The Clinical Effect of Diode Laser in the Treatment of the periodontal Pockets in Comparison with the use of photodynamic therapy (Comparative study)

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ABSTRACT: *Background*: Periodontal diseases a group of microbial infections that's found in gingiva and supporting tissues of the teeth. The effect of microorganisms in the periodontitis could be confirmed. *Purpose:* The current study was conducted to evaluate the effects of Diode laser versus PDT in periodontitis treatment as non-surgical method of treatment. *Materials and methods:* Thirty patients' males and females suffering from gingival pockets with age range from 20 to 65 years old from faculty of oral and dental medicine out clinics and selected randomly and divided in 2 groups each group contains fifteen patients. Group A received scaling and root planning in addition to 980 nm diode laser while Group B group received scaling and root planning in addition to PDT. *Results:* showed statistically significance improvement in group A (F=114.697, P=0.000) and in group B (F=126.308, P=0.000). Also, there was statistically significant difference between the two groups (F=5.904, P=0.000) with most difference in Pocket depth only (F=21.122, P=0.000) with statistically significant differences in post treatment value (F= 2.333, P=0.000) and follow up at one (F=0.700, P=0.019) and six months (F=1.100, P=0.000). *Conclusion:* Both PDT and Diode therapy have significant effect in pocket depth, bacterial count and bleeding examination in periodontitis treatment, but PDT have Superior effect when pocket depth is the target.

Keywords: Clinical Effect Diode Laser periodontal Pockets photodynamic.

1. INTRODUCTION

Periodontal diseases a group of microbial infections that's found in gingiva and supporting tissues of the teeth. The effect of microorganisms in the periodontitis could be confirmed. Periodontal diseases are usually treated by mechanical procedures thats include scaling ,root planing in and plaque control. As we know mechanical therapy mainly provides long term stability, but it also fails to eliminate the pathogenic bacteria completely and do not produce complete elimination of the disease [14].

Periodontitis is a multifactorial disease, that causes destruction of the periodontium is a result of interactions between a subgingival microbes and host defense mechanism. usual treatment of periodontal disease includes mechanical debridement of the tooth to disrupt the microflora and provide a more clean and biologically compatible root . However, mechanical

scalling has low efficiency in deep pockets and in furcation areas. Limited access causes inproper mechanical scalling. And so, treatment planes including antimicrobials in association with mechanical debridement more favorable [5].

Complete removal of bacteria may be difficult, especially in case of of deep periodontal pockets. E.g, patients with chronic periodontitis, had full-mouth scaling and root planing within 48 h showed reduced number of pockets more than 4 mm and bleeding on probing from 30 to three per subject [3].

Use of Dental lasers in the periodontal disease tretment can decrease the bacteria`s total numbers in the gingival tissue, and so decreases the need for antibiotics [6].

Use of diode laser, with a wavelength between 655 and 980, usually with soft tissues not with dental hard tissues. It is used only for soft tissue, and also for

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sulcular mechanichal debridement and for curettage. Moritz et al. said that pocket treatment with a diode (805 nm) after scaling decrease bacteria numbers in the pockets more than using scaling alone. Bleeding on probing also and pocket showed better results with laser [13].

Photodynamic therapy (PDT) appeared as a non – invasive therapeutic technique for the treatment of bacterial, fungal, and viral infections [4].

PDT can be used topically inside the periodontal pocket to avoid overdoses and drawbacks of the systemic antimicrobial treatments. It decreases the bacterial resistance [4, 10].

PDT antimicrobial treatments can be used as an alternate to antibacterial, antifungal, and antiviral treatment to overcome the drug - resistant organisms [16], use of Photo Dynamic Therapy in dentistry are increasing. And they can be used as a treatment of oral cancer, bacterial and fungal infections, and in the diagnosis of the malignant tumors of oral lesions [17].

2. MATERIAL AND METHODS

Thirty patients' males and females suffering from gingival pockets with age range from 20 to 65 years old from faculty of oral and dental medicine out clinics and selected randomly and divided in 2 groups each group contains fifteen patients.

Subjects

LASER diode group was treated with 980 nm diode laser only for 60 second in each point from the distal aspect of the 2nd molar to the distal aspect of the canine in the lower arch points and with power of 1 watt. These processes would be repeated twice weekly for 3 weeks.

