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Laser Applications as a Preventive Measure Treatment for Those with Periodontitis: Randomized Clinical Trail

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ABSTRACT

Background: Mechanical debridement is the best option when treating periodontitis. Nevertheless, it has been suggested that the use of lasers as an adjunct may lead to better treatment outcome. long-term gingival disease leads to destruction of periodontal tissues. Diode lasers have shown potential effect in both therapeutic and preventive applications.

Objective: Evaluate the effect of diode lasers as assistant to scaling and root planning (SRP)

Methods: Forty patients with stage III periodontitis were enrolled in a randomized controlled clinical trial and randomly assigned to receive SRP alone (control group) and combined SRP with diode laser (980 nm) (test group) with beam parameters: 400 lm fiber diameter, 1.5 W average power, and 10 s/pulse duration. Pocket depth (PD), bleeding on probing (BOP), and relative attachment level (RAL) were measured at baseline and after six weeks recall visit.

Results: By the end of the trial, both groups evaluated clinical indices had improved relative to the baseline, with notable distinctions between groups.

Conclusion: When treating stage lll periodontitis with laser therapy in addition to SRP is considered to be viable treatment option.

Keywords: *Periodontitis, laser, inflammation*

1. INTRODUCTION

The complex interaction between bacterial infection and host response, influenced by systemic and behavioral risk factors, leads to periodontitis, which is characterized by inflammation of tooth-supporting tissues, progressive loss of periodontal ligament, and bone loss. (Abusleme, Silva, et al. 2015). The term "periodontal pocket" refers to the space that forms between the tooth and the pathologically separated gums (Bosshardt 2018). The gums, periodontal ligament, and alveolar bone that support the teeth are all susceptible to inflammation and degradation in periodontitis, in addition to additional antimicrobial medications, a mechanical debridement procedure called scaling and root planning (SRP) is used to treat periodontitis. While effective, these traditional procedures can be invasive and often require multiple treatments to achieve the desired results, especially in cases of deep periodontal pockets. Surgical periodontal treatment is usually indicated for sites that have not responded to nonsurgical treatment, have residual periodontal pockets of 6 mm or greater, and continue to bleed on probing examination (BOP) to access the diseased area and improve periodontal healing (Tonetti, Muller -Campanile et al. 2018, Mertens, Orti et al. 1998). Various complementary techniques and treatment options used as adjunct to mechanical debridement, such as antimicrobial photodynamic therapy (PDT) or systemic antibiotics are recommended, in addition, many laser-assisted techniques and treatment options have been reported to have encouraging clinical results (Isola, Matarese et al. 2017). Laser irradiation is thought to improve the disinfection of the infected root surface by removing the gingival pocket epithelium and prolonging the time required for the junctional epithelium to reattach (Centty, Blank et al. 1997).

In addition, blood coagulation within the pocket by diode laser irradiation can promote wound healing within the pocket. (Blank et al., Centty, 1997). Additionally, laser-treated tissue releases collagen and fibrin within 6 hours. The release of fibrin in the pocket improves the quality of the natural filling material (blood and fibrin) and the integration of the soft tissue in the pocket with the debrided root surfaces. (Marques, Pereira, et al., 2004).

The abbreviation "laser" stands for "light amplification by stimulated emission of radiation". There are many types of lasers, each with special properties and possible uses. In 1962, Robert N. Hall invented the semiconductor diode laser. The laser mechanism produces laser light by passing an electric current through a diode. Diode lasers are available in different wavelengths (Hideaki, 2020). 980 nm. Diode lasers are commonly used for these types of applications. (Nadhreen et al., 2019).

Because low-level lasers emit relatively little energy and do not cause thermal harm to the surrounding tissues, they are utilized to relieve pain. The process by which the low-level laser contact with the gingival tissue cells results in alleviation can be understood. The laser light will be absorbed by photo-acceptors, and the absorbed light will change the cells by encouraging particular chemical reactions within the cells (Nambi, 2021). Instantaneous direct reactions that result in oxidation or reduction of the cell's redox state occur during laser irradiation (Hassan et al., 2021). The other processes occur after laser irradiation.

