Dental Research Journal

Original Article

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

Ali Seyed-Monir[1], Ebrahim Seyed-Monir[2], Sanaz Mihandoust[3]

[1]Dental Sciences Research Center, School of Dentistry, Guilan University of Medical Sciences, [2]Department of Periodontology, School of Dentistry, Guilan University of Medical Sciences, [3]Dental Sciences Research Center, School of Dentistry, Guilan University of Medical Sciences, Rasht, Iran

ABSTRACT

Background: Diode lasers can be used in the treatment of periodontal diseases as they have an anti-bactericidal effect, and regulate oral tissue inflammatory responses. This study aimed to evaluate the adjunctive effects of Diode 940 nm laser on mechanical periodontal debridement.

Materials and Methods: In this split-mouth single-blind randomized clinical trial, 12 patients were selected. Forty-four oral segments were enrolled in the scaling and root planing (SRP) group and SRP + Laser group with a 1:1 allocation ratio following a simple randomization procedure (coin flip). Clinical parameters (pocket depth, clinical attachment loss [CAL], and bleeding on probing [BOP]) were measured at baseline. After the SRP, a 940 nm Diode laser (1 Watt power and continuous wave mode) was used in the SRP + Laser group as an adjunctive treatment. The clinical parameters were remeasured 2 months posttreatment. Statistical analysis was carried out using an unpaired *t*-test with a 5% significant level by SPSS.

Results: Although all clinical parameters had more improvements in the SRP + Laser group, the differences were not significant between the two study groups ($P > 0.05$). Only in individual tooth evaluations, CAL changes in first and second premolars and BOP changes in second premolars show statistically significant improvement in the SRP + L group compared to the SRP group ($P < 0.05$).

Conclusion: Using diode 940 nm laser as an adjunctive treatment for SRP may be helpful and be suggested for periodontal treatment.

Key Words: Dental scaling, lasers, periodontal diseases, periodontitis, root planing, semiconductor

Received: 17-Dec-2022
Accepted: 08-Sep-2023
Published: 26-Oct-2023

Address for correspondence:
Dr. Sanaz Mihandoust,
Naderi Building, 3rd Floor,
Bousar Bridge (Pol-e Bousar),
Rasht, Guilan, Iran.
E-mail: mihandoust.sanaz3@gmail.com

INTRODUCTION

Periodontal diseases are one of the most common health problems worldwide.[1] Chronic periodontitis is an infectious disease caused by periodontal pathogens and can lead to inflammation, attachment loss, bone resorption, plaque formation and/or gingival recession.[2] In periodontal treatments, the removal of subgingival and supragingival plaque is performed to prevent the onset or progress of the disease. Surgical and nonsurgical treatments are two common approaches in periodontal treatments.[3] The

Access this article online

Website: www.drj.ir
www.drjjournal.net
www.ncbi.nlm.nih.gov/pmc/journals/1480

How to cite this article: Seyed-Monir A, Seyed-Monir E, Mihandoust S. 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. Dent Res J 2023;20:113.

mechanical removal of bacterial plaques through scaling and root planing (SRP) by using hand or ultrasonic scalers is the basis of both surgical and nonsurgical periodontal treatments.[1]

However, such a procedure may not be effective in completely removing pathogenic bacteria. This may be due to the accumulation of bacterial biofilm and their endotoxins in deeper areas of pockets and surrounding soft tissues or unavailable areas, such as the furcation of multi-rooted teeth where it is difficult to perform SRP.[2,4] Therefore, the use of adjunctive methods, such as the administration of systemic and local antibiotics or laser therapy in combination with mechanical procedures, seems to be necessary.[1,2]