PDT group was treated with Scaling and root planning is to be carried out before PDT. While doing the PDT, the photosensitizer is first infused in the periodontal pocket and allowed to pigment for 2 min. Then the fiber is inserted 1 mm short of the pocket and lased by moving in a sinusoidal manner from side to side toward the coronal third only for 60 second in each point from the distal aspect of the 2nd molar to the distal aspect of the canine in the lower arch points and with power of 1 watt. these processes would be repeated twice weekly for 3 weeks. In antimicrobial PDT, photosensitizers used are toluidine blue O and methylene blue. Both have similar chemical and physicochemical characteristics. Toluidine blue O is a solution that is blue violet in color. It stains granules within mast cells and

proteoglycans/glycosaminoglycans within connective tissues. Methylene blue is a redox indicator that is blue in an oxidizing environment and becomes colorless upon reduction.

Then follow up will be made one month later, 3 months later and 6 months later. Before starting the treatment and in each time of the 3 follow up sessions we will take a sample from the deepest part of the pockets in each patient in each time then it would be sent to microbial analysis for the detection of A. aclinomycetemcomitans and P. gingivalis.

Those patients are systemically healthy with residual pockets, previously treated for periodontal pockets. The eligibility criteria were that those after completion of comprehensive periodontal therapy since 3 to 24 months, presence, in the region from the distal aspect of the 2nd molar to the distal aspect of the canine in the lower arch and with a probing pocket depth (PPD) >4 mm, bleeding upon probing.

Inclusion criteria, Patients had at least twenty teeth, with a minimum of fourmultirooted teeth and four teeth per quadrant, all patients suffered from chronic periodontitis,15% of the pockets were >4 mm that bled upon probing.

Exclusion criteria included major systemic illnesses (i.e., diabetes mellitus, cancer, HIV, bone metabolic diseases or disorders that compromise wound healing, radiation, or immunosuppressive therapy), antibiotics, anti-inflammatory drugs, or other medication taken within the previous 4 months that may affect the outcome of the study, confirmed, and any physical limitations or restrictions that might preclude normal oral hygiene procedures. The smoking history was recorded, but smoking was not an exclusion criterion. Written informed consent was obtained from all included subjects. A patient number was attributed in ascending order. The deepest pocket in the area between the 2nd molar and the distal aspect of the canine with PPD >4 mm, and BOP was designated as the study site. Then follow up was done one after one month and another after 3 months and one after 6 months. Patient instructed how to wash his teeth and how to keep good oral hygiene between settings and within the follow up sessions.

Investigation and evaluation
Patients examination
Clinical examination

This will done intra orally in each setting to detect the pocket depth with graduated probe in 9 areas from the distal aspect of the upper canine to the distal aspect of the 2nd lower right molar as following

(1_distal to 2nd molar , 2_median aspect of the 2nd molar , 3_mesial aspect of the 2nd premolar ,4_ median aspect of the 1st molar,5_ distal to 1st molar, 6_median aspect of the 2nd premolar,7_ distal to 2nd premolar,8_ median aspect of the 1st premolar, 9_distal to 1st premolar, distal aspect of the canine) and the deepest point from the pretreatment setting tested in each time in the treatment settings every 3 days for 2 times and in each follow up setting one after month, other after 3 months and the last one after 6 months.

Fig-1: Pocket depth examination

Bleeding examination
Bleeding with probing tested in the pretreatment setting and then tested in each time in the treatment settings every 3 days for 2 times and in each follow up setting one after month, other after 3 months and the last one after 6 months.

Microbiologic Investigations
Sampling procedure
Periodontal pocket was sampled before and after high power diode laser and PDT in each patient for antibacterial evaluation by culture or PCR at different times.

Culture sample
For microbial sampling, periodontal pocket were sampled before and after high power diode laser and PDT in each tooth. Three sterile paper points were introduced sequential into the full length of the periodontal pocket and kept in place for one minute. The paper points samples from the Periodontal pocket were immediately transferred to one ml of brain heart infusion broth (BHI) transport medium and transport within one hour to microbiological laboratory.

