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Efficacy of Diode Laser With Different Intensities as an Adjunct to Traditional Mechanical Treatment of Chronic Periodontitis

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Abstract

The recent decades, considerable attention has focused on using of different types of laser irradiation in treatment of periodontal diseases. The aim of the present study was the assessment of efficacy of low-level and high-level diode laser treatment in combination with scaling and root planing (SRP) in patients with chronic periodontitis. The total sample of the present study consisted of twelve patients had moderate to severe chronic periodontitis in at least (**3)** vital single-rooted teeth in different quadrants of each patient.

These teeth of the twelve patients were allocated into three groups according to the type of the received treatment (12 teeth from 12 patients for each group).

1- Group A (GA) treated with scaling & root planing (SRP).
2- Group B (GB) (SRP + low-level laser).
3- Group C (GC) (SRP + high-level laser).

Clinical measurements were performed by a single well trained and calibrated examiner, and they included, plaque index (PI), gingival index (GI), bleeding on probing (BOP), clinical attachment level (CAL) and probing pocket depth (PPD). The results of the present study were positive and predictable in both lasers irradiation modes. The differences between the changes of the SRP group (GA), and two lasers low and high density lasers combined with SRP groups (GB & GC) at baseline were not significant. All of the clinical parameters that were investigated in this study have showed a significant improvement at 6 months from the baseline for the three groups of the study. These findings reported that low & high-level diode laser can have a beneficial effect in treatment of chronic periodontitis in combination with traditional mechanical treatment.

Introduction

Periodontitis is a bacterial-related inflammatory disease which leads to the destruction of tooth-supporting tissues. Successful periodontal treatment is dependent on the stoppage of tissue destruction, elimination or control of etiological agents together with a microbial shift toward one typically present in health [1,2]. The elimination of the pathogenic subgingival microbiota may be achieved by scaling and root planing [3-5]. However, mechanical therapy alone, may fail to eliminate the pathogenic

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bacteria because of their location within the gingival and dental tissues or in other areas inaccessible to periodontal instruments [6,7].These limitations and the improved biological understanding of periodontal diseases (PDD) together with the emerging evidence of bacterial specificity have led to a move in emphasis from a pure mechanical approach to other methods which include the use of adjunctive antimicrobial measures. Methods of killing periodontal pathogens, therefore, are of great interest and considerable attention has been devoted to the possibility of using antibiotics or antiseptics in this respect [8].

Non-surgical treatment of destructive periodontal diseases is based on professional debridement, together with self plaque control performed by the patients themselves. Mostly professional and self plaque control are efficient in the treatment of periodontal diseases [9]. On the other hand, there are situations, because of which improper outcome of periodontal mechanotherapy or even chemotherapy do not reveal the desired results either because of difficulties in the scaling procedure itself [10], or because of the pathogenicity and/or resistance of the microorganisms [11], or even due to systemic conditions which may compromise host response to the treatment [12], or may contraindicate surgical procedures. In these situations, antimicrobial treatment adjunctive to mechanotherapy might be instituted, promoting bacterial reduction and providing additional benefits to non-surgical treatment [13]. On the other hand, chemical antimicrobial therapy may lead to harmful side effects and promote bacterial resistance to antimicrobial drugs [14,15]. So that new treatment modalities have been investigated. In recent decades, considerable attention has focused on the use of lasers (diode, erbium:yttrium-aluminum-garnet, neodymium:yttrium-aluminum-garnet, carbon dioxide, and erbium,chromium–doped yttrium-scandium-gallium-garnet lasers of varying wavelengths) as adjunct management approaches to enhance nonsurgical periodontal treatment, as they offer a less invasive surgical approach [16,17]. The diode laser has been used for gingivectomy procedures and involved the removal of gingival soft tissues only. Evidence of the effectiveness of lasers as an adjunct measure to nonsurgical periodontal treatment in the management of gingival enlargement in patients receiving medications or fixed orthodontic appliance causing gingival enlargement remains uncertain [18,19]. The diode lasers have been attracted the attentions of clinicians may be because of its cheap prices and its small size in comparison to other types laser machines. The diode lasers machines provide (High and low density diode lasers), depending on wavelengths and power output.

