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# Effect of Photodynamic Therapy on Aggressive Periodontitis - A Systematic Review

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**Abstract:** ***To analyze the available scientific evidence on the effects of photodynamic therapy with scaling and root planning on aggressive periodontitis. A broad literature search was performed using both electronic database and hand search. The databases like MEDLINE, COCHRANECENTRAL, GOOGLE SCHOLARS, EBSCO and PROQUEST were used for online search. Hand search was performed in the institute library, articles that satisfied the inclusion criteria comparing effectiveness of photodynamic therapy on aggressive periodontitis were selected. Included studies were subjected to critical analysis following the Cochrane Collaboration tool for evaluating the risk of bias. The initial search resulted in 112 articles; our final review included 8 articles. Out of 8 studies 6 studies showed photodynamic therapy as an adjunct to scaling and root planning was effective than scaling and root planning. 1 study showed antibiotics with scaling and root planning was effective than photodynamic therapy.1 study did not show any significant changes after photodynamic therapy. With the constraints of limited available literature photodynamic therapy is effective with scaling and root planning for the management of aggressive periodontitis. But, the antibiotics with scaling and root planning show a greater impact on the clinical outcomes of aggressive periodontitis***

**Keywords:** Photo chemotherapy, Photodynamic therapy, Photosensitizing agents and Aggressive periodontitis

## 1. Introduction

Periodontitis is a multifactorial disease associated with loss of supporting tissues of the tooth caused by certain periodontopathogenic species of bacteria and extracellular macromolecules responsible for periodontal breakdown. Aggressive periodontitis (AgP) is a rapidly progressive periodontal disease, which is not coincident with the amount of oral biofilm and typically shows no association with any systemic disease[1]. Except for periodontal disease, patients are systemically healthy. Photodynamic therapy is a new treatment modality that has been developing rapidly within various medical specialties[2]. Photosensitizers in antimicrobial PDT (aPDT), such as porphyrins, phthalocyanines, and phenothiazines can target both Gram-positive and negative bacteria by bearing a positive charge, suggesting that aPDT may be useful in oral application; especially for periodontal treatment.[3] PDT can also eradicate a wide variety of pathogens of the skin and of the oral cavities. It is used in the treatment of verrucous carcinoma, Oral Squamous Cell Carcinoma, Oral Lichen Planus, Leukoplakia, aggressive periodontitis, Common herpes simplex infections[2-7]. PDT is selective in its effect, non-invasive, convenient for the patient with highly selective tissue necrosis, which is achieved by localizing the drug to the proliferating tissue. Repeated doses can be given without the

need for total dose limitation and absence of phototoxicity to human cells are the potential advantages of PDT[5-9]. The purpose of this study was to systematically evaluate the existing evidence to verify whether photodynamic therapy provided a better performance in treating the aggressive periodontitis.

## 2. Methodology

**Focused question**:

What is the effectiveness of photodynamic therapy on aggressive periodontitis in comparison with scaling and root planning and antibiotics with scaling and root planning?

**Search process**:

The articles were searched from important available databases MEDLINE, COCHRANE CENTRAL, GOOGLE SCHOLARS, EBSCO and PROQUEST.

Search strategy was based on the following key words Photo chemotherapy, Photodynamic therapy, Photosensitizing agents, Periodontitis, Aggressive periodontitis, chronic periodontitis and periodontal diseases either isolated or in combination of these words according to Boolean operators. A comparison of titles was done from different search engines to delete the repeated studies. At this stage abstracts of all available articles were examined. All studies, which appeared to meet the inclusion criteria, were obtained in the full text format and were assessed for validity. Application of the Cochrane Collaboration tool for evaluating the risk of bias was done. Then selected articles were grouped into high risk bias and low risk bias articles.

**Inclusion criteria**:

1. Randomized clinical trials.
2. Studies conducted on humans with aggressive periodontitis
3. Follow up time of 3-6 months.
4. Studies published from 2000 to May 2016.
5. Studies published in English language only.