Sampling for PCR
Periodontal pocket contents were absorbed into at least three paper points. These paper points were then transferred to cryotubes containing 1 ml of 5%

dimethyl sulfoxide (DMSO) in trypticase soy broth (TSB). Samples were then immediately frozen at -20ºC until they were processed.

Armamentarium
1) Mouth mirror
5. Periodontal probe
6. Tweezer
7. Cheek retractor
8. Cotton rolls
9. Suction tip
10. Local anesthetic solution-Lignocaine with adrenaline 1: 80,000 8. 3 ml disposable syringe.
11. Gauze pieces
12. G curettes
13. Diode laser
14. Ultra-sonic scaler
15. paper point
16. methyline blue
17. PCR-C1000 Gradient Thermal Cycler (BIO-RAD)

Fig-2: Diode laser application

Post-operative instructions
5. Avoid using any commercially available mouth rinses.
6. Avoid vigorous brushing, eating hard and hot foods.
7. Follow the oral hygiene instructions regularly.
8. Patient demonstrated and motivated for Modified Bass brushing.
9. Technique.

3. STATISTICAL ANALYSIS
The statistical analysis was performed using the Statistical Package for the Social Sciences 24.0 (SPSS Inc. v.24.0; IBM, Chicago, IL, USA). Test of normality was conducted using the Shapiro-Wilk test in conjunction with histograms, P-P and Q-Q plots. Paired t test was applied to determine the differences in the means of clinical parameters (PD, probing depth; and CAL, clinical attachment level) between baseline and 3 months and baselineand 6 months within each group. One-Way ANOVA with repeated measures was used to

find differences in the means of the clinical parameters (PD, probing depth; and CAL, clinical attachment level) between groups in the same period. The nonparametric McNemar's X2 test was applied to determine the differences in the proportions of clinical parameters (pocket depth, bleeding on probing, bacterial count) before, after, one month, 3 and 6 months later within each group. Cochran's Q test was used to find differences in the proportions of clinical parameters between groups in the same period. Relationships with a p value (p) ≤ 0.05 were considered as statistically significant. All reported p values are two-sided. In the presentation of results, continuous variables are shown asmeans with standard deviation (SD), while frequencies with percentages are used for categorical variables N(%).

Ethical issues

This paper was made following the instructions and standards of (Declaration of Helsinki) and all steps is monitored by the medical ethics committee of the National Institute of Laser Enhanced Science (NILES), Cairo University, Cairo, Egypt, who monitor the medical consent of the participants that include all the prospected side effects and they also assure that there is no conflict of interest between authors and they are dealing fairly with patients selection and also they are not oriented to a specific results and also the consent of participation.

4. RESULTS

The current study was conducted to evaluate the effects of Diode laser versus PDT in periodontitis treatment as non-surgical method of treatment. Thirty patients' males and females suffering from gingival pockets with age range from 20 to 65 years old from faculty of oral and dental medicine out clinics and selected randomly and divided in 2 groups each group contains fifteen patients. Group A received scaling and root planning in addition to 980 nm diode laser only without photosensitizer. Group B received scaling and root planning in addition to PDT.
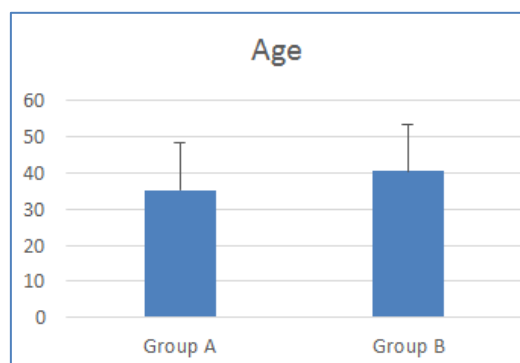
Demographics of the patients
Age

The mean age of group A was 35.2±13.18, while in group B equaled 40.47±12.82 with no statistically significant difference between both groups (t= -1.109, P=0.277) as shown in table (00) and figure (00).

Table-1: Descriptive and inferential statistics of age among both groups

	Group A	Group B	t	Sig
Age	35.2±13.18	40.47±12.82	-1.109	0.277

**Fig-3: Mean and standard deviation of age among both groups**

Gender

Group A include 8 males and 7 females while group B include 6 males and 9 females. The chi-square statistics showed no statistically significant differences between both groups when looking to gender distribution as shown in table (00) and figure (00).

