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# Clinical Comparison of Photodynamic Therapy with Methylene Blue and Malachite Green Adjunctive to SRP in Chronic Periodontitis

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***Abstract***

*Chronic periodontitis is an infectious disease resulting in inflammation within the supporting tissues of the teeth, progressive attachment and bone loss. The removal of the plaque biofilm and mineralized deposits from the tooth surface are the fundamental aspects of periodontal therapy which is achieved primarily by scaling and root planing (SRP). Since mechanical therapy alone fails to eliminate bacteria that penetrate the connective tissue, the use of adjuncts to SRP has been advocated. There is evidence that local antimicrobials adjunctive to SRP provide additional benefits to the result of periodontal treatment. Photodynamic therapy (PDT) is one such approach that combines low level laser light with a photosensitizer that binds to the target cells. In the excited state, photosensitizers react with oxygen in the environment generating reactive oxygen species that cause oxidative damage to target cells. This study has shown a significant reduction in probing depth (PD) and increase in clinical attachment level (CAL) when PDT with methylene blue / malachite green was employed adjunctive to SRP. Thus, PDT can be an alternative modality for management of chronic periodontitis.*

**Keywords:** *Periodontal Pocket, Periodontitis, Photodynamic therapy, Photosensitizer, Laser, Scaling and Root Planing*

## 1. Introduction

Chronic periodontitis is an infectious disease resulting in inflammation within the supporting tissues of teeth, progressive attachment and bone loss characterized by pocket formation and/or recession of gingiva. This multifactorial disease is mainly prevalent in adults with plaque being the primary etiologic factor and calculus, overhanging restorations, faulty prosthesis being predisposing factors (Kataria et al., 2015).

The removal of plaque biofilm and mineralized deposits from the tooth surface are fundamental aspects of periodontal therapy achieved primarily by scaling and root planing (SRP) (Braun et al., 2008). SRP forms a vital part of Phase I periodontal therapy resulting in significant improvement in clinical parameters. Since mechanical therapy alone fails to eliminate bacteria that penetrate connective tissue, the use of additional modalities as adjuncts to SRP have been advocated.

Photodynamic therapy (PDT) is one such approach that combines low level laser light with a photosensitizer that binds to target cells. In the excited state, photosensitizers react with oxygen in the environment generating reactive oxygen species causing oxidative damage to target cells. Thus, PDT can be an adjunct for reducing bacterial load in pockets. Studies have shown significant reduction in probing depth (PD) when PDT was employed adjunctively to SRP (Braun et al., 2008; Berakadar et al., 2012).

However, there is dearth of studies in literature that have compared the photosensitizers, methylene blue and malachite green. Hence, this study was undertaken to compare the efficacy of 1% methylene blue and 1% malachite green when used as a component of PDT in chronic periodontitis patients.

## 2. Materials And Methods

### Patient screening and site selection

Five adults, aged 30 to 58 years contributing 40 sites who reported as outpatients to the Department of Periodontology were enrolled in this split-mouth study. All patients (3 male; 2 female) were diagnosed with Chronic Periodontitis (CP) as per the International Workshop for Classification of Periodontal Diseases and Conditions, 1999. The subjects were informed in detail about the study and written consent obtained. The study was approved by the Institutional Ethical Committee and registered in the Clinical Trials Registry-India [CTRI/2021/04/032704]. Criteria for exclusion were: smokers, pregnant and lactating women, those allergic to malachite green or methylene blue and those who underwent active periodontal treatment within the last 6 months. For inclusion, the patients had to have a minimum of one site each in two contralateral quadrants with a probing depth of ≥ 5mm and ≤ 7mm. In addition, patients should be systemically healthy, not have taken antibiotics in the past 6 months and have a score of less than 1 in both plaque and gingival indices. By means of randomization (coin toss), two different treatment modalities were assigned: scaling and root planing followed by single episode of PDT consisting of diode laser irradiation with either 1% methylene blue (SRP+ 1%MB) or 1% malachite green (SRP+ 1%MG).

