Evaluation of efficacy of photodynamic therapy as an adjunct to nonsurgical periodontal therapy in treatment of chronic periodontitis patients: A clinico-microbiological study

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ABSTRACT

Background and Objectives: Photodynamic therapy (PDT) is a local noninvasive treatment modality without side effects caused by antibiotics. The aim of this study was to evaluate the efficacy of adjunctive use of PDT with scaling and root planing as compared with SRP alone in the treatment of chronic periodontitis.
Subjects and Methods: Twenty participants with chronic periodontitis having probing pocket depths (PDs) of ≥5 mm were selected for the study. Patients were randomly divided into control group and test group with ten patients in each group. Full-mouth SRP was performed in both the groups, followed by PDT in test group. Assessment of plaque index (PI), gingival index (GI), PD, and clinical attachment level (CAL) was done at baseline and after 3 months. Microbiological assessment of Porphyromonas gingivalis, Tannerella forsythia, and Treponemadenticola was done by polymerase chain reaction (PCR) at baseline and 3 months after the therapy.
Results: There was a significant reduction in PI, GI, PD, CAL, and microbiologic parameters in test group, following SRP and PDT, when compared with SRP alone in control group.
Conclusion: PDT in conjunction with SRP has shown additional improvement in periodontal parameters when compared to SRP alone and has a beneficial effect in chronic periodontitis patients.

KEYWORDS: *Periodontitis, photodynamic therapy, photosensitizer, pocket*

Periodontitis is a multifactorial disease associated with loss of supporting structures of the tooth caused by certain periodontopathogenic bacteria and/or extracellular macromolecules as well. [1]
In the management of periodontally involved teeth, the current concepts are based on mechanical scaling and root planing (SRP) to remove bacterial deposits, calculus, and diseased cementum. However, removal of plaque and reduction of the number of infectious cells by mechanical SRP can be impaired in sites with difficult access. [2] The efficacy of the classical antiseptic/antibiotic approach is limited by the development of bacterial resistance which can account for unsatisfactory clinical outcomes. [3] As a result, there is pronounced interest and keenness in the development of alternatives to antimicrobial therapies. [1] Photodynamic therapy (PDT) involves the use of a photoactive dye (photosensitizer) that is activated by exposure to light of a specific wavelength in the presence of oxygen. [4] It could provide an alternative for targeting microbes directly at the site of infection, thus overcoming the problems associated with antimicrobials. [5] As the antimicrobial activity of photosensitizer is mediated by singlet oxygen, it has a direct effect on extracellular molecules, and the polysaccharides in extracellular polymeric matrix also are susceptible to photodamage. Antioxidant enzymes, such as superoxide dismutase and catalase, protect against some oxygen radicals but not against singlet oxygen. Both these activities that are not displayed by antibiotics represent a significant advantage of PDT. [6]

The aim of the present study was to evaluate the efficacy of PDT as an adjunct to nonsurgical periodontal therapy (SRP) in the treatment of chronic periodontitis patients both clinically and microbiologically.

SUBJECTS AND METHODS

This was a randomized, controlled clinical trial undertaken to evaluate the efficacy of PDT as an adjunct to nonsurgical periodontal therapy (SRP) in the treatment of chronic periodontitis patients. The study population included twenty patients diagnosed with chronic periodontitis, aged 35-50 years from the outpatient section, Department of Periodontics, St. Joseph Dental College, Eluru, between June 2014 and June 2015.

Approval of the study was obtained from the Institutional Ethics Committee, and informed consent was taken from all the participants before commencing the study. Patients who were willing to take part in the study, patients with more than 16 natural teeth, chronic periodontitis patients having a pocket depth (PD) of ≥5 mm, and patients with no history of allergies were included in the study. Exclusion criteria were pregnant and lactating women, patients having teeth with endo-perio lesions, patients using tobacco or tobacco-related products, patients on antibiotics within 3 months prior to the study, patients having systemic diseases such as diabetes mellitus, hypertension, bleeding disorders, hyperparathyroidism, and compromised medical conditions, patients who underwent periodontal surgery, restorative procedures, and tooth extraction adjacent to either of the test area in the previous 3 months, long-term therapy with medications within a month prior to enrollment that could affect periodontal status or healing, and patient's medical or dental therapy that could have an impact on the subject's ability to complete the study.