For the past decades, many studies have investigated the adjunctive use of high-intensity lasers in periodontal therapy. However, these studies did not provide sufficient evidence that supports the efficacy of this additional treatment, therefore, indicating the need to perform more clinical trials [20]. Due to its characteristics, as well to other known advantages such as low cost and practicality, the diode laser has been compared to the other lasers [21] , and has been subject of a diversity of studies intended to evaluate its potential in relation to its biocompatibility [22], and to its ability in reducing bacterial counts [23]. Results have been controversial; Caruso et al. [24] and De Micheli et al. [25] did not find any additional benefits

by using the diode laser during nonsurgical periodontal treatment. Other studies have shown positive results both clinically as well as microbiologically using the same type of laser [26,27] . Diode lasers may offer significant biologic benefit with respect to treatment of dentinal hypersensitivity [28-30] In addition, in vitro studies have reported that diode low-level light therapy (LLLT) decreases cell apoptosis and levels of tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β) in cultures of diabetic and hypoxic cells.[31] Further, animal studies have shown that LLLT appears to accelerate wound healing through biostimulatory effects that promote fibroblast development and proliferation [32,33].The divergence of results may be related to the different methods used by the investigators. Most studies failed to describe the fluency or the energy density used, making comparative analyses and systematic reviews difficult, if not impossible [34]. It is also important to note that, in some of the earliest studies [35,36] , a high potency laser (2.5 W) was used which is no longer rendered safe & may cause damage such as fusion, carbonization and necrosis, as well as excessive heating of the root surface [37]. According to the conflicting results of these treatment modalities with the suggestions & recommendations of the authors to perform further studies in this field of treatment, the present study was carried out using high density and low density diode lasers as an adjunct to SRP for evaluation of the efficacy of using these lasers in treatment periodontal diseases in comparison to SRP alone.

Materials and Methods

The study was conducted at the specialized dental and implant private center of the researchers. The total sample of the present study consisted of twelve patients (7 males & 5 females) with an average age of (36.66) years old, in whom, each patient had moderate to severe chronic periodontitis in at least (**3)** vital single-rooted teeth with at least 5 mm or more pocket depth in different quadrants of each patient. Each tooth from the (study 3 teeth of each patient) was designated to receive one of three types of treatment procedures. Subjects were excluded were smoker patients or alcohol or drug-dependent subjects, patients who had received periodontal treatment or antibiotics in the previous 6 months, subjects who had systemic diseases or conditions which could act as modifying factors of the periodontal condition, as well as pregnant or lactating women were also excluded of this study. The subjects went through a complete dental and systemic history recordings, impression and received radiographic and periodontal examination. The teeth of the twelve patients were allocated into three groups according to the type of the received treatment (12 teeth from 12 patients for each group).

1- Group A (GA) treated with scaling & root planing (SRP).

2- Group B (GB) (SRP + low-level laser).

3- Group C (GC) (SRP + high-level laser).

According to the study design, seven days before commencement of the experimental procedures, oral hygiene instructions were given. At day 0 (baseline) the clinical parameters records were taken before starting any treatment procedure. These parameters included, plaque index (PI), gingival index (GI), bleeding on probing (BOP), clinical attachment level (CAL) and probing pocket depth (PPD) to the nearest mm using a calibrated manual probe (Williams periodontal probe).