**Exclusion criteria**:

1. Studies done on pregnant women.
2. Animal studies.
3. Studies published in other languages were excluded.
4. Patients with systemic diseases
5. Studies with follow up less than 4 weeks.

**Types of outcome measures**:

Outcome variables are probing pocket depth (PPD), Clinical attachment level (CAL), Bacterial species like Aggregatibacteractinomycetemcomitans and Bleeding on probing (BOP)

## 3. Results

The initial search resulted in 112 articles; however, 52 of these articles were excluded after reviewing the abstracts because they were duplicates and 34 articles were excluded because they did not have the proper clinical trial design as RCT with cross over and parallel designs were considered. After analyzing the full text from 26 clinical trials, 18 were excluded because they did not fulfil the selection criteria table 1. Our final review included 8 articles figure 1. Demographic details and General characteristics of included studies were described in table 2&3.

**Risk of bias of included studies:**

The included studies were subjected to critical analysis following the Cochrane Collaboration tool for evaluating the risk of bias, and we classified three articles as having a low risk of bias and four articles as having a high risk of bias. Table 4 shows the domain in which the trails were judged to have the high risk of bias.

**Description of studies**

Studies included in this systematic review compared the effectiveness of photodynamic therapy on aggressive periodontitis in comparison with scaling and root planning and or antibiotics with scaling and root planning

*Probing pocket depth*: Oliveria et al., in 2007 reported that there was no statistically significant difference in the PDT group. Arweiler et al., in 2014 reported that both groups demonstrated a significant reduction in pocket depth after 6 months. Antibiotic group showed a significantly greater reduction compared to photodynamic therapy group. Chitsazi et al., in 2014 reported that a significant reduction in pocket depth was observed in the two groups after treatment. Moreira et al., in 2014 reported that a marked reduction in pocket depth was observed in two groups after treatment. Annaji et al., in 2016 reported that there was no significant reduction in pocket depth both in test group and control group after 3 months.

*Clinical attachment level*: Oliveria et al., in 2007 reported that significant gain of clinical attachment level took place in both groups. Arweiler et al., in 2014 reported that both groups showed significant improvement in Clinical attachment level and differed significantly from each other. Chitsazi et al., in 2014 reported that a significant gain in

clinical attachment level was observed in the two groups after treatment. Moreira et al., in 2014 reported that a significant gain in clinical attachment level was observed in two groups after treatment. Annaji et al., in 2016 reported that there was no significant gain in clinical attachment level scores both in test group and control group after 3 months.

*Bleeding on probing*: Oliveria et al., in 2007 reported that statistically significant difference was observed in bleeding on probing after photodynamic therapy. Arweiler et al., in 2014 reported that bleeding on probing decreased significantly in both groups. Chitsazi et al., in 2014 reported that bleeding on probing showed a significant decrease in the control group compared to the test group. Moreira et al., in 2014 reported that bleeding on probing showed a significant decrease in photodynamic therapy group compared to scaling and root planning group. Annaji et al., in 2016 reported that there was no significant reduction in bleeding on probing scores both in test group and control group after 3 months.

*Bacterial species*: Novaes et al., in 2012 reported that after 3 months, a significant reduction in mean counts of A.actinomycetemcomitans was observed for the photodynamic therapy group. Chitsazi et al., in 2014 reported that in both test group and control group a significant reduction was seen in A.actinomycetemcomitans counts after 3 months. Moreira et al., in 2014 reported that more species of orange and red complexes decreased in test group when compared with control group. Annaji et al., in 2016 reported that there is no significant difference between the test group and control group. Photodynamic therapy group showed significant greater reduction than scaling and root planning group.