### Clinical parameters

Clinical parameters were recorded at baseline, three and six months after treatment. Probing depth (PD) and clinical attachment level (CAL) were recorded to the nearest millimetre using a UNC-15 graduated periodontal probe. To assess the patients' compliance, gingival index [GI, Löe and Silness, 1963] and plaque index [PI, Silness and Löe, 1964] were documented. The above parameters were recorded by a single examiner and entered in a customized proforma designed for the study.

### Outline of treatment

On the first appointment, scaling and root planing was performed in all patients by the same clinician employing both hand instruments (U 15/30 scaler and Gracey curettes, Hu-friedy, Chicago, IL, USA) and a piezoelectric ultrasonic hand piece with a scaler tip (Woodpecker™, China).

At the second appointment (after 24 hours), Group A sites were filled with 1% MB solution and left for 3 minutes. The photosensitizer was activated using a 940 nm diode laser (EpicX, Biolase USA) at a power of 1W for a duration of 10 seconds per site. The fiber optic tip was introduced into the pocket and with a smooth stroking action moved from the gingival margin to the base of the pocket. Periodontal dressing was placed over the treated area for one week and relevant oral hygiene instructions were given. For Group B sites, 1% MG solution was used and the same clinical protocol as Group A sites was followed.

## 3. Results and Discussion

The mean age of the study subjects was 38.66 ± 7.88 years. 3 males (60%) and 2 females (40%) contributing a total of 40 sites participated in the study with none lost to follow up. No significant age and gender distribution difference was noted among the subjects. However, significant differences were observed in both the study groups with respect to the clinical parameters assessed. Mann Whitney test was used to compare the mean values of the clinical parameters between the groups at different time intervals. Friedman's test followed by Wilcoxon signed rank post hoc test was used to compare mean values of each parameter at different time intervals in each group. There was a statistically significant increase in mean PI score at all the assessed time intervals from a score of 0.84 to 1.42 at the baseline and 6-month evaluation respectively ($p<0.001$).

The GI score too showed a similar trend with a mean score of 0.84 at baseline and 1.38 at 6 months ($p<0.001$) (Figure 1). This increase in the scores could be explained by the gradual slackness in plaque control exhibited by the subjects when participating in long term studies. The mean PD and CAL scores conversely showed a gradual reduction from baseline to 6 months. In Group A, the mean PD reduced from 5.55 to 2.30 ($p<0.001$) while in Group B it moved down from 5.40 to 2.80 ($p<0.001$). Similarly, the mean CAL score reduced from 4.40 to 1.50 in Group A ($p<0.001$) and from

4.10 to 1.95 in Group B (p<0.001) (Figure 2). The reduction in the mean PD and CAL score was significantly greater in the baseline to 3-month interval (p<0.001) in both the groups than the 3 months to 6-month interval (PD - Group A: p=0.002 & Group B: p=0.01; CAL - Group A: p=0.01 & Group B: p=0.09). This clinical improvement could be attributed in part to the beneficial effects of photodynamic therapy as evidenced in several research studies. The results also seem to suggest that Group A sites fared marginally better than Group B sites with respect to the improvement noted in the PD and CAL parameters.