In recent years, laser therapy has become popular because of its bactericidal, detoxifying, and hemostatic effects.[5,6] The application of laser as an adjunctive nonsurgical treatment for periodontal diseases includes the disinfection of the area before the mechanical treatment, subgingival curettage, and contamination removal from the sulcus.[1] Dental lasers have different clinical applications based on the type of gain medium, wavelength, function, emission modes, and tissue absorption. The diode laser is a semiconductor laser whose gain medium is a combination of gallium (Ga), arsenide (Ar), and other elements such as aluminum (Al) and indium (In) that can convert electrical into light energy.[2,7,8] Diode laser in the wavelength range of 655–980 nm, can accelerate wound healing, increase angiogenesis and release of growth factor, and prevent damage to the root surface. The most common wavelengths in nonsurgical and surgical therapy are 800–980 nm.[9,10]

Lasers can remove microbial species and modulate the inflammatory responses of the oral tissues by affecting the inflammatory mediators such as interleukin 1ß and matrix metalloproteinase-8.[6,11] As it is well-known that diode laser has bactericidal effects, and considering that the main cause of periodontal diseases is bacterial plaque, it can be effectively used in periodontal therapy. Some studies showed that the diode laser, in combination with SRP, resulted in better therapeutic results.[5,6,9,10] In contrast, other studies concluded that SRP combined with diode laser demonstrated no additional therapeutic effect in comparison with SRP alone.[9,11] The present study was performed to assess the effects of diode laser as an adjunct to SRP in the treatment of periodontal patients to find a more effective treatment protocol.

MATERIALS AND METHODS

Patients and study design

This split-mouth single-blind randomized clinical trial was approved by the Research Ethics Committee of Guilan University of Medical Sciences (Approval ID: 2909609080) and the Iranian Registry of Clinical Trials (IRCT20221210056769N1). In this clinical trial study, 12 periodontal patients referred to a specialized dental clinic participated. The sample size was determined based on the following calculations:[12]

$\alpha = 0.05 \quad \beta = 0.10$

$\bar{x}_1 \pm SD_1\ 4.29 \pm 1.51$

$\bar{x}_2 \pm SD_2\ 3.85 \pm 1.31$

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \left[SD_1^2 + SD_2^2\right]}{(\mu_1 - \mu_2)^2}$$

$$n = \frac{(1.96 + 1.28)^2 \left[1.51 + 1.31\right]}{(4.29 - 3.85)^2} \simeq 44$$

All patients signed an informed consent before the study, and the study protocol was approved by the university ethics committee. The study was designed according to the CONSORT 2010 guidelines [Flow Diagram 1].

The patients were included if aged from 20 to 56 years old, had at least 2 of the 3 teeth (first premolar, second premolar, and first molar), and at least 1 probing point more than 3 mm, in each quadrant. Patients who had any periodontal treatment during the last year, or used any antibiotics or anti-inflammatory drugs during the last 3 months, or had any systemic diseases or drug usage, and pregnant patients or oral contraceptive users were excluded from this study. Furthermore, teeth with furcation involvement or any stage of mobility were excluded from the study.

Participants who satisfied inclusion criteria were assessed by a dentist as a calibrated researcher (with intra-examiner reliability of 0.987 in 36 examinations) at baseline. The trained dentist who measured clinical parameters was unaware of the side that had been laser treated.

Clinical parameters were measured in six areas (mesiobuccal, buccal, distobuccal, mesiolingual, lingual, and distolingual) around each tooth using

William's probe (CP-12/thin Williams color-coded probe, Hu-Friedy, Chicago, IL, USA) as follows:

Clinical attachment loss (CAL) was recorded as the distance between CEJ and the gingival margin. To measure bleeding on probing (BOP), the periodontal probe was moved through the gingival sulcus, and the presence of bleeding after 15 s was considered positive BOP. To measure pocket depth (PD), the distance from the gingival margin to the depth of the pocket.

In the next step, SRP was performed by Cavitron Bobcat Pro 25K Ultrasonic Scaler® and then, the oral segments were randomly assigned to the SRP group and SRP + Laser group with an allocation ratio of 1:1 following a simple randomization procedure (Coin flip). In the SRP + Laser group, the segment received laser, while in the SRP group, segments did not receive laser. The calibrated researcher who was blinded from the laser treatment, remeasured the clinical parameters 2 months after the SRP.

