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DIODE LASER IN THE TREATMENT OF CHRONIC PERIODONTITIS IN DIABETIC PATIENTS

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ABSTRACT

Background: Diabetes mellitus (DM) is one of the common chronic diseases in adult populations in the world. DM has a strong influence on the oral cavity and represents a risk factor for gingivitis and periodontitis. Conventional periodontal therapy includes both non-surgical and surgical approaches. The first category includes SRP, the adjunctive use of chemotherapeutic agent, local route of drug delivery and recently laser therapy Applying lasers as an adjunctive or alternative to mechanical treatment had a great run in the treatment of chronic periodontitis (CP). Among laser applications, low-level laser therapy (LLLT) is recommended for its pain-reducing, wound-healing promoter and anti-inflammatory effects.

Objective: The aim of the study was to assess the effect of diode laser as adjunct to scaling and root planing in management of moderate chronic periodontitis in diabetic patients with glycemic control (Type II-non insulin dependent).

Material and methods: Twenty sites in ten diabetic patients with glycemic control (Type II-non insulin dependent) with moderate chronic periodontitis were selected and randomly divided into two groups. **Group I** ten sites received only SRP; **group II** ten sites received SRP + LLLT. The following clinical parameters (plaque index (PI), bleeding on probing (BOP), probing pocket depth (PPD), and clinical attachment level (CAL) were recorded for each patient in both groups before treatment (baseline), 3 and 6 months after treatment. Gingival crevicular fluid (GCF) samples were collected and analyzed using ELISA test for quantative measurements of MMP-9.

Results: The results showed significant improvement in the mean PI, BOP, PPD, and CAL gain for the two groups at 3 and 6 months as compared to baseline value. Furthermore, when comparing the two groups, the results showed non-significant difference at all study period (P>0.05). While group II showed better reduction in the mean PI as compared to group I at 3 and 6 months for PI and at 3 months for BOP at 6 months. Moreover, results showed more reduction in the mean PPD and CAL at group II than group I. Also, ELISA test demonstrated significant improvement in MMP-9 levels till 6 month regarding both groups. While there were no significant difference when comparing group I and II at all study period (P>0.05).

Conclusion: Both treatment modalities resulted in a significant clinical improvement without a clear superiority of one procedure.

Keywords: Type 2 diabetes mellitus; chronic periodontitis, low level lase therapy (LLLT), matrix metalloproteinase 9 (MMP-9), scaling and root planing (SRP).

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INTRODUCTION

Diabetes mellitus (DM) is a complex metabolic disorder characterized by chronic hyperglycemia. Diminished insulin production, impaired insulin action, or a combination of both result in the inability of glucose to be transported from the blood stream into the tissues, which in turn results in high blood glucose levels[1].

There are two main types of diabetes mellitus: Type I diabetes, insulin dependent diabetes mellitus (IDDM), is caused by lack of insulin secretion by beta cells of the pancreas. Type II diabetes, non-insulin dependent diabetes mellitus (NIDDM), is caused by decreased sensitivity of target tissues to insulin[2]. The second type is the most common form of diabetes, and it accounts for 90% to 95% of all diagnosed cases in adults, with the other 10% due primarily to diabetes mellitus type I and gestational diabetes[3].

Periodontal disease is considered the sixth most common complication in individuals with diabetes[4]. Periodontitis is defined as an inflammatory disease of the supporting tissues of the teeth caused by specific groups of microorganisms, resulting in increased destruction of the periodontal ligament and alveolar bone with increased pocket formation, recession, or both[5].

The relationship between diabetes mellitus and periodontal disease is bidirectional. Periodontitis generally coexist with diabetes and inadequate glycemic control can increase risk of developing periodontal disease. Moreover, periodontal therapy reduces both systemic inflammation and resistance to insulin[6].

The critical objective of periodontal treatment is to alter the microbial etiology, arrest the disease progression and resolve inflammation[7].

Several modalities are available to achieve these goals and they can be broadly classified into non-surgical and surgical therapy. The first category includes scaling and root planing (SRP), the adjunctive use of chemotherapeutic agent, local route of drug delivery and recently laser therapy[4,7]. Low-Level Laser Therapy LLLT is thought to reduce pain, accelerate wound healing and reduce the inflammatory process by reduction of prostaglandin E2 that may inhibit progression of gingivitis and periodontitis with no side effects[8].