The clinical parameters of the selected teeth were measured and recorded by a single well trained and calibrated examiner. On the (days 1 and 7) SRP were done. The mechanical supragingival & subgingival scaling was undertaken using the ultrasonic piezoelectric device (Mectron®, Italy), and root planing under a 2% lidocaine local anesthesia, was carried out using Gracey curettes, (GC-American® Co., USA), followed by tooth polishing. The mechanical supragingival & subgingival scaling and manual root planing were undertaken by one experienced periodontist. The low density diode laser device used was (FOX, A.R.C. Laser GmbH – Germany). Low density laser irradiation was operated at a frequency of **5.0 Hz** and delivered a **0.5 W** continuous wave output at **810 nm** with a power density of **1.6 J/cm^2** . Patients received one minute treatment. The low density diode laser irradiation was applied to periodontal pockets on the (days 1, 3 and 7) after SRP. The high density laser irradiation was performed by a diode-laser equipment (FOX, A.R.C. Laser GmbH-Germany), after coronal polishing of both teeth, the fiber optic was introduced in the periodontal pocket parallel to the long axis of the tooth with slight angulations toward the soft tissue lining of periodontal pocket, one millimeter coronal to the base of the pocket, and it was moved coronally with sweeping movements, using a **power of 2 W, 25 seconds** with continuous wave output **at** a **wave length of 980 nm** with a **power density of 1,193.7 W/cm^2**.

The high density laser irradiation was performed at (day 1 & day 7) after SRP of the experimental sites. During application, protective eye-glasses were worn both by the operator and the patient. Methylene blue was applied as a mouth rinse prior to soft laser application. Three weeks after therapy procedures, clinical measurements were repeated.

Statistics: Differences between the pre- and post-treatment values within each group and differences between the changes of the low and high density lasers irradiation pre- and post-treatment values among groups were compared using the Wilcoxon matched-pairs signed rank test using the NCSS statistics package program on an IBM compatible computer. The P- value for statistical significance was set at $P < 0.05$.

Results

Table (1) shows the mean values and standard deviations of PLI & GI with the percentages of BOP of the three groups at baseline, 3 months & 6 months. The mean values of **PLI for GA** were **2.107, 1.401 & 0.812** at baseline, 3 months & 6 months respectively. The mean values of **GI for GA** were **2.549, 1.471 & 0.784** at baseline, 3 months & 6 months respectively. Regarding **BOP**, the results were as follows for **GA 100 %, 63.98% & 27.42%** at baseline, 3 months & 6 months respectively. The mean values of PLI for GB were **1.989, 0.890 & 0.173** at baseline, 3 months & 6 months respectively. The mean values of GI for GB were 2.443**,** 0.869 **&** 0.162 at baseline, 3 months & 6 months respectively. Regarding **BOP**, the results were as follows for **GB 100 %, 32.33 % & 8.11 %** at baseline, 3 months & 6 months respectively. In GC the mean values of PLI were **2.194, 0.806 & 0.204**. The mean values of GI for GC were 2.399**,** 0.970 **&** 0.201 at baseline, 3 months & 6 months respectively. The percentages of BOP of the GC were **100 %, 36.12 % & 10.04 %** at baseline, 3 months & 6 months respectively. **Table (2)** demonstrates the mean values of PPD

& CAL at different time points. The mean values of PPD for GA were **7.21, 5.79 & 4.78** at baseline, 3 months & 6 months respectively. The mean values of PPD for GB were **6.99, 4.46 & 3.11** at baseline, 3 months & 6 months respectively. The mean values of PPD for GC were **7.03, 4.33 & 3.30** at baseline, 3 months & 6 months respectively. The mean values of CAL for GA were 8.87**,** 6.58 **&** 5.58 at baseline, 3 months & 6 months respectively. The mean values of CAL for GB were 8.49**,** 5.72 **&** 3.96 at baseline, 3 months & 6 months respectively. The mean values of CAL for GC were 9.10**,** 6.04 **&** 4.12 at baseline, 3 months & 6 months respectively. **Table (3)** shows the comparative differences between each pair of groups among the 3 study groups in PPD & CAL at 3 months & 6 months. The PPD & CAL differences were statistically significant between all pairs of groups except the difference between GB & GC which was not significant at p-value < 0.05. Comparative differences between each pair of groups among the 3 study groups in PLI, GI & BOP at 3 months & 6 months are revealed in **table (4)**. The **table (5)** PLI, GI & BOP comparative differences in relation to different time points in (baseline Vs 6 months). The three study groups (GA,GB & GC) were demonstrated significant differences in values of the PLI, GI & BOP parameters between baseline and 6 months. **Table 6** shows the intragroup comparative differences at baseline and 6 months of PPD & CAL in the three study groups (GA,GB & GC). The three study groups (GA,GB & GC) were demonstrated highly significant differences in values of the PPD & CAL parameters between baseline and 6 months at p-value < 0.01.