Table-2: Frequency and Chi square of gender among both groups

Gender	Group A	Group B	Total	Chi value	Sig.
Male	8	6	14	0.536	0.464
Female	7	9	16		
Total	15	15	30		

Table-3

	Group A	Group B	t	Sig.
PD_2M_Dis	5.53±1.05	5.7±0.95	-0.455	0.652
PD_2M_Mid	5.43±0.98	5.5±0.78	-0.206	0.838
PD_1M_Dis	5.7±0.88	6.07±0.86	-1.15	0.26
PD_1M_Mid	5.3±0.93	5.5±0.75	-0.65	0.521
PD_2PM_Dis	5.3±0.85	5.5±0.92	-0.619	0.541
PD_2PM_Mid	5±0.74	5.13±0.68	-0.512	0.613
PD_1PM_Dis	4.93±0.83	5.03±0.78	-0.34	0.736
PD_1PM_Mid	4.53±0.84	4.67±0.74	-0.461	0.648
Canine_Dis	4.17±0.82	4.3±0.7	-0.48	0.635
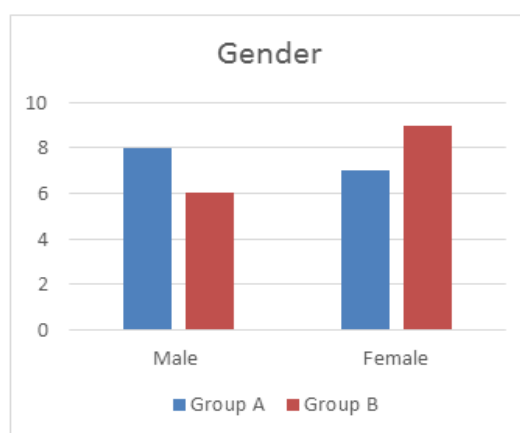
**Fig-4: Frequency of male and females among both groups**

Deepest site

Regarding the deepest site, there were no statistically significant differences between both Groups as deepest site is Pocket depth at first molar distal.

**Table-4: Frequency and Chi square of Deepest site among both groups**

Deepest site	Group A	Group B	Total	Chi value	Sig.
PD_2M_Dis	5	3	8	2.083	0.72
PD_1M_Dis	7	9	16		
PD_1M_Mid	1	1	2		
PD_2PM_Dis	2	1	3		
PD_2PM_Mid	0	1	1		
Total	15	15	30		

PD: Pocket depth, 1M: First Molar, 2M: Second Molar, 1PM: First Premolar, 2PM: Second Premolar, Dis.: Distal, Mid: Medial, *: Significant
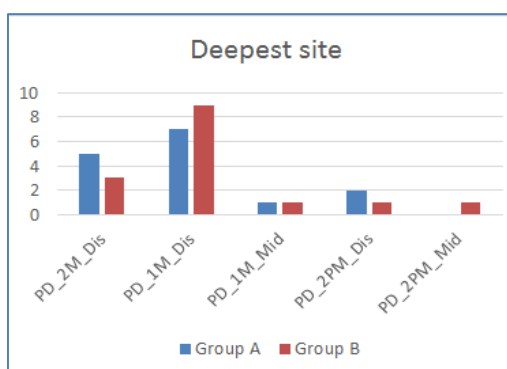
Fig-5: Frequency of Deepest site among both groups

Basic measures
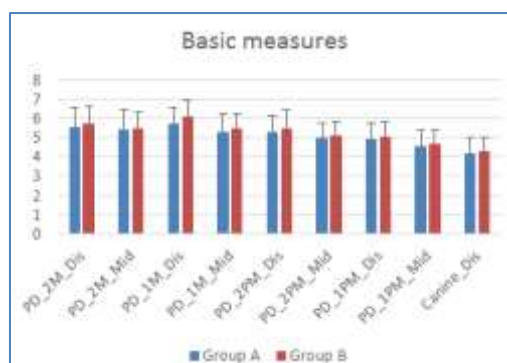
Fig-6: Mean and standard deviation of basic measures among both groups

Measurement variables
Pocket depth

The pocket depth was measured in both groups pre- and post-treatment with follow up at one, three and six months. Group A pretreatment value was 6.1 ± 0.8 while the post treatment value was 6.1 ± 1.29 and follow up values at one, three and six months were 3.37 ± 0.9, 2.57 ± 0.68 and 2.4 ± 0.46 with total improvement percentage of 60.66% and statistically significant effect of treatment ($F=94.939$, $P=0.000$).

