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Comparative evaluation of the efficacy of photodynamic therapy and diode laser as an adjunct to non-surgical periodontal therapy- A clinical study

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ABSTRACT

Background: Photodynamic therapy (PDT) and diode laser (DL) therapy have been proposed to improve the effectiveness of periodontal treatment. However, clinical studies evaluating the efficiency of these treatments have been inconclusive. Therefore, the aim is to evaluate and compare the efficacy of photodynamic therapy and diode laser as an adjunct to non-surgical periodontal therapy.

Methods:A split-mouth clinical trial was conducted in 20 patients presenting at least two contralateral teeth with a probing pocket depth (PD) ≥ 5 mm and bleeding on probing (BOP) on both sides of the mouth. All patients were submitted to anone-stage full-mouth disinfection (OSFMD) protocol. The selected sites randomly received either (1) PDT (methylene blue as a photosensitizer activated by diode laser) or (2) Diode Laser. Clinical parameters were assessed at baseline and at 4and 12 weeks post-treatment.

Results: In both of the groups there was a significant reductions in PD, number of deep pockets and BOP and an increase in clinical attachment level (CAL) after 4 and 12 weeks, but there were no differences between the two groups. There was no change in the gingival level (GL) of either group for all periods of analysis. A decrease in the number of moderate pockets (4–5 mm) was found in the DLgroup(5.17 ± 4.21) when compared to the PDT group (7.12 ± 5.25),, but only after 4 weeks.

Conclusion:PDT and DL therapies resulted in the improvement of periodontal clinical parameters; however, there were no distinct differences between the two treatment modalities were observed.

KEYWORDS: Periodontal treatment, Periodontal disease, Photodynamic therapy, Periodontal pathogenic bacteria, Diode laser.

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INTRODUCTION: Periodontitis is a multifactorial disease that is associated with loss of the supporting tissues (i.e., periodontal ligament and alveolar bone) around the tooth. A major objective of periodontal therapy is to remove soft and hard, supra- and subgingival deposits from the root surface to stop disease progression. Numerous Studies reported significant improvements in clinical and microbial parameters following non-surgical periodontal therapy. To further enhance the effectiveness of scaling and root planing (SRP), power-driven instruments, such as sonic and ultrasonic scalers, have been introduced. Despite the fact that non-surgical periodontal treatment may result in significant clinical improvements in the great majority of cases, none of the currently available instrumentation techniques are effective in completely eliminating subgingival bacteria and calculus[1]. Photodynamic therapy (PDT), also called photoradiation therapy, phototherapy, or photochemotherapy, was introduced in medical therapy in 1904[2].

Photodynamic therapy (PDT) involves the combination of visible light, usually through the use of a diode laser and a photosensitizer. The photosensitizer is a compound that is capable of absorbing light of a specific wavelength and transforming it into useful energy. Each factor is harmless by itself, but when combined they can produce lethal cytotoxic agents that can selectively destroy cells[3]. Thus, PDT may represent a promising alternative for reducing the bacterial load or even for eradicating certain periodontal pathogens[4,5]. Photodynamic therapy (PDT) has been performed to promote periodontal wound healing and tissue regeneration generally by activating the photosensitizer by laser light of a specific wavelength to produce reactive oxygen species (ROS) against pathogenic microorganisms[6]. Advantages of laser treatment when compared to conventional methods include low cellular loss and tissue inflammation, hemostasis, increased visualization of surgical sites, excellent tissue ablation, sterilization of the operating site, reduced pain after operating and patient acceptance[7,8] The penetrating power of the Nd:YAG laser can effectively reduce the bacteria in the deep periodontal pocket and promote the migration, proliferation and differentiation of osteoblasts. Er:YAG is currently clinically recognized as a relatively safe laser that can vaporize water through the thermal-mechanical effect, generate strong pressure and cause micro explosion, thus playing the role of removing dental plaque stones and alleviating inflammatory reactions Laser is a promising alternative or adjunctive means of conventional and mechanical periodontal therapy. Diode laser has a bactericidal detoxifying effect, but does not erode calculus on the root surface, therefore, it may be useful as a supportive means for SRP[9]. Based on the aforementioned studies, the current study aims to compare the photodynamic therapy and diode laser as an adjunct to non-surgical periodontal therapy.

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METHODOLOGY:

Source of data: study participants were selected from the OPD section of the Department of Periodontology Rama Dental College, Hospital and Research Center, Kanpur, Uttar Pradesh, India. Participants were informed about the study and written consent was taken from them. Ethical approval was granted by the institutional ethics committee.

Study Design: This study is designed as comparative evaluation of photodynamic therapy and diode laser as an adjunct to non-surgical periodontal therapy. All patients were recruited after a screening examination that included a full medical and dental history, intraoral examination, full-mouth periodontal probing and radiographs. A split-mouth clinical trial was conducted in 20 patients diagnosed with periodontal disease presenting at least two contralateral teeth with a probing pocket depth (PD) ≥ 5 mm and bleeding on probing (BOP). All patients were submitted to a one-stage full-mouth disinfection (OSFMD) protocol. The selected sites randomly received either half of the mouth received PDT + SRP (Test group) and Half of the mouth received Diode laser + SRP (Control Group). Clinical parameters were assessed at baseline and at 4 and 12 weeks post-treatment. All the patients included in the study received information about the Etiology of periodontal disease and instructions for maintaining adequate biofilm control, including interdental cleaning with dental floss and interdental toothbrushes.