## Figures and Tables

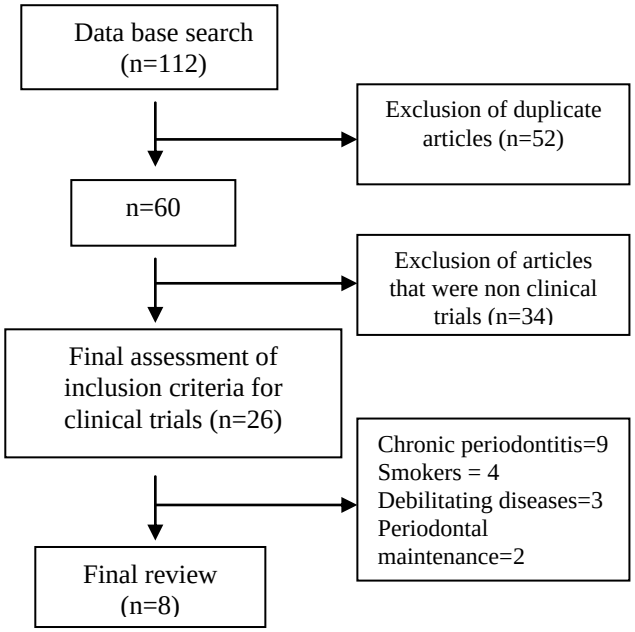


**Figure 1:** Flow chart showing analysis of articles

***Tables*** **Table 1:** Articles excluded from the study

| Author | Title of article | Reason for exclusion |
|---|---|---|
| Petelin M et al.,(2015) | Microbiological effect of antimicrobial photodynamic therapy on sub gingival periodontal pathogens in chronic periodontitis | Chronic periodontitis |
| Malgikar S et al.,(2015) | A randomized controlled clinical trial on efficacy of photodynamic therapy as an adjunct to nonsurgical treatment of chronic periodontitis | Chronic periodontitis |
| Queiroz AC et al(2014) | Antimicrobial photodynamic therapy associated to nonsurgical periodontal treatment in smokers: microbiological results. | Smokers |
| Queiroz AC et al.,(2013) | Adjunctive effect of antimicrobial photodynamic therapy to nonsurgical periodontal treatment in smokers: a randomized clinical trial. | Smokers |
| MacedoGD et al.,(2013) | Additional effects of aPDT on nonsurgical periodontal treatment with doxycycline in type II diabetes: a randomized, controlled clinical trial. | Type II diabetes mellitus |
| Bassir SH et al., (2013) | Photo activated disinfection using light-emitting diode as an adjunct in the management of chronic periodontitis: a pilot double-blind split-mouth randomized clinical trial. | chronic periodontitis |
| Arweiler et al.,(2013) | Non-surgical treatment of aggressive periodontitis with photodynamic therapy or systemic antibiotics | It is same study with difference in study duration |
| Campos GN et al., (2012) | The adjunctive effect of photodynamic therapy for residual pockets in single-rooted teeth: a randomized clinical trial. | Residual pockets |
| NoroFilho GA et al.,(2012) | PDT in non-surgical treatment of periodontitis in HIV patients: a split-mouth, randomized clinical trial. | HIV patients with periodontitis |
| Berakdar M et al.,(2012) | Comparison between scaling-root-planing (SRP) and SRP/ photodynamic therapy: six-month study | Chronic periodontitis |
| Ge L et al (2011) | Adjunctive Effect of Photodynamic Therapy to Scaling and Root Planning in the Treatment of Chronic Periodontitis | chronic periodontitis |
| Lui J et al.,(2011) | Combined photodynamic and low-level laser therapies as an adjunct to nonsurgical treatment of chronic periodontitis | Smokers |
| Alzahrani MSetal.,(2011) | Photodynamic therapy as an adjunctive to scaling and root planning in treatment of chronic periodontitis in smokers. | Smokers |
| Romeo U et al.,(2010) | Non-surgical periodontal therapy assisted by potassium-titanyl-phosphate laser: a pilot study | Chronic periodontitis |
| Ruhling A et al.,(2010) | Photodynamic therapy of persistent pockets in maintenance patients-a clinical study. | Residual pockets |
| Chondros et al.,(2009) | Photodynamic therapy as adjunct to non-surgical periodontal treatment in patients on periodontal maintenance: a randomized controlled clinical trial. | periodontal maintenance |
| Polansky R et al.,(2009) | Clinical effectiveness of photodynamic therapy in the treatment of periodontitis. | Chronic periodontitis |
| Al-Zahrani MS et al.,(2009) | Short-term effects of photodynamic therapy on periodontal status and glycemic control of patients with diabetes. | Type II diabetes mellitus |