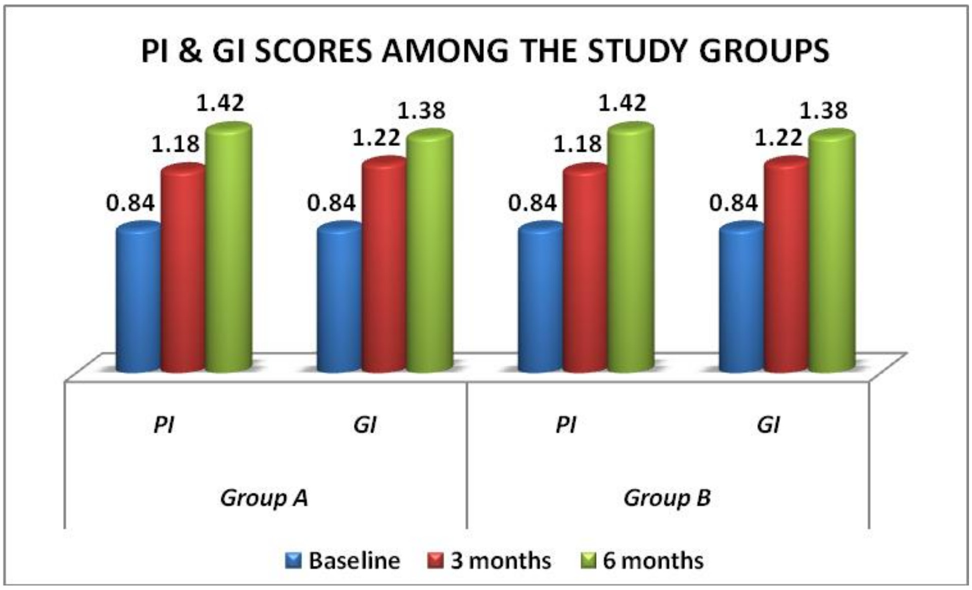


**Figure 1:** Comparison of the plaque index and gingival index scores among Groups A & B at different time intervals

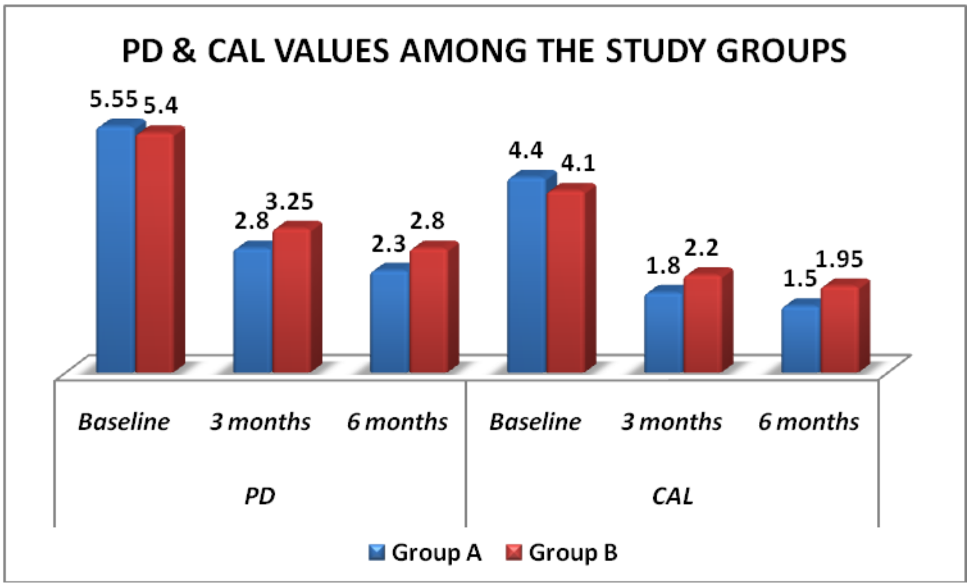


**Figure 2:** Probing depth and Clinical attachment level comparison among Groups A & B at baseline, 3 months and 6 months

Mechanical debridement can create significant changes in the microbiological environment of periodontal pockets by shifting the pathogenic biofilm to a beneficial one by significant reduction in the population of bacteria associated with chronic periodontitis including *Porphyromonas gingivalis*, *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia*, *Tannerella forsythia* and *Treponema denticola* (Lui et al., 2011).

During supportive therapy, residual pockets are a risk factor for the development of periodontal disease and consequently, tooth loss. It happens in part because it is challenging to completely remove bacterial deposits, and in part because a microbiota that is harmful to periodontal health repopulates the pocket (Renvert & Persson, 2002; Matuliene et al., 2008; Quirynen et al., 1995; Adriaens, 2004).

