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Original Research Article

Clinical Evaluation of Diode Laser as an Adjunct in Non-Surgical Periodontal Therapy

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Abstract:

Aim: The study aimed to determine and compare pocket depths (PD), relative attachment levels (RAL), bleeding on probing (BOP), and plaque indices (PI) in patients treated with scaling and root planning (SRP) alone versus SRP combined with diode laser therapy.

Materials and Methods: The study involved 30 subjects who met the inclusion and exclusion criteria. Group I consisted of 15 patients treated with SRP and diode laser irradiation, while Group II included 15 patients treated only with SRP. Clinical parameters, including PD, RAL, BOP, and PI, were recorded at baseline, 7 days, and 1 month. Statistical analysis was conducted using the Kolmogorov-Smirnov test, Shapiro-Wilk test, t-test, and chi-square test.

Results: The addition of diode lasers to SRP during the maintenance phase showed better results compared to SRP alone. Moderate periodontal pockets with moderate attachment loss significantly improved in Group I compared to Group II. However, there was no change in deep pockets with severe attachment loss in either group.

Clinical Significance: The study demonstrates that using the specified laser parameters and application modality results in faster healing. Therefore, this treatment can be recommended for moderate periodontal pockets.

Keywords: Dental laser, Laser dentistry, Laser dentistry treatments, Laser uses in dentistry.

Introduction

Periodontal therapy encompasses both nonsurgical and surgical approaches, as well as systematic follow-up care. Supportive therapy is crucial within a periodontal treatment regimen, as evidenced by several studies1. Methods for supportive periodontal therapy include oral hygiene reinforcement, scaling and root planning (SRP), polishing, chemical irrigation with antiseptic agents, local drug delivery with antibiotics such as tetracycline fibers, low-level laser therapy (LLLT), photodynamic therapy, and other techniques.

Low-level laser therapy involves the use of low-power lasers or light-emitting diodes (LEDs) for therapeutic purposes. Among the various physiological effects exerted by lasers, the biostimulatory effects of low-level laser irradiation on tissue cells during therapy are notable for potentially facilitating faster wound healing in periodontal tissue repair, an outcome not typically achieved with conventional mechanical therapy [2]. Advantages of laser treatment compared to conventional methods include reduced cellular loss and tissue inflammation, hemostasis, improved visualization of surgical sites, excellent tissue ablation, and sterilization of the operating site, reduced postoperative pain, and high patient acceptance. [3]

Low-level laser therapy is also widely used in dentistry for treating oral diseases. This therapy utilizes a light source that produces extremely pure light with a single wavelength. The effects on cells result from photochemical reactions rather than thermal effects, although the precise mechanisms remain unclear. Laser therapy presents a promising alternative or adjunctive means to conventional mechanical periodontal therapy. [2] Diode lasers, in particular, have bactericidal and detoxifying effects but do not erode calculus on the root surface, making them potentially useful as a supportive treatment for SRP. Many studies have reported the use of SRP combined with lasers, but there are very few studies on laser use during the maintenance phase. To the best of the author's knowledge, there are no reports

evaluating the diode laser with the specific parameters described in this study during the maintenance phase. This study aims to determine the effectiveness of diode lasers as an adjunct to SRP during the maintenance phase. [4]

Materials and Methods

Patient Selection and Study Design:

Patients were recruited from the Department of Periodontics, Government Dental College and Hospital, Rahui, Nalanda, after obtaining ethical clearance. Inclusion criteria were adult periodontal maintenance patients with a history of chronic periodontitis treatment, having received no active or maintenance therapy for at least 6 months prior to the study, systemically healthy individuals aged 25 to 60 years, one or more periodontal sites with pocket depth ≥4 mm, relative attachment level (RAL) ≥3 mm, bleeding on probing (BOP), and subjects compliant with study terms. Exclusion criteria included pregnant or lactating women, smokers, and individuals using antibiotics or analgesics within 6 months prior to the study. This study was a randomized clinical trial.

Thirty-five patients were initially assessed, of whom five were excluded: three did not meet the selection criteria and two declined participation. Thirty patients completed the allocated periodontal therapy. Patients were randomly assigned to two groups using a coin toss method (Heads = Group I - 15 patients, Tails = Group II - 15 patients). Periodontal pockets in each patient were categorized into two subgroups based on baseline probing pocket depth (PD) and RAL:

