treatment of Periodontitis: Clinical and Bacteriological Study with Real Time Polymerase Chain Reaction (PCR). *Life*, **12**, Article 1637. <https://doi.org/10.3390/life12101637>
- [22] Mokhtari, M.R., Ahrari, F., Dokouhaki, S., Fallahrestegar, A. and Ghasemzadeh, A. (2021) Effectiveness of an 810-Nm Diode Laser in Addition to Non-Surgical Periodontal Therapy in Patients with Chronic Periodontitis: A Randomized Single-Blind Clinical Trial. *Journal of Lasers in Medical Sciences*, **12**, e37. <https://doi.org/10.34172/jlms.2021.37>
- [23] Mulder-van Staden, S., Holmes, H. and Hille, J. (2020) *In Vivo* Investigation of Diode Laser Application on Red Complex Bacteria in Non-Surgical Periodontal Therapy: A Split-Mouth Randomised Control Trial. *Scientific Reports*, **10**, Article No. 21311. <https://doi.org/10.1038/s41598-020-78435-7>