These reactions affect the production of proteins within the cell, which promotes cellular proliferation and the formation of new cells, according to Dompe et al. (2020). Chen et al. (2019) claim that the release of toxins and metabolic wastes into the native tissue is the mechanism by which bacterial accumulations cause inflammation. The laser beam will decimate the colonies of pathogenic bacteria, resulting in a minimal number of these microorganisms. The damaged sulcular epithelium will also be eliminated throughout this process, The use of laser systems in dentistry has created new avenues for the development of faster, less intrusive, and more effective treatments for periodontal diseases. These treatments can shorten treatment times and help stabilize the inflammatory process over the long run. (Minić 2019).

2. MATERIALS AND METHOD

Participants and Study Design

The present investigation was conducted as a randomized clinical trial (RCT) at the Dental Teaching Hospital of AL-Ayen Iraqi University located in AL-Nasiriya, Iraq. The research was conducted in compliance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 2013 (Schulz, Altman et al. 2010), and the CONSORT statement acted as a reference for reporting this work. Participants who required nonsurgical periodontal care and were planned to visit the dental teaching hospital between September 2023 and January 2024 were recruited using the following inclusion criteria: (1) ≥18 years old; (2) a diagnosis of generalized periodontitis, grade B or C, or stage III–IV (Tonetti, Greenwell et al. 2018). (3) good compliance and dedication to attending appointments for follow-up reviews. Participants who had received systemic antibiotics during the previous six months, periodontal therapy within the previous twelve months, were expecting or nursing a child, or who were unable to give informed permission. Individuals who consume ≤10 cigarettes daily (Costello, Dierker, et al. 2007). Individuals with managed health conditions were not disqualified.

Sample Size Estimation

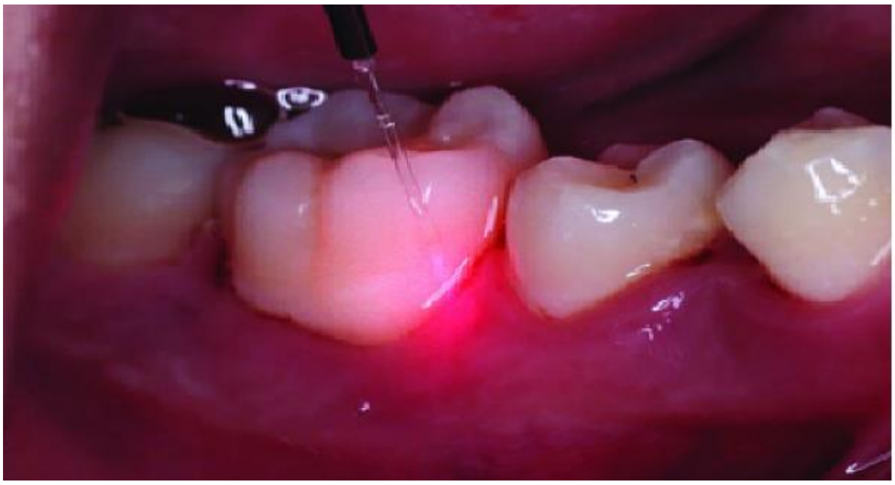
An estimated 5% alpha error and 80% research power were used to calculate the sample size (Guerrero, Nibali et al. 2014). Forty individuals, ages 24-55, who had been diagnosed with stage III severe periodontitis, were divided into two equal groups at random: Group I (control n = 20) received SRP only, whereas Group II (test n = 20) received SRP with intrapocket application of a diode laser (980 nm). Using a list of random numbers created by a computer, participants who met the eligibility requirements were simply randomized.

Clinical Procedure

Every participant was told to wash his mouth before the examination. Periodontal measurements were performed with the University of Michigan O probe, using William's labeling. Periodiapical X-rays were taken in order to confirm the diagnosis of periodontitis and to stage and grade the case in line compatible with new classification of periodontal disease (Tonetti, Greenwell et al. 2018). Each individual underwent a full-mouth periodontal examination, which included baseline full mouth bleeding on probing (BOP), relative attachment level (RAL), and probing pocket depth (PPD) assessments. Additionally, dental hygiene advice was given to them (Sanz, Herrera, et al. 2020). To measure RAL, an acrylic stent was made with a vertical groove. Using a manual periodontal probe, which was gently pushed parallel to the long axis of the tooth until resistance was seen, the measurement was reported from the reference point marked on the lower edge of the stent's groove to the most apical penetration of the probe, as shown in this figure.