The term LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. There are two types of lasers: hard lasers such as carbon dioxide and neodymium-doped yttrium aluminum garnet which offer both hard tissue and soft tissue applications and cold or soft lasers based on the semiconductor diode devices, which are used predominantly for LLLT [9].

So the aim of this study was to assess the effect of diode laser as adjunct to scaling and root planing in management of moderate chronic periodontitis in diabetic patients with glycemic control (Type II-non insulin dependent).

MATERIALS AND METHODS

1) **Diode laser***, 808 nm +/- 10 nm wavelength, 300μm fiber (figure 1).
2) **Enzyme Linked Immuno-Sorbent Assay {ELISA} (Quantikine)** for the determination of Matrix metalloproteinase 9 (MMP-9) concentration in the GCF** (figure 2).
3) **Sterile paper points** (Absorbent colour coded, Ref A 022R) for collecting GCF samples for immunological analysis.

Approval for this study was obtained from Faculty of Dentistry, Tanta University Research

* GaAlAs diode (Elexxion claros nano compact class IV dental laser, Radolfzell, Germany).
*** R&D Systems, Inc.

Fig. (1) Ga Al As diode laser (elexxion claros nano compact class IV dental, Radolfzell, Germany) and 200 µm fiberoptic.

Ethics Committee (REC). The purpose of the present study was explained to the patients and informed consents were obtained.

A total of twenty sites in ten diabetic patients with glycemic control (Type II-non insulin dependent) with moderate chronic periodontitis were selected who fulfilled the following criteria: Their age ranged from 35 to 55 years old of both genders, clinical attachment loss ranged from 3-4 mm, pocket depth ranged from 5-6 mm and optimal compliance as evidenced by no missed treatment appointments and a positive attitude toward oral hygiene. Excluded from this study patients with risk factors (e.g. - smoking, pregnancy or any other systemic disease that may alter the course of periodontal therapy), history of antibiotics or anti-inflammatory drugs in the previous three months, acute condition in the mouth and history of periodontal surgery in the last year in the selected sites.

Site grouping:

The twenty sites among the patients were randomly classified into two groups using sealed envelopes. The patients treated with one of the following modalities as follow:

- **Group I: (Control group)** sites received only SRP.
- **Group II: (Test group I)** sites received SRP + LLLT.

Treatment steps:

Group I: Complete SRP was done for all patients on two sessions within a week.

Group II: Laser application was done 3 minutes after SRP and pockets were irradiated by the laser light 1.0 CW/cm^2 for about 30 seconds (according to the laser machine manufacturer's instructions) (figure 4).

All the treatment steps were performed by the same doctor and during LLLT procedures; both patients and doctors should wear the protective glasses.

Collection of GCF samples:

The GCF samples were taken from the area showing the deepest pocket depth of the selected teeth.

For each site, (GCF) sample were collected after removal of the plaque (to prevent site contamination) using paper points, which inserted into the pockets until resistance felt, and kept there for 30 seconds. The samples then diluted in phosphate buffer saline (PBS) up to 0.2ml. After 15 min., the paper points were removed and the samples frozen at -20 C for analysis. Blood contaminated samples were discarded (Figure 3).

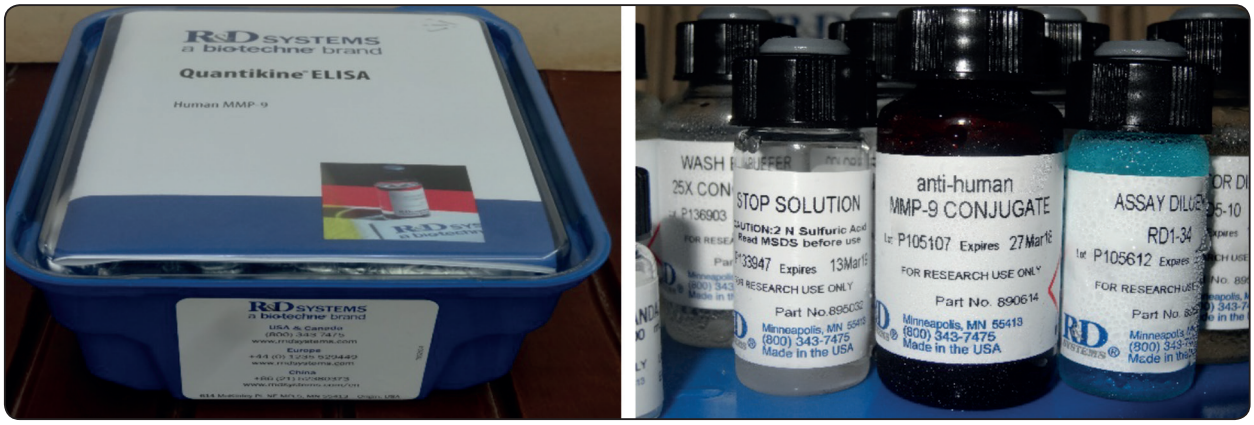

Fig. (2) ELISA kit for determination of MMP-9 concentration in GCF.