| Author | Study design | Sample size | Age | M : F | Study group Test | Control | Follow up | Clinical variables measured |
|---|---|---|---|---|---|---|---|---|
| Annaji S et al.,2016 | Pilot study (split mouth design) | 15 | 27.8 ±3.71 years | 6: 9 | 15 (SRP +PDT) | 15 (SRP) | 3 months | Plaque index, bleeding on probing, probing pocket depth, clinical attachment level and cultured for aggregatibacteractinomycetecomitans, porphyromonasgingivalis and prevotellaintermedia. |
| Skurska A et al., 2015 | Randomized clinical trial | 36 | 23-55 years | 12:24 | 18 (SRP + AB) | (SRP) | 6 months | Levels of sulcus fluid flow rate, matrix metalloproteinase 8 and 9. |
| Moreira etal., 2015 | Randomized clinical trial (split mouth design) | 20 | <35 years | 2:18 | 20 (SRP +PDT) | 20 (SRP) | 3 months | Probing depth, clinical attachment level, gingival recession, IL-1β,IL-10, Tumour necrosis factor-α and 40 bacterial species. |
| Arweiler et al.,2014 | Randomized clinical trial | 36 | 23-55 years | 12:24 | 18 (SRP + AB) | 18 (SRP) | 6 months | Probing depth, clinical attachment level, gingival recession, plaque index, bleeding on probing, full mouth bleeding on probing. |
| Chitsazi et al., 2014 | Randomized clinical trial (split mouth design) | 24 | 29 years | 9: 15 | 24 (SRP +PDT) | 24 (SRP) | 3 months | Probing depth, clinical attachment level, gingival recession, bleeding on probing, plaque index, gingival index and detection of aggregatibacteractinomycetecomitans. |
| Novaes et al., 2012 | Randomized clinical trial (split mouth design) | 10 | 31 years | 2: 8 | 10 (SRP +PDT) | 10 (SRP) | 3 months | 40 subgingival bacterial species. |
| Oliveria et al., 2009 | Randomized clinical trial (split mouth design) | 10 | 31 years | 2: 8 | 10 (SRP +PDT) | 10 (SRP) | 3 months | Gingival crevicular fluid, Tumour necrosis factor-α and receptor activator of nuclear factor-kappa B ligand (RANKL) |
| Oliveria et al., 2007 | Randomized clinical trial (split mouth design) | 10 | 31 years | 2: 8 | 10 (SRP +PDT) | 10 (SRP) | 3 months | Probing depth, gingival recession, relative clinical attachment level, bleeding on probing. |

**Table 2: Demographic and clinical characteristics of included studies**

**Table 3: photodynamic therapy parameters for included studies**

| Studies | Wave length | Duration of irradiation | Type of PS used | Pre-irradiation time with PS | Concentration of PS used | Frequency of photodynamic therapy application |
|---|---|---|---|---|---|---|
| Annaji S et al.,2016 | 870 nm | Not given | Toludine blue | 3min | 1mg/ml | 3(0,7,21days) |
| Skurska A et al., 2015 | 660 nm | 60 sec | Phenothiazine chloride | 3min | 10mg/ml | 1 |
| Moreira etal., 2015 | 670 nm | 60 sec | Phenothiazine chloride | 1min | 10mg/ml | 4(0,2,7,14days) |
| Arweiler et al.,2014 | 660 nm | 60 sec | Phenothiazine chloride | 3min | Not given | 2(0,7days) |
| Chitsazi et al., 2014 | 690 nm | 120 sec | Toludine blue | 1min | 10mg/ml | 1 |
| Novaes et al., 2012 | 660 nm | 60 sec | Phenothiazine chloride | 1min | Not given | 1 |
| Oliveria et al., 2009 | 660 nm | 60 sec | Phenothiazine chloride | 1min | 10mg/ml | 1 |
| Oliveria et al., 2007 | 660 nm | 60 sec | Phenothiazine chloride | 1min | 10mg/ml | 1 |