Discussion

The use of laser is one of the most recent methods in nonsurgical periodontal treatment. Efficacy and side effects of each type of laser treatment have yet to be determined [38] .The results of the present study were positive and predictable in both lasers irradiation modes applied. The differences between the changes of the SRP group (GA), and two lasers low and high density lasers combined with SRP groups (GB&GC) at baseline were not significant. All of the clinical parameters that were investigated in our study have showed a significant improvement at 6 months from the baseline for the three groups of the study. Intergroup comparison revealed a clinical improvement of all parameters in laser groups (GB&GC). The improvement was clinically and statistically more significant than SRP alone (GA). The comparison between the high & low density diode lasers at 6 months demonstrated no significant differences between them in all tested clinical parameters. The current study was conducted as a result of numerous suggestions and recommendations of other studies because of the controversy and divergence of the related studies of the use of laser therapy as an adjunct to conventional mechanical treatment of periodontal diseases. The choice of high-intensity diode laser was grounded in previous in vitro studies. Our preliminary concern was that laser could be effective and also safe other characteristics about diode laser were taken into account in order to use in dental practice: it is one of the cheaper high intensity laser; furthermore the diode laser machine used in this research is small and light, therefore portable. To set these parameters we based on the studies of Theodoro et al.[22], that demonstrated high intensity diode laser (1.4 W/30 s) did

not provide signs of thermal effects such as charring, necrosis or fusion on the root. Kreisler et al. [39] which inferred about the angle of laser beam, time and power irradiation on gingival fibroblasts. There are many evidences through a number of studies showed positive results in different and clinical and microbiological aspects of PPD. The fact that laser therapy is effective in periodontal regeneration. Human periodontal ligament fibroblasts were higher proliferation activity when cultured and irradiated with an 809-nm wavelength diode laser, this study suggested that the laser treatment may be beneficial in regenerative periodontal therapy. The results of the present study are also in agreement with the findings of a study of Angelov et al (2009) [40] They used low-level diode laser (630 to 670 nm) as an adjunct to conventional mechanical treatment (SRP). They performed laser application for five days for the first test group and the same laser treatment was administered for a total of 10 days for the second test group. For all clinical parameters, the two laser groups reported statistically significant differences compared to baseline data and compared to SRP alone, these findings suggested that a low-level diode laser can have a beneficial effect for treating inflammatory chronic advanced periodontitis. Another study by Walter et al (2012) [2] indicated that multiple adjunctive applications of a 980-nm diode laser with SRP showed periodontal pocket depth (PPD) improvements in moderate periodontal pockets compared to SRP alone. This finding is in accordance with our current study in relation to PPD. As the periodontal diseases are bacterial inflammatory conditions. A part of the complex series of events triggered by the micro-organisms is the production of the host prostaglandins (PGE2) and cyclooxygenases (COX), which have been involved in bone resorption in periodontal and endodontic lesions. After irradiation with a diode laser, the results indicated that the irradiated cells produced considerably less PGE2 and COX, indicating the possible anti-inflammatory role of the diode laser, which may have a therapeutic effect on the aggravation of gingivitis and periodontitis [41] . The findings of our study are augmented by other clinical and microbiological studies. Moritz, et al.[23] have been used a diode laser with an 810-nm on fifty patients with chronic periodontitis. Subgingival bacterial samples were collected from all patients after 6 months, the final values of the periodontal indices and further microbiologic samples were measured. The total bacterial count, as well as specific bacteria (eg, *A. actinomycetemcomitans, P. intermedia*, and *P. gingivalis*), were assessed. The sites that received the subgingival laser treatment exhibited a much lower bacterial count. Furthermore, the reduction of values of bleeding on probing was 96.9% in the laser group compared to 66.7% in the control group. The authors concluded that diode laser treatment following scaling and root planing had a bactericidal effect and reduced inflammation. Diode lasers have also been used as adjuncts to periodontal surgery [42]. In the case of root proximity and very narrow interradicular space made thorough manual periodontal instrumentation impossible. A 0.4-mm laser fiber-optic was easily introduced to reach the narrow bottom of a 10-mm periodontal defect, and the area was irradiated. In a short strokes/steps motion at 0.8 W, the granulation tissue was carefully ablated, most likely reducing bacterial presence in the area, and according to the literature previously cited, the level of inflammation was decreased. These outcomes demonstrated the benefits of