Patient's general examination and full-mouth periodontal examination were carried out, followed by fabrication of acrylic stents for the measurement of PDs [Figure 1] and [Figure 2] in the test sites during the study. Chronic periodontitis patients were divided by coin toss method into two groups, i.e., test group (SRP, followed by local application of photosensitizer, i.e., toluidine blue dye and activation with the light source) and control group (only scaling and root planing).

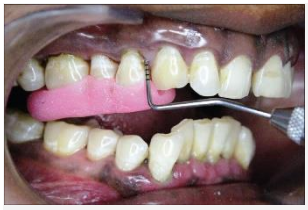


Figure 1: Preoperative probing depth measurement with occlusal stent

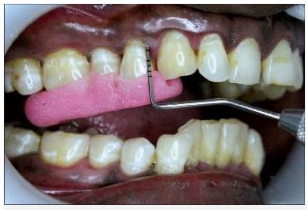


Figure 2: Postoperative probing depth measurement with occlusal stent using Williams probe

The parameters recorded were plaque index (PI), gingival index (GI), probing depth, and clinical attachment level (CAL). Subgingival plaque samples were collected using a Gracey curette by inserting it subgingivally into the deepest portion of the periodontal pocket along the long axis of the tooth and moved coronally by scraping the root surface [Figure 3]. The samples were stored in tris-ethylenediaminetetraacetic acid medium and sent for performing

PCR.

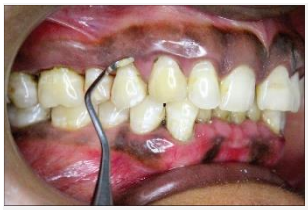


Figure 3: Plaque sample collection with 4R/4L universal curette

Photosensitizer (toluidine blue) (photo-activated disinfection [PAD] plus viscous solution, Denfotex Research Ltd.,) was applied with a subgingival cannula to the instrumented sites [Figure 4], starting from the apical end of the pocket and moving coronally to avoid entrapment of air bubbles. One minute later, pocket was rinsed thoroughly with sterile saline to remove the excess photosensitizer. Immediately after rinsing, the light source (PAD [Lit 600], Apoza, Taiwan), with 635 nm wavelength and 0.5 W of power output, equipped with a probe tip, was placed at the depth of the pocket [Figure 5] and moved circumferentially around the tooth for 60 s, according to the manufacturer's instructions.

Figure 4: Application of photosensitizer

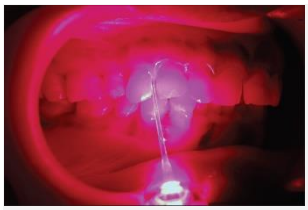


Figure 5: Activation with light

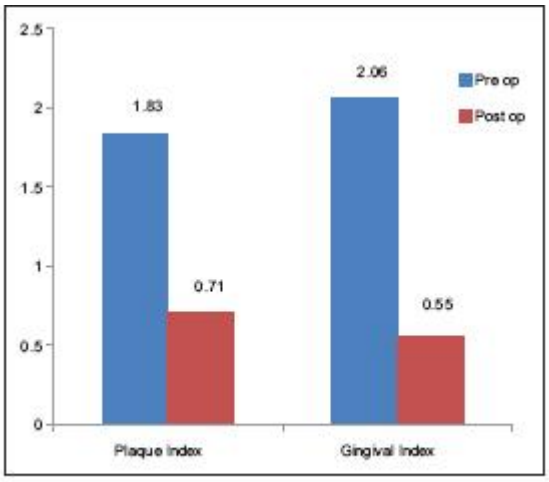
STATISTICAL ANALYSIS

The means and standard deviations were calculated for all clinical parameters of both groups. Paired t-test has been used to find the significance of study parameters within each group. The data collected were assessed using statistical software (GraphPad Prism 6 software, GraphPad Software, Inc., CA, USA).