**Table 4: Studies having high risk of bias**

| | |
|---|---|
| Improper randomization | 3 Studies (Arweiler et al.,2014; Chitsazi et al., 2014; Annaji S et al.,2016) |
| Improper blinding | 4 Studies(Oliveria et al., 2007; Oliveria et al., 2009; Novaes et al., 2012; Annaji S et al.,2016) |
| Improper blinding and Improper Randomization | 1 Study(Annaji S et al.,2016) |
| Improper randomization, Improper blinding and Improper reporting of incomplete outcomes | 1 Study(Annaji S et al.,2016) |

## 4. Discussion:

The present study aimed to analyse the available scientific evidence on the effects of photodynamic therapy as an adjunct to scaling and root planning on aggressive periodontitis. The result of this systematic search of the literature showed that only a few randomized controlled clinical studies had been performed for evaluating the effect of PDT in the treatment of AgP. As a result, it was unfeasible to perform a meta-analysis with the existing data, because of the heterogeneity in methodologies of the included studies as well as the lack of publications. All the studies included in the present systematic review proved that PDT showed significant improvement in the clinical parameters and also showed reduction in periodontal pathogens in patients of AgP[28-35]. In the present review, studies conducted by Oliveira RR et al[30, 31] compared the efficacy of PDT as a monotherapy to SRP alone in the management of AgP. In these studies a statistically significant improvement of clinical

parameters was identified after both treatments (SRP or PDT). In studies done by Arweiler NB et al[29] and Skurska A et al[34] application of PDT significantly improved the periodontal inflammatory parameters; however the use of antibiotics showed significantly better outcome as compared to PDT. These studies mentioned that PDT in contrast to the use of antibiotics has the advantage of repeated applications as bacterial resistance to PDT has not been reported. Moreover the clinical application of PDT in the management of AgP has relevance, because Schar et al[36] in a study comparing localized antibiotic application and PDT in the management of peri-implantitis, showed comparable outcomes in terms of clinical peri-implant parameters at follow-up. In few of the included studies done by Oliveira RR et al and others[29,30,33] the use of PDT did not improve the clinical parameters after non-surgical therapy of AgP to a statistically significant level. On the contrary, an included study done by Arweiler NB et al[29] showed that six months after therapy with SRP and antibiotics, the clinical outcome was greater than SRP and PDT. The result of this publication confirmed the result of the meta-analysis of Keestraetal[37] who aimed to identify the effectiveness of systemic antibiotics as an adjunct to SRP in patients with untreated AgP. Similarly, the results of the study done by Chitsazi MT et al[33] stated that the utilized PDT in conjunction with SRP without antibiotic control group revealed that PDT had no additional benefit in the treatment of AgP. A study done by Moreira AL et al[28] revealed a positive role of PDT in combination with SRP in comparison with SRP alone, in which repeated application of PDT in four sessions was applied. In the present systematic review studies done by Novaes AB et al and others[28,32,35]reported the microbiological parameters following PDT in AgP patients. A common finding among these studies was a significant reduction in the microbial profile particularly in Aggregatibacteractinomycetemcomitans count after 3 months following PDT. It is worth mentioning that the included studies had significant heterogeneity in the wavelengths of the lasers used and irradiation times for photosensitizers. Furthermore, other parameters related to PDT, such as period of light application was not reported in all studies. Also frequency of PDT application has varied from four applications to just one which could have influenced the overall efficacy of PDT in the included studies of the present review. In all the studies included in the present review patients with systemic disorders were excluded and all study participants were apparently healthy individuals.

## 5. Conclusion

With the constraints of limited available literature photodynamic therapy is effective as an adjunct to scaling and root planning for the management of aggressive periodontitis. But, the antibiotics use in conjunction with scaling and root planning show a greater impact in the clinical outcomes of aggressive periodontitis than after therapy with a combination of scaling and root planning and photodynamic therapy.

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