Fig. (3) GCF Sample collected and preserved in phosphate buffer saline (PBS).

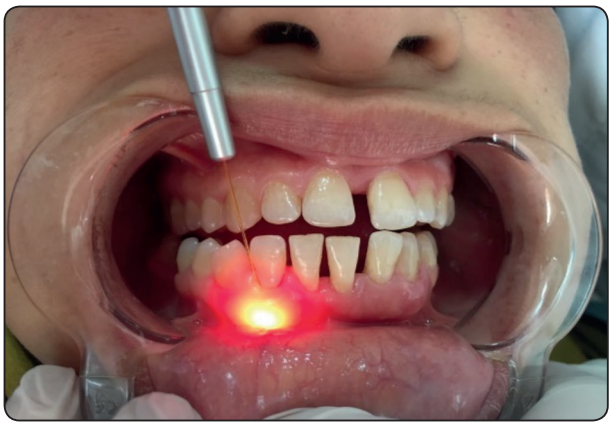

Fig. (4) LLLT application.

Treatment evaluation

The following clinical parameters (Plaque index (PI), Bleeding on probing (BOP), Probing pocket depth (PPD) and Clinical attachment loss (CAL)) and immunological parameter (Enzyme-Linked Immuno-Sorbent Assay (ELISA) for the quantitative measurement of MMP-9 concentration in the GCF) were measured at baseline (before treatment), 3 months and 6 months (after treatment).

RESULTS

The results of this study compromised two categories namely clinical and immunological. No undesirable reactions such as burning sensation, discomfort, pain or adverse effects to LLLT have been observed throughout the study period.

I- Clinical results

Plaque index results: group I showed statistically highly significant reduction of the mean PI score at 3 months as compared to mean value at baseline which maintained up to 6 months (P<0.001). In group II, statistically highly significant reduction of the mean PI score at 3 and 6 months as compared to their mean value at baseline (P<0.001). However, the reduction at 6 months was non-significant as compared to 3 months (P>0.05). While comparing group I and II, there was a statistically non-significant reduction at all study period (P>0.05). However, group I showed better improvement than group II at 3 and 6 months (tables 1 and 2).

TABLE (1): Comparison of PI score along the study periods in group I and II

PI	Group I (SC/RP alone) (n= 10)	Group II (SC/RP+ LLLT) (n= 10)	H	P	GI vs. GII
Baseline	1.50 ± 0.71	2.0 ± 0.82	2.168	0.338	NS
Three months	0.50 ± 0.53	0.60 ± 0.52	3.412	0.182	NS
Six months	0.50 ± 0.53	0.70 ± 0.48	4.920	0.085	NS

*H, p: H and p values for **Kruskal Wallis test**,*

Bleeding on probing results: In both group I and II showed statistically significant reduction at 3 and 6 months when compared to their mean values at baseline (P<0.05), however a statistically non-significant reductions were recorded comparing 3 and 6 months results to each other (P>0.05). While comparing group I and II, the mean BOP reduction was statistically non-significant at all evaluation period (P>0.05). However, at 6 months, group II showed better improvement than group I (table 3 and 4).

TABLE (2): Comparison of PI score between the three studied periods in group I and II

PI	Baseline vs. 3m.	Baseline vs. 6m.	3m. vs. 6m.	$^{Fr}\chi^2$	P
Group I (SC/RP alone)	0.004* (HS)	0.004* (HS)	1.000	18.000*	<0.001*
Group II (SC/RP+ LLLT)	0.006* (HS)	0.003* (HS)	0.564	16.938*	<0.001*

*c^2: Chi square for **Friedman test**, Sig. bet. Periods was done using **Marginal Homogeneity Test;***