Laser treatment

Laser therapy was performed using a 940-nm diode laser instrument (Biolase®, USA) with 100 mW power in continuous wave mode, power density of 2.831 KW/cm^2, energy density of 398 J/cm^2, and 400 μm fibers with 9 mm long tips. The fiber were initiated first according to the standard instructions and then used for de-epithelialization [Figure 1]. To initiate the fiber, its tip touched the surface of the initiate block without activating the laser, then the Footswitch was pressed to activate the laser, allowing the tip to sink into the block, and then, the tip was pulled out when the metal cannula touched the block, still firing until just before the tip is out of the block. The Footswitch was pressed to activate the laser into the air once, and the tip glowed, which indicated the fiber was initiated. The fiber's tip was inserted to about 1 mm coronal to the PD and moved mesiodistally in a horizontal sweeping mode so that for every 2 mm of mesial movement, 1 mm was moved back distally [Figure 2]. This procedure was repeated until the most mesial point of the tooth was reached. Then, the fiber's tip was located 2 mm more coronally and swiping from distal to mesial direction was repeated in this location. This procedure was continued until the margin of the gingiva was reached. During the height change, tissue debris attached to the surface of the tip was removed using a sterile gauze.

Figure 1: Initiation of the diode laser fiber.

Figure 2: Horizontal sweeping movement of fiber's tip in the gingival pocket.

Statistical analysis

Data were analyzed using the SPSS software version 22.0 (IBM Corp, Armonk, NY, USA). The studied clinical parameters (PD, CAL, and BOP) are presented as mean ± standard deviation, and frequency where applicable. A $P < 0.05$ was considered statistically significant. Differences between the studied clinical parameters in the studied groups were assessed using unpaired *t*-test.

Ethical approval was obtained from ethical committee before starting the research.

RESULTS

In this study, the data of 12 patients (44 oral segments) were analyzed. The left and right maxillary and mandibular oral segments of 10 patients (40 oral segments) and the left and right mandibular

oral segments of two patients (4 oral segments) were included. Each segment had two or three of the first premolar, second premolar, and first molar [Table 1]. 33.3%[4] of participants were male and 66.7%[8] were female. The mean age of the patients was 36.08 ± 10.88 years old (ranging from 20 to 56 years old).

The mean PD change in all studied teeth was higher in the SRP + Laser group than in the SRP group. However, the difference was not statistically different ($P > 0.05$).

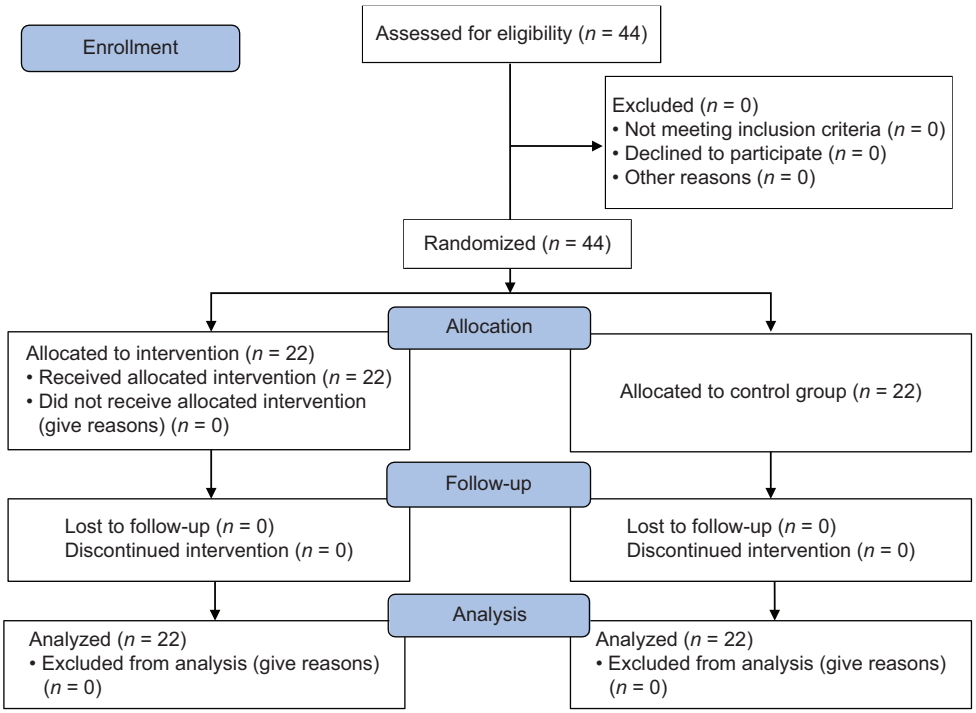
The mean CAL changes in all three studied teeth in the SRP + Laser group were higher than in the SRP group. The differences were statistically significant for the first premolar teeth and the second premolar teeth [$P < 0.05$, Table 2].