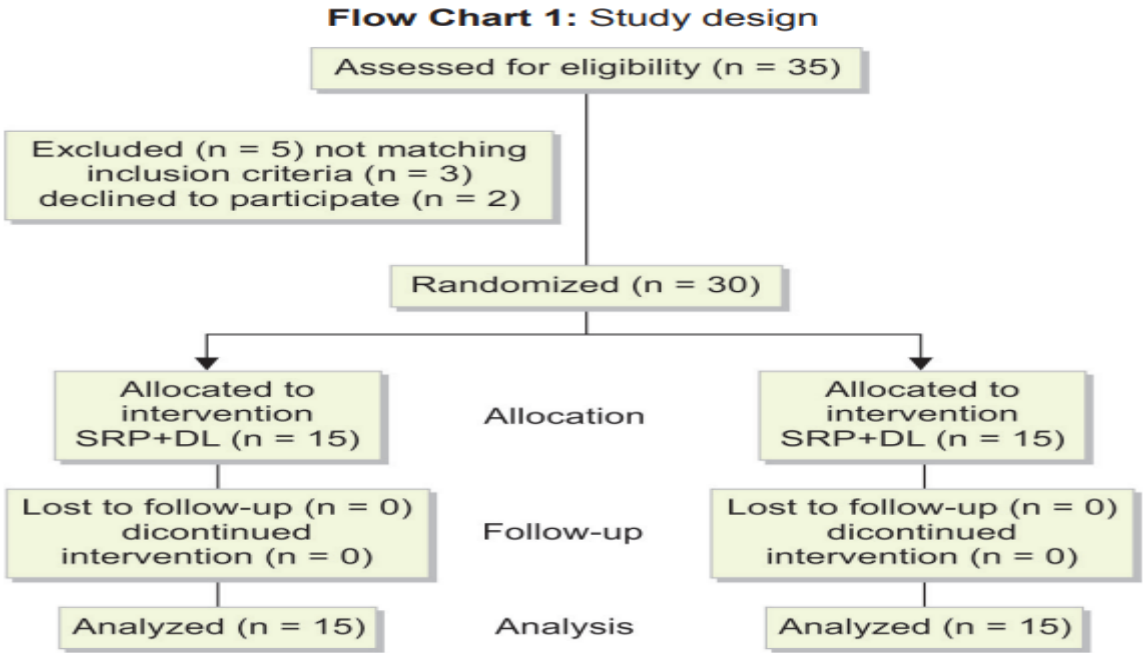
1. Pocket depths of 4 to 6 mm (moderate pockets) and relative attachment loss of 7 to 9 mm (moderate loss).
2. Pocket depths ≥7 mm (deep pockets) and relative attachment loss ≥10 mm (severe loss).

Patients were thoroughly briefed about the study's nature and objectives, and written informed consent was obtained from each participant (see Flow Chart 1).

Clinical Parameters

These clinical parameters were assessed at baseline, day 7, and 1 month:

- **Plaque Index (PI):** Recorded at four sites around each tooth using the Silness & Loe (1964) criteria.
- **Probing Pocket Depth (PD):** Assessed using a Michigan O probe with Williams's markings on four surfaces of the teeth (mesiobuccal, buccal, distobuccal, palatal, or lingual). PD was measured from the gingival crest to the base of the pocket, using the occlusal level as a reference point.
- **Relative Attachment Level (RAL):** Measured with a Michigan O probe with Williams markings. RAL indicates the measurement from a fixed point at the occlusal level to the base of the pocket.
- **Bleeding on Probing (BOP):** Recorded as present or absent.



Flow Chart 1: Study Design

All parameters were evaluated by the same investigator at each time interval, which was blinded to the type of treatment. Treatment according to randomization was performed by another operator, ensuring blinding of the outcome assessor.

Treatment Protocol

Thorough scaling and root planning (SRP) were performed using a piezoelectric ultrasonic unit (EMS) set to a moderate intensity, with appropriate tips and curettes used as needed.

The time spent on SRP for each tooth was not restricted. In addition to SRP, Group I patients received treatment with a diode laser. At baseline and subsequent visits, all patients received oral hygiene instructions, which were reinforced during follow-up appointments.

Laser Treatment

A Gallium-aluminium-arsenide diode laser (ezlase™) with a wavelength of 940 nm was used for treatment. The laser was set at a power output of 2 W, with an average power of 0.66 W in a pulse interval of 20 ms and a pulse length of 20 ms, delivering 30 J/cm² and 15 J/cm² of energy. Irradiation was conducted using a 300 µm fiber optical delivery system, which was moved from the coronal to the apical side of interdental pockets. In buccal pockets, lasing proceeded from mesial to distal, while in lingual/palatal pockets, it proceeded from distal to mesial.

A sweeping motion was used in parallel paths for each pocket, inclined approximately 20° toward the gingival wall, totaling 30 seconds of lasing per tooth. Each pocket received two sessions of 30-second lasing, separated by a 60-second interval at baseline and day 7 (see Fig. 1).

The fiber tip was regularly inspected and cleaned with damp sterile gauze to remove soft tissue debris buildup during lasing.

All laser safety protocols were strictly followed. After each lasing session, the periodontal pocket was irrigated with normal saline.