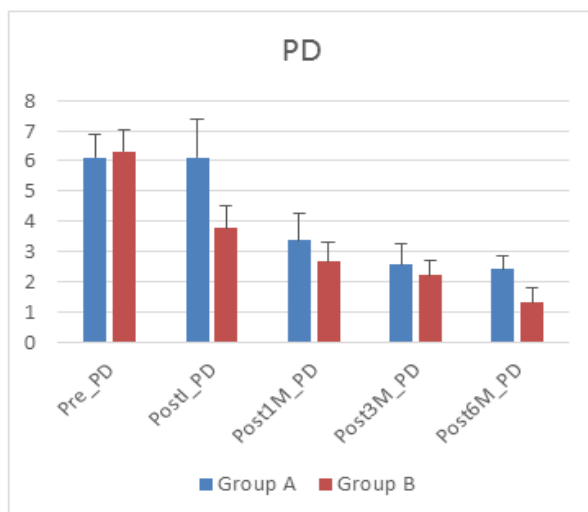Group B pretreatment value was 6.3 ± 0.74 while the post treatment value was 3.77 ± 0.74 and follow up values at one, three and six months were 2.67 ± 0.61, 2.2 ± 0.5 and 1.3 ± 0.51 with total improvement percentage of 79.37% and statistically significant effect of treatment ($F=148.340$, $P=0.000$).

Regarding between group comparison, there were statistically significant differences between both groups overall ($F=21.122$, $P=0.000$) with statistically significant differences in post treatment value ($F=2.333$, $P=0.000$) and follow up at one ($F=0.700$, $P=0.019$) and six months ($F=1.100$, $P=0.000$).

Table-5: Descriptive and inferential statistics of Pocket depth among both groups at different time intervals

	Group A	Group B	F	Sig.
Pre-PD	6.1±0.8	6.3±0.74	-.200	.481
PostI-PD	6.1±1.29	3.77±0.74	2.333*	.000
Post1M-PD	3.37±0.9	2.67±0.61	.700*	.019
Post3M-PD	2.57±0.68	2.2±0.5	.367	.101
Post6M-PD	2.4±0.46	1.3±0.51	1.100*	.000
Change	DE-60.66%	DE-79.37%		
F	94.939*	148.340*	21.122*	
Sig	0.000	0.000		0.000

PD: Pocket depth, 1M: One month, 3M: Three months, 6M: six months, *: Significant

Fig-6: Mean and standard deviation of Pocket depth among both groups at different time intervals

Bacterial count

The Bacterial count was measured in both groups pre- and post-treatment with follow up at one, three and six months. Group A pretreatment value was 89545.33±17592.59 while the post treatment value was 50756.67±11571.26 and follow up values at one, three and six months were 31713.33±6709.6, 19126.67±6739.28 and 10578±5163.54 with total improvement percentage of 88.19% and statistically significant effect of treatment (F=83.186, P=0.000).

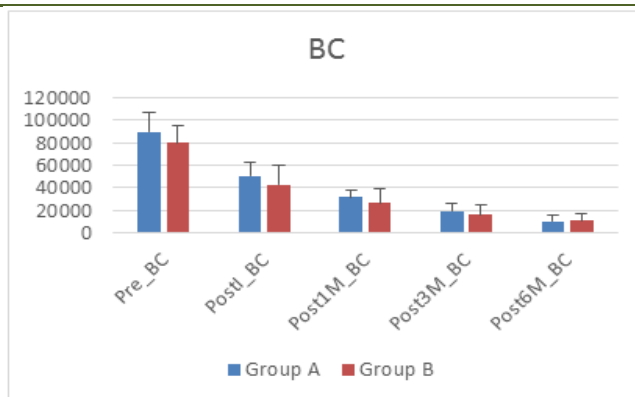Group B pretreatment value was 79427.33±14923.56 while the post treatment value was 42940±16402.45 and follow up values at one, three and six months were 26738.67±12819.17, 15954.23±8976.99 and 10773.33±5700.13 with total improvement percentage of 86.44% and statistically significant effect of treatment (F=110.109, P=0.000).