The mean frequency change of BOP in all studied teeth was higher in the SRP + Laser group than in the SRP group. The difference was only statistically significant for the second premolar teeth [$P < 0.05$, Table 3].

Table 4 shows the mean changes of PD, CAL, and BOP for overall assessment of the quadrants in the studied groups. No statistically significant difference was observed in these clinical parameters. However, the mean CAL and BOP changes were very close to being statistically significant ($P = 0.06$ and 0.07, respectively).

DISCUSSION

The present study was performed to assess the effects of diode laser as an adjunct to SRP in the treatment of periodontal patients. All studied clinical parameters, including PD, CAL, and BOP in the studied areas, were higher in the SRP-Laser group than the SRP group. However, the differences were not statistically



Flow Diagram 1: Study design according to the CONSORT 2010 guidelines.

Table 1: The frequency of teeth, oral segments, and patients according to scaling and root planing group and scaling and root planing + laser group

Study groups	Teeth (*n*)				Oral segments (*n*)	Patients (*n*)
	First premolars	Second premolars	First molars	Total		
SRP group	11	12	11	34	22	12
SRP + laser group	10	12	10	32	22	12
Total	21	24	21	66	44	12

SRP: Scaling and root planing

Table 2: The changes of clinical attachment loss in the scaling and root planing and scaling and root planing/laser groups (mm)

Teeth	Method	Mean±SD	*P*
First premolars	SRP	0.81±0.29	0.042 (significant)
	SRP + laser	1.17±0.45	
Second premolars	SRP	0.86±0.51	0.048 (significant)
	SRP + laser	1.26±0.4	
First molars	SRP	0.92±0.54	0.23 (NS)
	SRP + laser	1.15±0.29	

SD: Standard deviation; SRP: Scaling and root planing; NS: Not significant

Table 3: The changes of bleeding on probing in the scaling and root planing and scaling and root planing/laser groups (mm)

Teeth	Method	Mean±SD	*P*
First premolars	SRP	3.81±3.18	0.51 (NS)
	SRP + laser	4.72±3.25	
Second premolars	SRP	2.91±2.02	0.006 (significant)
	SRP + laser	6.16±3.12	
First molars	SRP	2.54±2.84	0.54 (NS)
	SRP + laser	3.36±3.41	

SD: Standard deviation; SRP: Scaling and root planing; NS: Not significant

Table 4: The changes in overall probing depth, clinical attachment loss, and bleeding on probing in the scaling and root planning and scaling and root planning/laser groups

Clinical parameter	Method	Mean±SD	*P*
PD	SRP	1.12±0.38	0.56 (NS)
	SRP + laser	1.21±0.27	
CAL	SRP	0.88±0.31	0.07 (NS)
	SRP + laser	1.14±0.21	
BOP	SRP	3.03±2.49	0.06 (NS)
	SRP + laser	5.16±2.44	

PD: Probing depth; CAL: Clinical attachment loss; BOP: Bleeding on probing; SD: Standard deviation; NS: Not significant; SRP: Scaling and root planning

significant for all parameters. In the case of PD, no significant difference was observed between the groups. In the SRP + Laser group, although the CAL in the first premolars and second premolars showed significant improvement ($P < 0.05$), no statistically significant difference was noted for the first molars. This may be because of the difficult access to the roots of the first molar.