RESULTS

A total of twenty subjects (12 females and 8 males) were included in the study.

On assessment of the clinical parameters, there was a statistically significant reduction in PI and GI values from baseline to 3 months [Table 1] and Graph 1].



Graph 1: Baseline and postoperative values of plaque index and gingival index

[Table 2] shows the results of control group, in which probing depth showed a statistically significant reduction after 3 months ($p < 0.0001$), whereas values for CAL were statistically nonsignificant ($P < 0.5086$). The PCR results of control group for Treponemadenticola (Td), Porphyromonas gingivalis (Pg), and Tannerella forsythia (Tf) were not statistically significant [Table 2] and Graph 2].

Comparison between	Mean±SD			p
	Preoperative	Postoperative	Differ from preoperative	
PI	1.83±0.40	0.71±0.37	1.12±0.03	0.0001 S*
GI	2.06±0.39	0.55±0.22	1.51±0.17	0.0001 S*

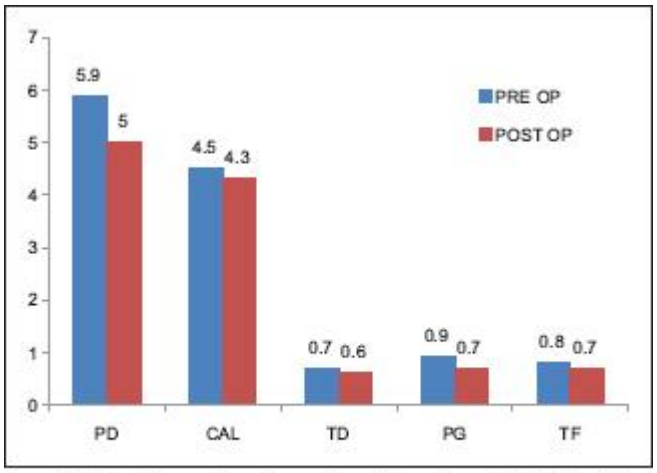
*S= Significant, Statistical analysis=Paired *t*-test. Statistically significant if *P*<0.05, GI=Gingival index, PI=Plaque index, SD=Standard deviation

Table 1: Plaque index and gingival index

Parameters	Mean±SD			p
	Preoperative	Postoperative	Differ from preoperative	
PD	5.9±0.99	5.0±0.66	0.9±0.33	0.0001 S*
CAL	4.5±1.08	4.3±0.94	0.2±0.14	0.5086 NS†
Td	0.7±0.48	0.6±0.51	0.1±0.03	0.5911 NS†
Pg	0.9±0.31	0.7±0.48	0.2±0.17	0.1679 NS†
Tf	0.8±0.42	0.7±0.48	0.1±0.06	0.3434 NS†

†NS=Not significant, SD=Standard deviation, CAL=Clinical attachment level, PD=Probing depth, Td=*Treponema denticola*, Pg=*Porphyromonas gingivalis*, Tf=*Tannerella forsythia* and S=Significant

Table 2: Clinical and microbiological parameters in control group



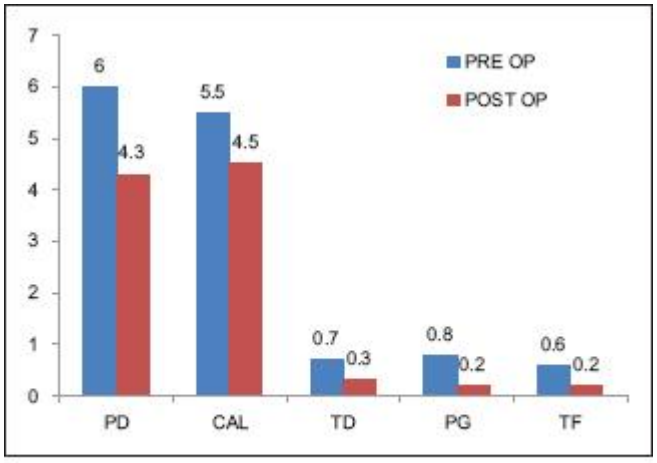
Graph 2: Baseline and postoperative values of pocket depth, clinical attachment level, and microbiological parameters in control group

The results of test group for probing depth and CAL showed statistically significant values $p < 0.0001$ and $p < 0.0038$, respectively. The PCR results of test group for Td, Pg, and Tf were statistically significant [Table 3] and Graph 3].