Regarding between group comparison, there were no statistically significant differences between both groups overall (F=2.375, P=0.056) with no statistically significant differences in neither post treatment value (F= 7816.667, P=0.143) nor follow up at one (F=4974.667, P=0.194), three (F=3172.44, P=0.283) and six months (F=195.333, P=0.922).

Table-6: Descriptive and inferential statistics of Bacterial count among both groups at different time intervals

	Group A	Group B	F	Sig.
Pre-BC	89545.33±17592.59	79427.33±14923.56	10118.000	0.100
PostI-BC	50756.67±11571.26	42940±16402.45	7816.667	0.143
Post1M-BC	31713.33±6709.6	26738.67±12819.17	4974.667	0.194
Post3M-BC	19126.67±6739.28	15954.23±8976.99	3172.44	0.283
Post6M-BC	10578±5163.54	10773.33±5700.13	-195.333	0.922
Change	DE-88.19%	DE-86.44%		
F	83.186*	110.109*	2.375	
Sig	0.000	0.000		0.056

BC: Bacterial count, 1M: One month, 3M: Three months, 6M: six months, *: Significant

Fig-7: Mean and standard deviation of Bacterial count among both groups at different time intervals

Bleeding examination

The Bleeding examination was measured in both groups pre- and post-treatment with follow up at one, three and six months. Group A pretreatment value was 4.8±0.85 while the post treatment value was 2.47±1.1 and follow up values at one, three and six months were 2.57±1.16, 2.13±0.83 and 1.67±0.8 with total improvement percentage of 65.21% and statistically significant effect of treatment (F=52.738, P=0.000).

Group B pretreatment value was 5±0.94 while the post treatment value was 2.93±0.74 and follow up values at one, three and six months were 2.93±0.78, 2.4±0.74 and 1.93±0.72 with total improvement percentage of 61.4% and statistically significant effect of treatment (F=47.084, P=0.000).

Regarding between group comparison, there were no statistically significant differences between both groups overall (F=0.316, P=0.866) with no statistically significant differences in neither post treatment value (F= -0.467, P=0.184) nor follow up at one (F=0.367, P=0.318), three (F=-0.267, P=0.361) and six months (F=-0.267, P=0.346).

Table-7: Descriptive and inferential statistics of bleeding examination among both groups at different time intervals

	Group A	Group B	F	Sig.
Pre-BLE	4.8±0.85	5±0.94	-0.2	0.545
PostI-BLE	2.47±1.1	2.93±0.74	-0.467	0.184
Post1M-BLE	2.57±1.16	2.93±0.78	-0.367	0.318
Post3M-BLE	2.13±0.83	2.4±0.74	-0.267	0.361
Post6M-BLE	1.67±0.8	1.93±0.72	-0.267	0.346
Change	DE-65.21%	DE-61.4%		
F	52.738*	47.084*	0.316	
Sig	0.000	0.000		0.866

BLE: Bleeding examination, 1M: One month, 3M: Three months, 6M: six months, *: Significant
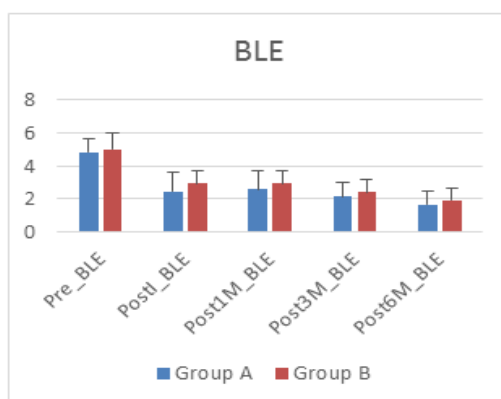
Fig-8: Mean and standard deviation of bleeding examination among both groups at different time intervals
Multivariate analysis

Regarding overall improvement of group, A and B, there was statistically significant improvement in group A (F=114.697, P=0.000) and in group B (F=126.308, P=0.000). Also, there was statistically significant difference between both groups (F=5.904, P=0.000).