In the SRP + Laser group, the second premolars showed significant improvements compared to the SRP group. However, for first premolars and first molars, the differences were not statistically significant. This may be explained by the fact that one side of the first premolars and first molars is in contact with other teeth (canine and second molar) that did not undergo laser therapy, however, due to the location of the second premolars which is between the first premolars and first molars, soft tissue around the second premolars received an appropriate level of laser therapy, leading to diminished inflammation and bleeding.

In the present study, the mean PD change in 22 studied areas was not statistically different between the groups. This finding is in accordance with other studies.[1,5,9,11-17] In contrast, some studies reported significant improvements in the SRP + Laser group.[6,10,18-22]

Simiarly, in line with other studies,[1,5,9,11-17,23,24] no significant improvement was observed for CAL in the studied groups. On the other hand, some studies reported significant improvements in CAL in the SRP + Laser patients than in SRP patients.[5,6,10,22]

These discrepancies may be because of differences in the study design, sample size, the initial PD, tooth type, and the type, wavelength, and power of the used lasers.

In the present study, results observed for BOP were not statistically significant, which was in contrast with other studies that reported significant improvements in BOP in SRP + Laser than SRP patients.[6,10,22]

CONCLUSION

All studied clinical parameters showed nearly better improvements in the SRP + Laser group than the SRP group. These differences were even statistically significant for the CAL (first and second premolars) and BOP (first premolars). Although the differences in the mean CAL and BOP changes were not statistically significant in the overall evaluation, they were very close to being statistically significant ($P = 0.06$ and 0.07, respectively). Overall, the findings of the present study indicated that 940 nm diode laser with 1 watt power can be considered an adjuvant therapy to SRP for periodontal patients.

Ethics approval and consent to participate

The informed consent obtained from study participants was written.

Ethical approval was obtained from ethical committee before starting the research.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