Figure 1:

Statistical Analysis

All results were recorded in a Microsoft Excel spreadsheet and analyzed using Statistical Package for the Social Sciences (SPSS) version 11.0 software. Normality tests were conducted using Kolmogorov-Smirnov and Shapiro-Wilk tests, confirming that most parameters followed a normal distribution. Parametric tests, including independent and paired t-tests, were employed to analyze the data obtained. For analysis of pocket depth and relative attachment level (RAL), the chi-square test was utilized. A p-value <0.05 was considered statistically significant.

Results

Group I: In Group I, significant reductions were observed in Plaque Index (PI) and Bleeding on Probing (BOP) at all-time points. Moderate pocket depths (PD) showed significant improvement from baseline to day 30 and from day 7 to day 30, whereas deep pockets did not exhibit statistically significant changes.

Analysis of Relative Attachment Levels (RALs) using paired t-tests showed significant differences from baseline to day 7 and from day 7 to day 30 for moderate RAL, but no significant changes were observed for severe RAL.

Group II: In Group II, significant reductions were noted in PI and BOP at all-time points except for PI between day 7 and day 30. Moderate PDs showed significant reductions from baseline to day 30 and from day 7 to day 30, although statistical significance was not achieved. Deep pockets did not exhibit statistically significant changes. Comparison of

RALs using group t-tests indicated no significant differences for both moderate and severe RALs.

Between-group Comparison: When comparing both groups, PI showed statistically significant reductions in both groups, while BOP reductions were statistically significant only in Group I at baseline and day 7. Reductions in pocket depths were observed in both groups from baseline to day 30, with statistically significant reductions observed in moderate pocket depths in Group I compared to Group II on day 30, but not on day 7. Deep pockets (≥7 mm) did not show statistically significant reductions in either treatment group. Significant differences in RALs were observed between Group I and Group II at baseline and day 7 for moderate RAL, while severe RAL did not show statistically significant attachment gain.

(Table 1, Table 2, Table 3 summarize these findings.)

These results suggest that the addition of diode laser therapy (Group I) alongside SRP may provide additional benefits in terms of reducing PI, BOP, and moderate pocket depths compared to SRP alone (Group II), particularly in the short-term follow-up period.

Table 1: Comparison of PI and BOP in groups I and II

Time intervals	Groups	n	Mean	Std. deviation	Std. error mean	p-value
PI-base line	I	15	1.5337	0.41191	0.11152	0.102
	II	15	1.6510	0.39835	0.10543	
PI-7th day	I	15	0.5207	0.19858	0.04869	0.102
	II	15	0.3613	0.21335	0.05767	
PI-30th day	I	15	0.5730	0.20692	0.05343	0.302
	II	15	0.3533	0.31176	0.08689	
BOP-base line	I	15	30.3233	11.05613	2.85468	0.030*
	II	15	25.5333	10.75945	2.79066	
BOP-7th day	I	15	14.4867	5.10464	1.57621	0.031*
	II	15	14.1667	4.62086	1.19310	
BOP-30th day	I	15	3.4000	4.01899	0.77950	0.238
	II	15	2.4667	2.16685	0.55948	
I: Plaque index; BOP: Bleeding on probing *p<0.05(Statistically significant)						

Discussion

Clinical studies have shown that the long-term success of periodontal therapy relies heavily on the continuing periodontal maintenance phase following the active phase of treatment. [5] During maintenance therapy, sites may experience persistent disease that never resolves or may become reinfected, requiring further treatment. Various interventions such as lasers, photodynamic therapy, and local drug delivery have been explored for maintenance therapy. Some studies have reported the use of different lasers to treat recurring periodontal disease in maintenance patients. [5,7,8] Diode laser-assisted periodontal therapy using photodynamic therapy was found not to be superior to conventional mechanical debridement; however, photodynamic therapy has shown superiority in eliminating pockets, especially in single-rooted teeth during the maintenance phase, as seen by Campos et al. [9]

In our study, a piezoelectric ultrasonic unit (EMS) was used to perform SRP. Chapper et al. found no significant difference in treatment outcomes between ultrasonic scaling alone and ultrasonic scaling followed by hand scaling as the final step. Ultrasonic scalers have been effective in removing subgingival biofilm and calculus. It is known that endotoxins are loosely adsorbed on the root surface and can be removed using ultrasonic insert tips. However, in our study, curettes were used for the complete and thorough removal of subgingival calculus.