Table-8: Multivariate analysis of all variables in both groups and in total

	Group A	Group B	F	Sig.
F	114.697*	126.308*	5.904*	
Sig	0.000	0.000		0.000

6. DISCUSSION

The current study was conducted to evaluate the effects of Diode laser versus PDT in periodontitis treatment as non-surgical method of treatment. Thirty patients' males and females suffering from gingival pockets with age range from 20 to 65 years old from faculty of oral and dental medicine out clinics and selected randomly and divided in 2 groups each group contains fifteen patients. Group A received scaling and root planning in addition to 980 nm diode laser only without photosensitizer. Group B received scaling and root planning in addition to PDT. There was statistically significant improvement in group A (F=114.697, P=0.000) and in group B (F=126.308, P=0.000). also, there was statistically significant difference between both groups (F=5.904, P=0.000) with most difference in Pocket depth only (F=21.122, P=0.000) with statistically significant differences in post treatment value (F= 2.333, P=0.000) and follow up at one (F=0.700, P=0.019) and six months (F=1.100, P=0.000).

The results of studies done on the impact of PDT with and use of laser only as an adjunctive way of treatment for chronic periodontitis are conflicting. Although in most of these studies, laser diode has been used, but none of them mentioned which types of laser, photosensitizer, wavelength, power and intensity are more effective. [4].

Diode laser for periodontal pockets

To investigate and compare the clinical, microbial, and inflammatory effects of a diode laser as an adjunct to (SRP) in comparison with SRP alone for the treatment of generalized aggressive periodontitis (GAgP). Methods: Using a split-mouth technique, thirty one volunteers with GAgP were participated in the study. The upper arch quadrants were assigned to SRP and diode laser or SRP alone. voulnteers were tested for clinical, microbiological, and inflammatory mediator changes for a year. (CAL) was the first outcome to be chosen. And also, subgingival samples

and (GCF) analysis for inflammatory mediators were analyzed and the Results was: Compared in, both treatments showed an improvement in periodontal parameters at 1 year. Although, SRP with diode laser showed high improvement in pocket depth (PD; 2.56 ± 0.44 vs. 3.36 ± 0.51 mm, $p < 0.05$) and CAL (3.47 ± 0.25 vs. 4.11 ± 0.26 mm, $p < 0.05$) values are compared to SRP alone.

PDT for periodontal pockets

Use of a Photo DynamicTherapy with open flap debridement of the in the surgical treatment of SCP: is significantly improved clinical periodontal parameters; ii) eliminates periodontal pathogens of the red complex more effectively (NCT02734784) (9) and this came in agreement with the current study.

Diode laser versus PDT for periodontal pockets

Total removal of bacteria from pockets is not possible with mechanical treatment, hence it is supplemented with antibiotics5. One of The draw backs of chemotherapy are bacterial resistance and side effects after systemic administration. Photodynamic therapy avoids that by adjuncting irradiation with laser with the PS dye. Methylene blue used as a photosensitizer in this study, as it was reported to be the safest photosensitizers for the treatment of periodontal disease. It has a better effect on sites with deep periodontal pockets, furcations and root concavity [2].

Considered the best clinical results, the laser diode can be routinely associated with mechanical therapy (SRP) in the treatment of periodontal pockets of patients with severe chronic periodontitis. In the present study patients with chronic periodontitis and the adjunctive use of PDT to scaling and root planing may result, on a short-term basis (up to 3rd week), in (i) comparable reductions in Plaque Index (PI) score when compared with scaling and root planing alone(ii) comparable higher probing pocket depth reductions and clinical attachment level gains when compared with scaling and root planing alone.(iii) there is more reductions in bacterial count than with scaling and root planning alone [5].

The uses of Photodynamic therapy as an adjunctive therapy for periodontal disease showed bactericidal effect and target pathogens more. The combination of laser therapy with conventional procedures allows, in fact, to obtain a more effective decontamination of the pocket, in addition to this the recolonization by bacteria is slower than the sites treated only with scaling and root planing. Moritz et al. and Angelov et al. showed that diode laser therapy can significantly improve periodontal pocket healing and periodontal indices [10].

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