REFERENCES

1. Pamuk F, Kantarci A. Inflammation as a link between periodontal disease and obesity. Periodontol 2000 2022;90:186-96.
2. Jepsen S, Caton JG, Albandar JM, Bissada NF, Bouchard P, Cortellini P, *et al*. Periodontal manifestations of systemic diseases and developmental and acquired conditions: Consensus report of workgroup 3 of the 2017 World Workshop on the classification of periodontal and peri-implant diseases and conditions. J Clin Periodontol 2018;45 Suppl 20:S219-29.
3. Arweiler NB, Auschill TM, Sculean A. Patient self-care of periodontal pocket infections. Periodontol 2000 2018;76:164-79.
4. Zafar F, Romano F, Citterio F, Ferrarotti F, Dellavia C, Chang M, *et al.* Chemical cleansing as an adjunct to subgingival instrumentation with ultrasonic and hand devices in deep periodontal pockets: A randomized controlled study. J Periodontal Implant Sci 2021;51:276-84.
5. Luchian I, Goriuc A, Martu MA, Covasa M. Clindamycin as an alternative option in optimizing periodontal therapy. Antibiotics (Basel) 2021;10:814.
6. Dascalu Rusu LM, Moldovan M, Sarosi C, Sava S, Dreanca A, Repciuc C, *et al*. Photodynamic therapy with natural photosensitizers in the management of periodontal disease induced in rats. Gels 2022;8:134.
7. Yu S, Zhao X, Zhang Y, Liu Y, Li A, Pei D. Clinical effectiveness of adjunctive diode laser on scaling and root planing in the treatment of periodontitis: Is there an optimal combination of usage mode and application regimen? A systematic review and meta-analysis. Lasers Med Sci 2022;37:759-69.
8. Qadri T, Javed F, Johannsen G, Gustafsson A. Role of diode lasers (800-980 nm) as adjuncts to scaling and root planing in the treatment of chronic periodontitis: A systematic review. Photomed Laser Surg 2015;33:568-75.
9. Kim HR, Son K, Son YT, Kim YG, Lee KB, Lee SC, *et al*. A comparative immunohistochemical study of wound healing after dental diode laser treatment in the rat oral mucosa. Bioengineering (Basel) 2022;9:466.
10. Zare D, Haerian A, Molla R, Vaziri F. Evaluation of the effects of diode (980 nm) laser on gingival inflammation after nonsurgical periodontal therapy. J Lasers Med Sci 2014;5:27-31.
11. Saglam M, Kantarci A, Dundar N, Hakki SS. Clinical and biochemical effects of diode laser as an adjunct to nonsurgical treatment of chronic periodontitis: A randomized, controlled clinical trial. Lasers Med Sci 2014;29:37-46.
12. Nguyen NT, Byarlay MR, Reinhardt RA, Marx DB, Meinberg TA, Kaldahl WB. Adjunctive non-surgical therapy of inflamed periodontal pockets during maintenance therapy using diode laser: A randomized clinical trial. J Periodontol 2015;86:1133-40.
13. Jose KA, Ambooken M, Mathew JJ, Issac AV, Kunju AP, Parameshwaran RA. Management of chronic periodontitis using chlorhexidine chip and diode laser-a clinical study. J Clin Diagn Res 2016;10:C76-80.
14. Dukić W, Bago I, Aurer A, Roguljić M. Clinical effectiveness of diode laser therapy as an adjunct to non-surgical periodontal treatment: A randomized clinical study. J Periodontol 2013;84:1111-7.
15. Vaziri F, Haerian A, Zare D, Molla R, Arab Farashahi M. Clinical evaluation of the use of diode (980 nm) laser as an adjunct to traditional periodontal treatment. SSU J 2018;25:780-9.
16. Dakhil FF, Mahmood AS. Evaluation of clinical effects of a 940nm diode laser as adjunctive therapy in the treatment of periodontal pockets. Iraqi Dent J 2020;39:12-5.
17. Meseli SE, Kuru B, Kuru L. Effects of 810-nanometer diode laser as an adjunct to mechanical periodontal treatment on clinical periodontal parameters and gingival crevicular fluid volume of residual periodontal pockets. Niger J Clin Pract 2017;20:427-32.
18. Lobo TM, Pol DG. Evaluation of the use of a 940 nm diode laser as an adjunct in flap surgery for treatment of chronic periodontitis. J Indian Soc Periodontol 2015;19:43-8.
19. Euzebio Alves VT, de Andrade AK, Toaliar JM, Conde MC, Zezell DM, Cai S, *et al.* Clinical and microbiological evaluation of high intensity diode laser adjutant to non-surgical periodontal treatment: A 6-month clinical trial. Clin Oral Investig 2013;17:87-95.
20. Chandra S, Shashikumar P. Diode laser – A novel therapeutic approach in the treatment of chronic periodontitis in type 2 diabetes mellitus patients: A prospective randomized controlled clinical trial. J Lasers Med Sci 2019;10:56-63.
21. Fenol A, Boban NC, Jayachandran P, Shereef M, Balakrishnan B, Lakshmi P. A qualitative analysis of periodontal pathogens in chronic periodontitis patients after nonsurgical periodontal therapy with and without diode laser disinfection using Benzoyl-DL Arginine-2-naphthylamide test: A randomized clinical trial. Contemp Clin Dent 2018;9:382-7.
22. Matarese G, Ramaglia L, Cicciù M, Cordasco G, Isola G. The effects of diode laser therapy as an adjunct to scaling and root planing in the treatment of aggressive periodontitis: A 1-year randomized controlled clinical trial. Photomed Laser Surg 2017;35:702-9.
23. Ciurescu CE, Cosgarea R, Ciurescu D, Gheorghiu A, Popa D, Franzen R, *et al.* Adjunctive use of InGaAsP and Er, Cr: YSGG lasers in nonsurgical periodontal therapy: A randomized controlled clinical study. Quintessence Int 2019;50:436-47.
24. Badeia RA, Muthenna Shaban Rajab BD, Hazeem MI. Efficacy of diode laser with different intensities as an adjunct to traditional mechanical treatment of chronic periodontitis. Mustansiria Dent J 2013;10:137-46.