Dental lasers have been shown to be potentially advantageous in non-surgical and surgical periodontal treatments. Diode lasers produce wavelengths corresponding to the absorption coefficient of haemoglobin, oxygenated haemoglobin and melanin. The antibacterial property of diode lasers against *A. actinomycetemcomitans* has been recognized. Photodynamic therapy claims to have a broad spectrum of action, with efficacy against antibiotic-resistant strains without evidence of development of photoresistant strains, extensive reduction in the bacterial population with limited damage to host tissues, the ability to target infected tissues, and overall beneficial economic factors (Lui et al., 2011).

Clinical studies combining PDT with non-surgical periodontal therapy have reported mixed outcomes. In comparison to SRP alone, two studies reported a significant decrease in PPD but not in the number of sites with bleeding on probing (BOP) after SRP plus PDT with methylene blue. According to other researchers, PPD and BOP have significantly improved (Al-Zahrani & Austyn, 2011; Andersen et al., 2007; Braun et al., 2008; Campos et al., 2013). This is in accordance with our study which showed similar results.

It is reported that only PDT-treated sites had elevated levels of the anti-inflammatory cytokines IL-4 and IL-10 and decreased levels of the pro-inflammatory cytokines GM-CSF, IL-1β, and IL-6 throughout the course of a study (Kolbe et al., 2014). The pro-inflammatory mediators GM-CSF, IL-8, IL-1β, and IL-6 only showed decreased levels after 3 months when PDT was employed as an adjunctive, according to another study investigating the efficacy of PDT as an addition to non-surgical debridement in furcation lesions (Campos et al., 2013).

Additionally, it was shown that as compared to SRP alone, the levels of GM-CSF, IFN-γ, IL-6, IL-1β, and IL-8 were lower in the PDT + SRP-treated sites over time (Luchesi et al., 2013). In fact, it has been suggested that photodynamic therapy's low-energy level lasers are responsible for a tissue's "photobiomodulation" as the light could accelerate the healing process and lessen periodontal inflammation, which would at least partially account for the modulation of the host immunoinflammatory response promoted by PDT (Campos et al., 2013; Kolbe et al., 2014; Woodruff et al., 2004).

According to another study, PDT significantly improved clinical measures like PPD and BOP while having no discernible effect on bacterial levels when compared to the control group. This might be explained by how differently malachite green and methylene blue absorb light at their maximal wavelengths. Every photosensitizer absorbs light at the appropriate wavelength, creating singlet oxygen and free radicals that are harmful to some bacterial species (Noro et al.,2012; Yeung et al., 1993; Atieh, 2010; Silva et al., 2014).

Malachite green PDT combined with adjunctive periodontal therapy significantly lowered *A. actinomycetemcomitans* and *P. gingivalis* levels in HIV patients with periodontal infections.[20] However, a number of variables, like the laser's wavelength and how it interacts with the photosensitizer, affect PDT's effectiveness. MG is one of the photosensitizers that have been employed for the aforementioned function and causes disruption of the cell membrane potential in both gram-positive and gram-negative bacterial species (Kowaltowski et al., 1999).

## 4. Conclusion

This study too has its limitations, firstly it may be questioned whether the biomodulatory capabilities of PDT are more important than the antimicrobial effects of this therapeutic strategy in improving clinical parameters during the management of persistent pockets, even though additional research is necessary to identify the most crucial mechanism by which PDT exerts encouraging clinical outcomes in periodontal therapy. Secondly, microbiological evaluations have to be carried out to establish the exact reduction of the microbial load.

The Hawthorne effect of the participants and its influence on the clinical outcome and the effect of scaling and root planing alone is also to be considered. However, it can be concluded that PDT as an adjunct to SRP has a significant benefit in the treatment of CP. Further comparative studies with larger sample sizes would be required to elucidate the benefits of using MG, MB and other photosensitizers in the adjunctive treatment of chronic periodontitis.

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