TABLE (3): Comparison of BOP along the study periods in group I and II

BOP	Group I (SC/RP alone) (n= 10)		Group II (SC/RP+ LLLT) (n= 10)		χ^2	^{MC}p	GI vs. GII
	No.	%	No.	%			
Negative	0	0.0			–	–	–
Positive	10	100.0	10	100.0			
Negative	7	70.0	6	60.0	2.372	0.454	NS
Positive	3	30.0	4	40.0			
Negative	6	60.0	7	70.0	1.009	0.879	NS
Positive	4	40.0	3	30.0			

*c^2, p: c^2 and p values for **Chi square test** for comparing between groups*

Probing pocket depth results: In both groups, the mean value of PPD was statistically significant at 3 months compared to the mean value at baseline (P<0.05) and statistically highly significant at 6 months compared to the mean value at baseline (P<0.001). On the other hand, there was non-significant difference at 6 month compared with

3month (P>0.05). While comparing group I and II, the results showed that the mean PPD reduction was statistically non-significant at all study periods. However, at 6 months, group II showed better improvement than group I (table 5 and 6).

TABLE (4): Comparison of BOP between the three studied periods in groups I and II

BOP	Baseline vs. 3m.	Baseline vs. 6m.	3m. vs. 6m.	$^{Fr}\chi^2$	P
Group I (SC/RP alone)	0.016*(S)	0.031*(S)	1.000	12.286*	0.002*
Group II (SC/ RP+ LLLT)	0.031*(S)	0.016*(S)	1.000	10.750*	0.005*

c2: Chi square for Friedman test,

Sig. bet. Periods was done using McNemar test

TABLE (5): Comparison of PPD along the study periods in group I and II

PPD	Group I (SC/RP alone) (n= 10)	Group II (SC/ RP+ LLLT) (n= 10)	H	P	GI vs. GII
Baseline	5.30 ± 0.48	5.20 ± 0.42	0.360	0.835	NS
Three months	4.0 ± 0.67	3.60 ± 0.84	1.511	0.470	NS
Six months	3.40 ± 1.07	2.90 ± 0.88	0.736	0.692	NS

*H, p: H and p values for **Kruskal Wallis test**,*

TABLE (6): Comparison between the three studied periods regarding PPD in group I and II

PPD	Baseline vs. 3m.	Baseline vs. 6m.	3m. vs. 6m.	$^{Fr}\chi^2$	P
Group I (SC/RP alone)	0.014*(S)	<0.001* (VHS)	0.264	15.314*	<0.001*
Group II (SC/ RP+ LLLT)	0.014*(S)	<0.001* (VHS)	0.146	17.886*	<0.001*

*c^2: Chi square for **Friedman test**, Sig. bet. Periods was done using **Post Hoc Test (Dunn-Bonferroni)***

Clinical attachment level results: In both groups, there were significant improvement of CAL mean gain comparing 3 months to the mean value at baseline (P<0.05) and highly significant improvement when comparing 6 months to the mean value at baseline (P<0.001). While a non-significant difference when comparing 3 and 6 months to each other (P>0.05). By comparing group I and II, the differences were statistically non-significant at all study period (P>0.05). While at 6 months, results showed more reduction at group II compared to group I (table 7 and 8).

TABLE (7): Comparison of CAL along the study periods in group I and II

CAL	Group I (SC/RP alone) (n= 10)	Group II (SC/ RP+ LLLT) (n= 10)	H	P	GI vs. GII
Baseline	3.30 ± 0.48	3.20 ± 0.42	0.360	0.835	NS
Three months	2.0 ± 0.67	1.60 ± 0.84	1.511	0.470	NS
Six months	1.50 ± 0.97	1.0 ± 0.67	1.534	0.646	NS

*H, p: H and p values for **Kruskal Wallis test**,*

TABLE (8): Comparison of CAL between the three studied periods in group I and II

CAL	Baseline vs. 3m.	Baseline vs. 6m.	3m. vs. 6m.	$^{Fr}\chi^2$	P
Group I (SC/RP alone)	0.010*(S)	0.001* (HS)	0.371	15.235*	<0.001*
Group II (SC/ RP+ LLLT)	0.010*(S)	0.001* (HS)	0.219	17.706*	<0.001*

*c^2: Chi square for **Friedman test**, Sig. bet. Periods was done using **Post Hoc Test (Dunn-Bonferroni)***

II- Immunological results:

In group I showed statistically significant reduction in the mean level of MMP-9 at 3 months as

compared to the mean value at baseline (P<0.05) and highly significant improvement when comparing 6 months to the mean value at baseline (P<0.001). However, these reductions were statistically non-significant by comparing 3 and 6 months (P>0.05). While in group II, results showed a statistically significant improvement when comparing 3 months to the mean value at baseline (P<0.05) and very highly significant improvement when comparing 6 months to the mean value at baseline (P<0.001). While, non-significant improvement when comparing 3 and 6 months (P>0.05). By comparing group I and II, there was statistically non-significant difference at all study period (P>0.05) (table 9 and 10).