Parameters	Mean±SD			p
	Preoperative	Postoperative	Differ from preoperative	
PD	6.0±1.1	4.3±0.94	1.7±0.16	0.0001 S*
CAL	5.5±1.4	4.5±0.84	1.0±0.56	0.0038 S*
Td	0.7±0.44	0.3±0.5	0.4±0.06	0.0368 S*
Pg	0.8±0.42	0.2±0.42	0.6±0.00	0.0051 S*
Tf	0.6±0.51	0.2±0.42	0.4±0.09	0.0368 S*

*S= Significant, SD=Standard deviation, CAL=Clinical attachment level, PD=Probing depth, Td=*Treponema denticola*, Pg=*Porphyromonas gingivalis*, Tf=*Tannerella forsythia*

Table 3: Clinical and microbiological parameters in test group



Graph 3: Baseline and postoperative values of pocket depth, clinical attachment level, and microbiological parameters in test group

DISCUSSION

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The aim of the study was to evaluate the efficacy of PDT as an adjunct to nonsurgical periodontal therapy (SRP) in the treatment of chronic periodontitis patients both clinically and microbiologically. Twenty chronic periodontitis patients were included in this study and were randomly divided into control group and test group.

There was a significant reduction in PI values in both the groups from baseline to follow-up visits. P values are as follows: For control group, p = 0.0001 and for test group, p = 0.0001. This can be attributed to the fact that there was a reduction in supragingival plaque after SRP and oral hygiene instructions received during preliminary visits. The results of this study were consistent with Sato et al. [7] and Cugini et al. [8] There was a significant reduction in GI scores in both the groups (p = 0.0001). This may be due to elimination of local etiological factors which harbor numerous pathogenic strains. This was in accordance with Becker et al., [9] Boretti et al., [10] and Cugini et al. [8] The difference in mean probing PD reduction was significant in the test group when compared to control group, i.e., p = 0.0007. This was due to the beneficial effect of low-level laser therapy on tissue healing, including augmentation of collagen synthesis, reduced healing time, and diminution of the size of the wound. This was in accordance with Andersen et al., [11] Braun et al., [12] Sigusch et al., [13] Berakdar et al., [14] and Alwaeli et al. [15]

The difference in mean clinical attachment gain was significant in the test group (p = 0.0038), but not significant in the control group (p = 0.5086). This CAL gain was may be due to the effectiveness of SRP. There was a slight but

not statistically significant gain in mean CAL levels in test group when compared to the control group, i.e., p = 0.063. This was in accordance with Braun et al., [12] Sigusch et al., [13] and Berakdar et al. [14] There was a significant reduction in microbial levels in the test groups, i.e., p = 0.0368, p = 0.0051, and p = 0.0368 for Td, Pg, and Tf, respectively; this was may be due to highly reactive oxygen species, in particular, singlet oxygen, that can damage a wide variety of proteins, lipids, and carbohydrates. This was in accordance with the study conducted by Braham et al. [16]

The limitation of this study includes short-term duration of evaluation, small sample size, and single session of exposure.

CONCLUSION

Within these 3 months clinical trial, the data suggest that SRP combined with PDT has a significantly better and prolonged effect compared to SRP alone. PDT can be effective as an adjunct to mechanical therapy in the treatment of chronic periodontitis. Further, randomized long-term clinical studies and meta-analyses are necessary to demonstrate the beneficial effect of antimicrobial PDT and in comparison with conventional methods.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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