Figure (1) acrylic stent

After administering a local anesthetic (a mixture of Lidocaine HCL 2% and 1:100,000 adrenaline), both groups underwent extensive instrumentation using a Cavitron ultrasonic insert (DENTSPLY Sirona) and Gracey curettes (Hu-Friedy) by hand. The test group participants underwent a procedure that involved the use of an ultrasonic device and hand tools first, followed by the use of a diode laser (type 4 Portable Soft-Tissue Diode Desktop Laser, MD-X USA) with a 400 µm fiber diameter with (980 nm). wavelength. The laser was only employed on pockets that measured at least 5 mm, and there was only one DL therapy session utilized. The participants, the dental assistant, and the operator all wore safety eyewear. The DL was configured in a pulsed mode at 10 Hz, using 2.5 watts (W). To ensure parallel alignment with the root surface from the apical to the coronal direction, the fiber tip was positioned at the base of the sulcus and swept circumferentially during the laser light emission. Treatment durations were restricted to no more than 20 seconds per tooth surface in order to prevent overheating the treated area. To preserve its physical qualities, the fiber tip was periodically washed and conditioned using a damp gauze sponge. The pockets were washed with saline solution following each laser disinfection. Periodontal parameter assessments, routine prophylaxis, and reminders to maintain proper oral hygiene were all part of the six-weekly follow-up



visit. **Figure (2) laser usage inside pocket**

Follow-up Intervals

Forty-two days following the intervention, the patients were summoned back, and the clinical parameters were assessed once more.

Statistical Analysis

The data was analyzed using SPSS (Statistical Package for the Social Sciences) version 21. For each group (control or test), the clinical parameters were assessed in order to ascertain statistical significance. The means and standard deviations were calculated from each clinical parameter that was recorded. All periodontal parameters displayed a normal distribution, according to the Kolmogorov-Smirnov test, at P > 0.05. The differences between the periodontal clinical parameters before and after therapy were investigated using a paired sampling t-test of the mean values. P is considered statistically significant if it is less than 0.05.

3. RESULTS

After screening 65 potentially eligible patients, forty individuals, aged 22 to 55 years, comprising 25 males and 15 females, who fulfilled the eligibility criteria were included in this study. Following a baseline assessment, as indicated in Table 1, they were randomized to research groups, each of which had twenty patients with stage III periodontitis (CAL>5). Every participant successfully finished the six-week clinical experiment. During the trial, none of the individuals mentioned having any oral health issues.

Table (1) distribution of study groups according to gender

Count	**Gender**		**Total**
	Male	**Female**	
Control group	**12**	**8**	**20**
Test group	**13**	**7**	**20**
Total	**25**	**15**	**40**

Since sample size equals 20 for each group, all periodontal parameters were normally distributed using Kolmogorov Smirnov test at P > 0.05. From descriptive and statistical analysis by the means and standard deviations (SD) of the clinical parameters (BOP 0, BOP 1, PPD and RAL) in the (control group and test group) at baseline and 6 weeks later. PPD, CAL, Bop 1 decreased significantly in both groups means of : (5698.10, 7536.95, 54.90) (6230.5, 7630.4, 53.10) to (4728.20, 6607.00, 36.95)(4772.85,6240.75, 22.85) respectively except for BOP 0 it was increased from (32.60 , 27.30 to 50.55, 57.75) as shown in table (2 ,3) were P value < 0.05 by using paired sampled t test as shown in table (4)

Table (2) Control

Base line	**Min**	**Max**	**Mean**	**SD**	**Recall Visit**	**Min**	**Max**	**Mean**	**SD**
BOP_0	17	42	32.60	6.581	BOP_0	34	66	50.55	6.909
BOP_1	44	70	54.90	6.905	BOP -1	16	54	36.95	9.378
PPD	5196	6119	5698.10	319.212	PPD	4129	5267	4728.20	329.123
RAL	6864	8175	7536.95	335.138	RAL	5243	7368	6607.00	509.626
Valid N (listwise)	20								

Table (3) Test

Base line	**Min**	**Max**	**Mean**	**SD**	**Recall Visit**	**Min**	**Max**	**Mean**	**SD**
BOP_0	18	38	27.30	5.620	BOP_0	44	72	57.75	6.781
BOP_1	42	64	53.10	6.365	BOP -1	16	31	22.85	4.184
PPD	5761	6955	6230.5	339.814	PPD	4113	5467	4772.85	402.880