using diode laser in very narrow inaccessible sites. There is no recommended time for the laser to be in the pocket; the total amount of time for the laser procedure is a function of the extent of the diseased soft tissue. However, in general, lase pockets 6 mm or less for approximately 30 seconds and those greater than 6 mm for 45 seconds. If the patient experiences noticeable discomfort, lower the power setting and administer anesthetic, if necessary.

Conclusion

While scaling and root planing remain the initial treatment modality in periodontal therapy, clinicians may also consider the use of a soft-tissue diode laser as an efficacious and helpful tool in their daily armamentarium. The periodontal treatment of periodontitis accompanied with deep periodontal pocket sites using (High and low density diode lasers after SRP have shown predictable results demonstrated as improvement in all of the investigated clinical parameters at 3 and 6 months in comparison with conventional mechanical debridement (SRP alone). The laser should be used as an adjunct to conventional therapy both for its decontaminating and biostimulating effects.

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Table 1: Shows the mean & standard deviation of PI, GI & percentages of BOP of all groups at study time intervals.

LL/SRP/GC		**HL/SRP/GB**		**SRP/GA**		**Parameter**
SD	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**PLI**
0.302	2.194	0.276	1.989	0.251	2.107	**Baseline**
0.221	0.806	0.103	0.890	0.138	1.401	**3 months**
0.0116	0.204	0.0251	0.173	0.112	0.812	**6 months**
SD	Mean	SD	Mean	SD	Mean	**GI**
0.458	2.399	0.296	2.443	0.327	2.549	**Baseline**
0.321	0.970	0.127	0.869	0.412	1.471	**3 months**
0.061	0.201	0.081	0.162	0.164	0.784	**6 months**
%		%		%		**BOP**
100 %		100 %		100 %		**Baseline**
36.12 %		32.33 %		63.98 %		**3 months**
10.04 %		8.11 %		27.42 %		**6 months**

Table 2: Shows the mean & standard deviation of PPD & CAL of all groups at study time points.

GC		**GB**		**GA**		**Parameters**
SD	**Mean**	SD	**Mean**	**SD**	**Mean**	**PPD**
1.65	7.03	1.34	6.99	1.26	7.21	**Base line**
1.93	4.33	1.12	4.46	1.11	5.79	**3 months**
0.87	3.30	0.52	3.11	1.0	4.78	**6 months**
SD	Mean	SD	Mean	SD	Mean	**CAL**
1.89	9.10	2.10	8.49	1.98	8.87	**Base line**
1.84	6.04	1.33	5.72	1.11	6.58	**3 months**
1.66	4.12	0.77	3.96	0.98	5.58	**6 months**

Table 3: Shows the comparative differences among the 3 groups in PPD & CAL.