In the present study, PI and BOP were reduced in both groups, consistent with previous studies except for PI in group II on the 7th and 30th days. The greater reduction in BOP in group I may be attributed to the reduction of periodontal inflammation and possibly the reduction of prostaglandin E2 (PGE2) levels due to the effects of laser treatment. [10]

Table 2: Comparison of PD in groups I and II

Time Intervals	Groups	No. of Sites with Moderate Pocket 4-6 mm	No. of Sites with Pocket ≥7 mm	Chi-square	p-value
Base line	I	240	26	0.042	0.837
	II	226	26		
7th day	I	240	26	0.002	0.964
	II	226	26		

30th day	I	50	26	11.759	0.001*
	II	147	26		

Prostaglandin E2 levels increase in the periodontal connective tissues of periodontal lesions and are potent stimulators of inflammation and bone resorption. [12]

A study by Sakurai et al. showed that low-level laser irradiation might inhibit PGE2 production by the lipopolysaccharide of periodontopathogens in human gingival fibroblasts (hGF), with the inhibitory effects being time- and dose-dependent. [13] Moderate pockets were reduced only in group I, which was also observed in various studies. [14] This reduction was more pronounced on the 30th day and not observed on the 7th day, possibly indicating the healing period of the treated pocket.

The reduction in PD can be due to the availability of new sites for the attachment of connective tissue. Neither treatment modality improved deep pockets, consistent with findings by Ambrosini et al, likely due to the incomplete elimination of microbial plaque.

Table 3: Comparison of RAL in groups I and II

Time Intervals	Groups	No. of Sites with Moderate Pocket 4-6 mm	No. of Sites with Pocket ≥7 mm	Chi-square	p-value
Base line	I	198	82	8.554	0.003*
	II	146	105		
7th day	I	185	88	4.266	0.036*
	II	147	106		
30th day	I	31	21	0.000	0.990
	II	112	77		

Group I showed a statistically significant difference compared to group II in moderate attachment loss on the 7th day only, possibly due to greater retraction of periodontal tissues in the laser group, which achieved stability by the 30th day . In our study, the diode laser led to significant improvement in clinical parameters (PD, RAL, BOP) after 30 days compared to SRP alone, similar to the findings of Dukic. Other lasers, such as Er and Nd, have been tried in periodontal maintenance patients but failed to show additional benefits over conventional therapies.

There may be other mechanisms for the improved clinical response to laser therapy. Romanos et al. showed that instrumentation of soft periodontal tissues with a diode laser led to complete epithelial elimination compared to conventional treatment with hand instruments. A study by Kreisler et al. [15] stated that more reduction in PD might be due to the de-epithelialization of the pockets leading to enhanced connective tissue attachment. Laser therapy also increases levels of vascular endothelial growth factor, transforming growth factor β, and mRNA expression of insulin growth factor in hGF, resulting in a predominant role in connective tissue metabolism. Collectively, it may be inferred that the laser leads to epithelial changes where epithelium modulates connective tissue turnover during wound healing. Epithelial-connective tissue interactions are important for periodontal structure homeostasis. Coagulation and blood clot stabilization are also shown by various studies. [16] The beneficial effects of nonsurgical laser therapy for treating periodontal diseases have been discussed in many studies and reviews. [17] These benefits could be due to better subgingival debridement of the pocket and eradication of periodontal microorganisms within the subgingival area. Diode lasers disinfect bacteria thermally, primarily limited to the root surface. Levels of Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis, and Prevotella intermedia were seen to be reduced for up to 6 months.

The reported results of using diode lasers have been mixed. Some studies reported SRP + L to be better than SRP alone. In contrast, a few studies found no additional effects of lasers. Meta-analyses and systematic reviews also showed no additional effect of lasers. Variations in results may be due to small sample sizes, differences in disease classification definitions, and the use of different laser systems and parameters. Studies evaluating parameters using lasers of the same wavelength reported different results, complicating result comparison and contributing to conflicting evidence in various clinical trials. Additional randomized controlled clinical trials are necessary to assess the efficacy of lasers used adjunctively to mechanical debridement, especially in cases of severe periodontal destruction. Limitations of this study include a small sample size and the need for longer follow-up intervals for the patients.

Conclusion

Within the limitations of this study, the use of diode lasers as an adjunct to SRP during the maintenance phase showed effective results compared to SRP alone. Moderate periodontal pockets with moderate attachment loss showed significant improvement in

the laser group alone. However, there were no significant changes in deep pockets with severe attachment loss in either group. The benefits of diode laser therapy may be due to its ability to reduce periodontal inflammation and promote connective tissue attachment. Despite these promising results, further studies with larger sample sizes and longer follow-up periods are necessary to confirm the efficacy of diode lasers in periodontal maintenance therapy. Additionally, randomized controlled trials are essential to better understand the potential advantages of lasers over conventional therapies, especially in cases of severe periodontal destruction.

Clinical Significance

This study demonstrated that the specified laser parameters and application modality result in faster healing, making it an appropriate treatment for moderate periodontal pockets. The use of diode lasers as an adjunct to SRP during the maintenance phase can significantly reduce periodontal inflammation and enhance connective tissue attachment, providing a beneficial option for managing moderate periodontal disease. These findings support the recommendation of diode laser therapy for more effective periodontal maintenance.

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