TABLE (9): Comparison of MMP9 along the study periods in group I and II

MMP9	Group I (SC/RP alone) (n= 10)	Group II (SC/ RP+ LLLT) (n= 10)	H	P	GI vs. GII
Baseline	206.0 ± 158.1	264.1 ± 218.1	0.180	0.914	NS
Three months	115.5 ± 102.5	132.0 ± 147.0	2.089	0.352	NS
Six months	96.60 ± 100.7	99.50 ± 104.2	0.371	0.831	NS

*H, p: H and p values for **Kruskal Wallis test**,*

TABLE (10): Comparison of MMP-9 level between the three studied periods in group I and II

MMP9	Baseline vs. 3m.	Baseline vs. 6m.	3m. vs. 6m.	$^{Fr}\chi^2$	P
Group I (SC/RP alone)	0.025* (S)	0.001*(HS)	0.219	13.351*	0.001*
Group II (SC/ RP+ LLLT)	0.019*(S)	<0.001*(VHS)	0.180	15.081*	<0.001*

c2: Chi square for Friedman test,

DISCUSSION

Diabetes Mellitus (DM) is caused by a deficiency in insulin or its action, resulting in hyperglycemia and hyperlipidemia, which are involved in the development of many systemic and oral complications[10].

Periodontal therapy aims to remove supra and subgingival dental biofilm to reduce periodontal inflammation, re-establish tissue homeostasis, and stop the progression of periodontal diseases[11]. Several modalities are available to achieve these goals and can be broadly classified into non-surgical and surgical therapy. The first category includes SRP, the adjunctive use of chemotherapeutic agent, local route of drug delivery and recently laser therapy[12].

The effectiveness of adjunct LLLT to periodontal mechanical therapy is still controversial. While some investigations have demonstrated additional clinical benefits for this approach in non-diabetic patients[13-15]. On other hand, others have failed to detect statistically significant differences in the evaluated clinical parameters[16-18].

To overcome the limitations of SRP and to reduce the bacterial load, contemporary research is now focused on the role of LLLT in the treatment of CP. So, this study was aimed to assess the effect of diode laser as adjunct to scaling and root planing in management of moderate chronic periodontitis in diabetic patients with glycemic control (Type II-non insulin dependent).

Patients shared in the current study were medically free except type II DM to avoid the possible impact of systemic diseases on the periodontal condition and their possible effect on the tested clinical parameters. Furthermore, smokers were also excluded from the present study as it has been reported that smoking is associated with decreased vascular flow and impaired wound healing[19].

It is well-recognized that periodontal treatment outcomes are poorer in patients with poorly

controlled diabetes as compared to well controlled diabetic individuals[20]. So, well-controlled diabetic patients with periodontal disease were selected in this study.

Laser therapy was applied in the second session of SRP because in the first session the presence of blood in gingival sulcus acts as an interventional factor which can elevate risk of thermal damage. This thin biofilm of blood products which cover root surfaces of periodontal pocket can considerably elevate absorption of energy and may lead to thermal damage to the dental pulp[21]. Thus, Based on this condition, to minimize the risk of periodontal damage, in the present study diode laser therapy was carried out in the last session of the first phase of periodontal therapy because in this phase, inflammation and bleeding has reduced to a degree which minimizes the risk of damage.

The power output used in this study was (1.0W) for LLLT according to laser machine manufacturer's instructions and **kreisler et al.,**[22] in their study who showed that 1.0W power has no or little effects on root surface and attachment level of periodontal tissue among different power of 1, 1.5, 2 and 2.5W diode laser, while 1.5W and higher power cause thermal damage and attachment loss. Additionally, low-level exposure produces a higher bactericidal effect. Besides, **Davoud Zare.,**[23] in their study demonstrated that, laser irradiation at a power output of 1.0 W or below, had no effect on the root surfaces and could achieve positive effect in the decontamination of periodontal pockets.