The inclusion criteria:subjects with untreated periodontitis (according to the criteria of the 2018 international classification [10] with at least two contralateral teeth with PD ≥ 5 mm, CAL ≥ 3 mm, BOP and radiographic signs of bone loss. Exclusion criteria **:**were pregnancy, current smoking and history of smoking in the past 10 years, use of mouth rinses containing antimicrobials in the preceding 2 months, orthodontic appliances, systemic conditions that could affect the progression of periodontitis, and the long-term administration of anti-inflammatory and immunosuppressive medications.

Clinical findings were taken on six sites (mesio-facial, mid-facial, disto-facial, mesiolingual, mid-lingual and disto-lingual) of each tooth included in the analysis at the baseline visit (immediately before the therapies) and again at 4 and 12 weeks after the therapies.All parameters were measured using a University of North Carolina periodontal probe by one examiner. The following clinical parameters were evaluated: gingival level (GL; measured from the cementoenamel junction to the free gingival margin), PD (measured from the free gingival margin to the bottom of the periodontal pocket), CAL (measured from the bottom of the periodontal pocket to the cementoenamel junction) and BOP, which is defined

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as the presence (+) or absence (-) of bleeding within 15 seconds after probe insertion into the pocket.

Statistical analysis: The data for periodontal clinical parameters, including BOP-positive sites, PD, number of sites with PD between 4-5 mm and PD ≥ 6 mm, CAL and GL were submitted to the Kolgomorov-Smirnov normality test, which confirmed that the data conformed to a normal distribution for all clinical parameters analyzed. Comparison between the groups was performed using paired t-test, while comparison within each group over the different experimental periods was performed using the ANOVA parametric test for repeated samples, supplemented by Tukey's post hoc test. GraphPad Prism 6 software was used for all statistical analyses, and all statistical tests were applied at a significance level of 5%

RESULTS:

Table 1 shows data pertaining to different periodontal parameters at different time intervals. Both treatment protocols promoted significant reductions in PD, number of deep pockets and BOP and an increase in clinical attachment level (CAL) after 4 and 12 weeks, but there were no differences between the two groups. There was no change in GL of either group for all periods of analysis. A decrease in the number of moderate pockets (4-5 mm) was found in the Diode laser(DL)group (5.17 ± 4.21) when compared to the PDT group (7.12 ± 5.25), but only after 4 weeks.

Table 1: Periodontal parameters at different time intervals for the two groups, presented as the mean and standard deviation.

Variables/Period	Baseline		4 weeks		12 weeks	
	Test	Control	Test	Control	Test	Control
PD	3.06 ± 0.72	3.02 ± 0.67	2.40 ± 0.62	2.27 ± 0.58	2.38 ± 0.56	2.34 ± 0.59
PD 4-5 mm	14.38 ± 8.31	12.63 ± 8.63	7.12 ± 5.25	5.17 ± 4.21	6.32 ± 3.57	4.95 ± 4.67
PD > 6 mm	5.23 ± 4.88	4.53 ± 3.66	2.43 ± 2.82	2.58± 2.84	2.267± 3.05	1.789± 1.99
GL	1.14 ± 0.67	1.15 ± 0.65	1.35 ± 0.60	1.34 ± 0.67	1.15 ± 0.67	1.20 ± 0.65
CAL	4.19 ± 1.14	4.16 ± 1.21	3.74 ± 0.94	3.62 ± 0.93	3.51 ± 0.94	3.44 ± 0.96
BOP	27.37 ± 15.98	26.16 ± 15.78	11.00± 14.84	8.89 ± 9.21	5.89 ± 5.61	5.05 ± 5.58

DISCUSSION:

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This study show that both treatments promoted significant reductions in PD, the number of deep pockets and BOP after 4 and 12 weeks, but there were no differences between photodynamic therapy(PDT) and DL groups. Moreover, an increase in CAL was observed after 12 weeks for both groups. The use of photosensitizer liquid (0.005% methylene blue dye) did not seem to promote additional gains in clinical periodontal parameters compared to DL use alone. Similarly, a split-mouth clinical trial by Katsikanis et al.[10] also demonstrated that both LLLT and PDT associated with SRP led to statistically significant improvements in the evaluated clinical parameters (PD, CAL and BOP) at 3 and 6 months compared to baseline, but with no differences between them. The results presented by Teymouri et al.[11] also support the findings of our study, showing an improvement in the PDT and DL groups in PD, CAL and BOP clinical parameters without any statistically significant differences in intergroup analysis. In a similar approach, Correa et al.[12] showed greater PD depth reduction and CAL gain in the Antimicrobial photodynamic therapy(aPDT) plus SRP group, associated with a statistically significant reduction in A. actinomycetemcomitans levels on day 3 and 7 after therapy in comparison to SRP alone. Berakdar et al.[13]compared aPDT (using a diode laser at a wavelength of 670 nm and maximum power of 150 mW, with 0.005% methylene blue) to SRP alone in initial periodontal treatment and reported a statistically significant reduction in PD with a combination of SRP and aPDT after 6 months.

CONCLUSIONS

Both the PDT and DL therapies promoted improvements in periodontal clinical parameters after the OSFMD protocol; however, in general, there were no distinct differences between the two treatment modalities evaluated in this study.

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