RAL	7128	7984	7630.4	280.256	RAL	5966	6476	6240.75	122.677
Valid N (listwise)	20								

Table (4) Paired Sample T test

Control Group		T (control group)	T (test group)	df	Sig. (2-tailed)
Pair 1	BOP_pre0 - BOP_post0	-7.489	-22.848	19	**.000**
Pair 2	BOP_pre1 - BOP_post1	11.311	21.889	19	**.000**
Pair 3	PPD_pre - PPD_post	13.901	28.924	19	**.000**
Pair 4	RAL_pre - RAL_post	14.258	21.538	19	**.000**

Regarding the comparison of PPD, RAL and BOP at base line and recall visit between control and test group, there were no significant difference between groups in the base line visit except for PPD and BOP 0. For the recall visit, all results were highly significant difference except for PPD, the result was not significant difference as shown in table (5):

Table (5) illustrate comparison of PPD, RAL and BOP among groups and in each visit using independent sample T test

Groups		PPD, Base line	PPD, Recall Visit	RAL Baseline	RAL, Recall Visit	BOP1, Baseline	BOP1, Recall Visit	BOP0, Baseline	BOP0, Recall Visit
Control group	Mean	5698.10	4728.20	7536.95	6607.00	54.90	36.95	32.60	50.55
	±SD	319.212	329.123	335.138	509.626	6.905	9.378	6.581	6.909
Test group	Mean	6230.55	4772.85	7630.45	6240.75	53.10	22.85	27.30	57.75
	±SD	339.814	402.880	280.256	122.677	6.365	4.184	5.620	6.781
T		5.107	.384	.957	3.125	.857	6.141	2.739	3.326
Df		38	38	38	38	38	38	38	38
P value		**0.000 HS**	0.703	0.345	**0.005 HS**	0.397	**0.000 HS**	**0. .009 HS**	**0.000 HS**

changes of PPD, RAL and BOP from base line to 2nd visit, indicated that there was decreased for all those parameters for each group except for BOP score 0, it was increased in each group with highly significant difference and more effect size and variability for with test group than those for control group as shown in table (6)

Table (6) Statistical test of PPD, RAL and BOP change between visits in each group using Paired T test.

Groups		Paired T test	df	P value	ES
Control Group	PPDpre - PPDpost	14.749	29	**0.000 ****	1.893
	RALpre - RALpost	15.895	29	**0.000 ****	2.134
	BOP1pre - BOP1post	12.429	29	**0.000 ****	1.631
	BOP0pre - BOP0post	13.668	29	**0.000****	1.754
Test Group	PPDpre - PPDpost	35.128	29	**0.000****	4.506
	RALpre - RALpost	25.423	29	**0.000****	3.327
	BOP1pre - BOP1post	30.545	29	**0.000****	3.976
	BOP0pre - BOP0post	29.999	29	**0.000****	3.918

4. DISCUSSION

Diode lasers have less therapeutic benefits when applied to dental hard tissues than when used on soft tissues because of their high ablation capabilities and potent bactericidal and detoxifying effects (Clayman, Kuo et al. 1997). (Jiang, Feng, et al. (2022)) suggest that adding lasers to conventional mechanical tools as an adjuvant may help with therapy and encourage healing. This study looked at the effectiveness of a 980 nm diode laser in improving periodontal parameters in patients with periodontitis in addition to conventional SRP. With the exception of BOP Score 0, all periodontal parameters were considerably lowered in all groups. This is because periodontal therapy aims to limit and prevent the inflammatory disease process while also attempting to eradicate or reduce pathogenic bacteria. According to (Teughels, Dhondt et al. (2014)), scaling and root planing is the first recognized non-surgical treatment option for stage III grade C periodontitis, formerly known as aggressive periodontitis. In addition, laser periodontal therapy has been pushed since 1994 (Aoki, Ando et al. 1994) as an alternative or addition to traditional mechanical periodontal therapies.

Research has demonstrated that several advantageous characteristics of lasers, such as their capacity to eliminate calculus, detoxify against periodontal bacteria, and exhibit hemostatic effects, improve treatment outcomes (Aoki, Sasaki et al. 2004). Due to its significant absorption by blood hemoglobin, diode laser light is an excellent substitute for removing the highly vascularized, inflammatory tissues that are common in the periodontal pocket (Cobb, Low et al. 2010).