At baseline, statistical analysis of data revealed no significant differences between the two treatment groups in terms of PI, BOP, PPD and CAL measurements. Accordingly, any difference during the study period between the groups at the assigned intervals would be due to the treatment modality used.

This study did not detect statistically significant differences in the evaluated clinical parameters (PI, BOP, PPD and CAL) when compared group I versus group II at 3 and 6 months. While the intragroup comparison in both groups showed statistically significant changes in all of the clinical parameters.

The results showed a reduction in the mean PI scores which was maintained up to 6 months in treated groups as compared to their mean baseline values. However, a slight rebound occurred in group II at 6 months evaluation period, which reflects the effectiveness of both treatment modalities that had been used till 6 months evaluation period.

The similar finding of PI for patients receiving SRP and LLLT till 6 months may be explained by the use of mechanical therapy (SRP) and all patients received oral hygiene instructions. So the observed lower indices are not surprising.

On the other hand, it was markedly found that more favorable results obtained for group II (SRP+LLLT) as compared to group I at 3 and 6 months. This can be attributed to the fact that, the policy of using full mouth conventional mechanical therapy (SRP) can only provide temporary quantitative plaque control, but it is extremely difficult to achieve plaque control qualitatively, which was one of the reasons to look for another improvement strategy for SRP, by using of LLLT.

In the current study, group I showed improvement in BOP score till 3 month evaluation periods recording (30%), and then a slight deterioration at 6 months (40%) in comparison to the mean baseline value (100%). While in group II, results showed a statistically significant reduction in the mean BOP value at 3 and 6 months (40%) (30%) respectively as compared to the mean baseline value (100%) in contrary to PI results which revealed deterioration at 6 months period in the same group which can be explained by "specific plaque hypothesis", suggesting that a single pathogenic species or a specific group of pathogens are the cause of inflammatory periodontal disease rather than an overall proliferation of non-specific bacteria. So, treatment of periodontal diseases should be directed toward specific elimination of the suspected species without necessarily changing the amount of plaque[24].

When the treated groups were compared to each other at 3 and 6 months, there was non-significant difference in BOP which may be attributed to single application of laser in group II which may not enough to sustain anti-inflammatory effect for long follow-up period and hence the comparable outcome[25].

The results of the current study showed an improvement in the mean PPD reduction and CAL gain values for the two groups at 3 months, which was maintained till the end of the study (6 months) with better results in favor to group II. Reduction in PPD and gain CAL are the major clinical outcomes measurements to determine the success of the treatment.

Immunological evaluation is an important parameter, since the balance between local levels of cytokines and chemokines stimulated in response to periodontopathogenic bacteria and their products, determines the outcome of the immune response. This means that cytokines play an important role in the initiation and progression of periodontal disease[26].

In the present study, the two groups showed a highly significant improvement of MMP-9 level in GCF when compared to baseline till the end of the study period (6 months). On the other hand, comparison between group I and II showed non-significant difference at all study periods.

This improvement in the MMP-9 levels can be explained by its relation with bacterial load and immune cells. The buildup of microbial plaque bacteria in periodontal lesions is followed by the advent of immune inflammatory cells such as lymphocytes, macrophages and neutrophils[27]. Therefore it may be hypothesized that improvement in the levels of MMP-9 could be the direct influence of the reduction in periopathogenic microbes in periodontal lesions through the two modalities of treatment.

The reduction in MMP-9 level after SRP was in agreement with **Chen Lei et al.,**[20] who suggested that non-surgical periodontal treatment could effectively control periodontal inflammation and reduce serum inflammatory markers level in patients with type II DM and periodontitis.

Additionally, in consistence with our results, **Marcaccini et al.,**[28] proved that higher levels of MMP-8 and MMP-9 form in the GCF of CP patients compared with controls, and these markers decreased 3 months after periodontal therapy**.**

On contrary to our results, **Koromantzos et al.,**[29] their results demonstrated that non-surgical periodontal therapy did not have a statistically significant effect on the levels of MMP-2 and MMP-9 in patients with type II DM.

Moreover, the reduction in MMP-9 level in laser group was in agreement with numerous studies which have found that diode laser exhibits anti-inflammatory action with improved periodontal wound healing in systemically compromised patients, especially in DM.

CONCLUSION

Both treatment modalities resulted in a significant clinical improvement without a clear superiority of one procedure. The application of a single episode of LLLT to SRP may be not enough to result in an improvement in terms of PPD reduction and CAL gain.

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