PPD	3 months	Significance	6 months	Significance
GA/GB	5.79 & 4.46	P < 0.05 (S)	4.78 & 3.11	P < 0.05 (S)
GA/GC	5.79 & 4.33	P < 0.05 (S)	4.78 & 3.30	P < 0.05 (S)
GB/GC	4.46 & 4.33	P > 0.05 (NS)	3.11 & 3.30	P > 0.05 (NS)
CAL	**3 months**	**Significance**	**6 months**	**Significance**
GA/GB	6.58 & 5.72	P < 0.05 (S)	5.58 & 3.96	P < 0.05 (S)
GA/GC	6.58 & 6.04	P < 0.05 (S)	5.58 & 4.12	P < 0.05 (S)
GB/GC	5.72 & 6.04	P > 0.05 (NS)	3.96 & 4.12	P > 0.05 (NS)

Table 4: Shows the comparative differences among the 3 groups in PLI, GI & BOP.

PLI	3 months	Significance	6 months	Significance
GA/GB	1.401 & 0.890	P < 0.05 (S)	0.812 & 0.173	P < 0.05 (S)
GA/GC	1.401 & 0.806	P < 0.05 (S)	0.812 & 0.204	P < 0.05 (S)
GB/GC	0.890 & 0.806	P > 0.05 (NS)	0.173 & 0.204	P > 0.05 (NS)
GI	**3 months**	**Significance**	**6 months**	**Significance**
GA/GB	1.471 & 0.869	P < 0.05 (S)	0.784 & 0.162	P < 0.05 (S)
GA/GC	1.471 & 0.970	P < 0.05 (S)	0.784 & 0.201	P < 0.05 (S)
GB/GC	0.869 & 0.970	P > 0.05 (NS)	0.162 & 0.201	P > 0.05 (NS)
BOP	**3 months**	**Significance**	**6 months**	**Significance**
GA/GB	63.98 & 32.33	P < 0.05 (S)	27.42 & 8.11	P < 0.05 (S)
GA/GC	63.98 & 36.12	P < 0.05 (S)	27.42 & 10.04	P < 0.05 (S)
GB/GC	32.33 & 36.12	P > 0.05 (NS)	8.11 & 10.04	P > 0.05 (NS)

Table 5: Shows the intragroup comparative differences in baseline and 6 months of PL, GI & BOP.

PLI	**Baseline**	**6 months**	**P-value**	**Significance**
GA	2.107	0.812	P < 0.05 (S)	P < 0.05 (S)
GB	1.989	0.173	P < 0.05 (S)	P < 0.05 (S)
GC	2.194	0.204	P < 0.05 (S)	P < 0.05 (S)
GI	**Baseline**	**6 months**	**P-value**	**Significance**
GA	2.549	0.784	P < 0.05 (S)	P < 0.05 (S)
GB	2.443	0.162	P < 0.05 (S)	P < 0.05 (S)
GC	2.399	0.204	P < 0.05 (S)	P < 0.05 (S)
BOP	**Baseline**	**6 months**	**P-value**	**Significance**
GA	100 %	27.42 %	P < 0.05 (S)	P < 0.05 (S)
GB	100 %	8.11 %	P < 0.05 (S)	P < 0.05 (S)
GC	100 %	10.04 %	P < 0.05 (S)	P < 0.05 (S)

Table 6: The intragroup comparative differences in baseline and 6 months of PPD & CAL.

PPD	Baseline	6 months	P-value	Significance
GA	7.21	4.78	P < 0.001	HS
GB	6.99	3.11	P < 0.002	HS
GC	7.03	3.30	P < 0.001	HS
CAL	**Baseline**	**6 months**	**P-value**	**Significance**
GA	8.87	5.58	P < 0.001	HS
GB	8.49	3.96	P < 0.001	HS
GC	9.10	4.12	P < 0.0012	HS