Furthermore, (wavelength 980 nm, 2 watts power) lasing eliminate periodontal pathogenic microorganisms by the heat and photodisruptive capabilities of a diode laser (Moritz, Schoop et al. 1998). When tissue temperatures are elevated by laser light absorption, the majority of nonsporulating bacteria, including anaerobes, are easily rendered inactive (Gutknecht 2007). Soft tissue lasers with variable degrees of effectiveness for subgingival curettage and periodontal pocket cleaning include these semiconductor diodes and Nd:YAG lasers, which emit light at 1064 nm (Aoki, Sasaki et al. 2004). But because lasers cannot remove calcified deposits from the root surface, it has been shown that they can only be used as a assistant to mechanical periodontal therapy (Tucker, Cobb et al. 1996). Our primary goal is to assess the efficacy of laser therapy versus conventional therapy for BOP, PPD, and CAL parameters in stage III periodontitis. The current study found that the laser group had a statistically significant decrease in BOP score 1, PPD, and CAL between the baseline and six weeks after therapy. This was in line with multiple other research that reached the same conclusion as ours by utilizing diode laser wavelengths between 660 and 980 nm in addition to different photosensitizers and follow-up times. (Kamma, Vasdekis et al. 2009, Annaji, Sarkar et al. 2016, Matarese, Ramaglia et al. 2017).

Furthermore, Ertugrul and Talamac et al., using an Er,Cr:YSGG laser instead of SRP alone, confirmed our findings. They found that the combination of SRP and Er,Cr:YSGG laser treatment improved the clinical periodontal parameters (PD+CAL) in aggressive periodontitis more than SRP alone. They attributed this to studies demonstrating Er,Cr:YSGG enhances cell attachment and migration on the root surfaces (Ertugrul, Tekin et al. 2017, Talmac, Yayli et al. 2022). According to statistics, there was a significantly larger effect size and variability for the test group compared to the control group. This is consistent with the findings of Sharaf et al., who found that after two and six weeks, SRP plus laser therapy (SRP + Laser) significantly decreased the amount of CAL. (Sharaf, Elkhodary et al. 2012). On the other hand, Kreisler et al. looked at the use of a semiconductor 809 nm diode laser in combination with split mouth treatment on 492 teeth among 22 patients. Plaque and gingival indices, bleeding on probing, and sulcus fluid flow rate did not differ statistically significantly between the two groups; however, the mobility, clinical attachment loss, and pocket depth were significantly reduced in the laser treatment group relative to the control group (Kreisler, Al Haj et al. 2005). Moreover, two comprehensive analyses (Jia, Jia et al. 2020, Yu, Zhao et al. 2022) showed noteworthy clinical advantages of treating periodontitis with a single diode laser session over a short three to six months' timeframe. But using DL at the same wavelength and laser power (980 nm) as we did in our trial produced better microbiological and clinical outcomes, with a discernible improvement in every clinical parameter (Kamma, Vasdekis et al. 2009).

It's crucial to remember that a lot of position papers and consensus statements regarding the role of supplemental laser therapy now offer conflicting advice and conclusions. For instance, the European Federation of Periodontology clinical practice guideline does not recommend the use of lasers as an adjuvant to SRP in the surgical and non-surgical treatment of periodontitis. (Sanz, Herrera et al. 2020). Nonetheless, research presented by the American Academy of Periodontology suggests that individuals with PPD of ≥7 mm may benefit more from adjuvant (Er:YAG) laser treatment in terms of clinical outcomes.

There is currently insufficient evidence, according to Mills, Rosen, et al. (2018), to conclude that the advantages of laser therapy are superior to or comparable with those of standard periodontal therapy. The presented results raise doubts about the necessity of the additional costs and work associated with adjunct DL therapy. Future randomized controlled trials should consider larger sample sizes and longer follow-up periods in order to validate or refute these results.

5. CONCLUSION

Overall, the results of this study indicated that during the course of the experiment, pocket depth and clinical attachment loss were dramatically reduced when using the usual mechanical approach of SRP, either by itself or in conjunction with diode laser radiation. Because of this, laser treatment of periodontal pockets should only be considered an adjunct to non-surgical periodontal therapy, even though it may have a modest positive impact on clinical parameters in patients with periodontitis.

Conflict of Interests

No conflict of interest was declared by the authors

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Data Sharing Statement

Upon reasonable request, the associated author can receive further data.

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