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Review Article

Photodynamic therapy and periodontal disease

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ABSTRACT

Periodontal diseases are global health concern since they affect almost 20-50% of global population and are widespread in both developed and developing countries. Periodontal disease develops as result of persistent infection caused by different periodontopathic bacteria and inflammation of tooth's supporting tissue. Traditional methods of periodontal care involve mechanical removal of biofilm and using antibiotics and antibacterial disinfectants as supplemental measure. However, in locations with restricted access, removal of plaque and decrease in quantity of pathogenic organisms may suffer. Furthermore, increased antibiotic resistance has led to development of newer therapeutic modalities, including photodynamic therapy (PDT). Application of PDT in periodontics, such as pocket debridement, gingivitis, and aggressive periodontitis, continues to develop into fully developed clinical therapeutic modality and is regarded as potential new strategy for eliminating pathogenic bacteria in periodontitis. Photosensitizer activated by light of certain wavelength in presence of O_2 is used in PDT, potent laser-initiated photochemical reaction. Because traditional therapy, such as scaling and root planing, is ineffective at entirely eliminating periodontal infections, especially in deep periodontal pockets, antimicrobial PDT may be viewed as alternate therapeutic approach. Additionally, dual selectivity of PDT, which restricts damage to healthy tissues, gives it competitive advantage over alternative therapies. Purpose of this research is to review the available information about PDT and periodontal disease.

Keywords: Photodynamic, Therapy, Periodontal, Disease

INTRODUCTION

Periodontal diseases are an umbrella of the wide range of inflammatory conditions that affect the supporting structures of teeth, including the gingiva, bone, and periodontal ligament, leading to the loss of teeth and the spread of inflammation throughout the body. Although aggressive periodontitis can infrequently affect

adolescents, chronic periodontitis primarily affects adults. Dental plaque, which undergoes dysbiosis during the onset and spread of periodontal disease, interacts with the host's immune system and is responsible for causing inflammation and illness.[1] Periodontal diseases affect almost 20-50% of global population and are widespread in both developed and developing countries, making them public health concern since they affect older people, adults, and young adults at such high rates. Periodontal diseases are associated with no. of risk factors, including smoking, poor dental hygiene, diabetes, medication, age, hereditary factors, and stress. Strong evidence links systemic diseases, including cardiovascular disease, diabetes, and adverse pregnancy outcomes, to periodontal diseases. Cardiovascular disease risk is predicted to increase by 19% as result of periodontal disease, and this relative risk increase rises to 44% for people 65 and older. When compared to people with minimal or mild periodontitis, mortality risk for type 2 diabetics with severe forms of periodontal disease is 3.2 times higher.[2]

The conventional methods of treating periodontitis have included mechanical removal of the biofilm and the supplementary use of antibacterial cleaners or other medicines. Due to the inappropriate use of antibiotics recently, there has been an increase in the number of bacterial strains developing resistance. The discovery of alternative antibacterial modalities is therefore of great interest and immediate need. As the scientific community studies alternatives to antibiotic therapy, researchers in the field of periodontics have discovered that PDT is useful for suppressing anaerobic bacteria. PDT might therefore be an alternative to traditional periodontal treatment techniques.[3] Antimicrobial PDT, photodynamic antimicrobial chemotherapy, or photodynamic disinfection are all terms used to describe the inactivation of bacteria using PDT. A non-toxic photosensitizer, safe visible light, and oxygen are required for the usage of antimicrobial PDT. The photosensitizer attaches to the desired bacterium and can subsequently be triggered by oxygen-containing light of the right wavelength. Bacterial photoinactivation is strictly confined to the localisation of the photosensitizer, protecting nearby cells from adverse consequences. Because traditional therapy, such as scaling and root planing, is ineffective at entirely eliminating periodontal infections, especially in deep periodontal pockets, antimicrobial PDT may be viewed as an alternate therapeutic approach.[4]

The dual selectivity of PDT, which restricts the damage to healthy tissues, gives it a competitive advantage over alternative therapies. Controlling the transmission of light and enhancing the selective accumulation of photosensitizers in the affected tissues are used to achieve this. Additionally, PDT employs low-level lasers, which have been demonstrated to lessen discomfort, promote fast healing, and help with haemostasis. Since both gram-negative and gram-positive bacteria are susceptible to photosensitizers used in PDT, such as phenothiazines, phthalocyanines, and porphyrins, PDT may be useful for oral applications, primarily for periodontal therapy. Studies on the effects of PDT on people with aggressive periodontitis have produced favourable outcomes for the subgingival flora. Both scaling and root planing and PDT have been suggested as potential adjuncts to nonsurgical treatment for aggressive periodontitis. Many studies examining effectiveness of PDT in periodontal therapy, however, have not demonstrated its advantage over the standard of care.[5] Purpose of this research is to review the available information about PDT and periodontal disease**.**

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on May 17, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about PDT and periodontal disease. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

PDT, which is the light-induced inactivation of cells, bacteria, or molecules, was first used in medical therapy in 1904 and combines visible light, typically through the use of a diode laser and a photosensitizer, with visible light. The absence of bacterial resistance to the antimicrobial mechanism is an important consideration when contemplating the use of PDT and becomes even more important in light of the global rise in bacterial resistance against conventional antibiotics. As a result, its continued use along with mechanical debridement may prove to be an effective treatment option for periodontal and peri-implant infections in the future. However, limited evidence currently supports the idea that PDT could take the place of systemic or local antibiotics.[6] PDT use may enhance periodontal outcomes. As a result, it may be utilized as an alternative to or in addition to conventional therapy for the treatment of periodontal and peri-implant disorders, thus creating a novel way for antibacterial treatment. Knowledge of advantages of PDT use in periodontal treatment outcomes is encouraging, albeit early. Among the particular targets that PDT can be applied to are peri-implantitis and periodontal diseases.[7]

Evidence from literature

Meimandi et al described that PDT treatment with scaling and root planing has been suggested as an effective additional method for the treatment of localized chronic periodontitis, particularly during the maintenance phase of non-surgical treatment, due to its safety, lack of side effects, and general benefits like increased patient compliance.[8] Results of the systematic review revealed

that, after repeated administrations, PDT may prove helpful in the treatment of aggressive periodontitis. The clinical outcomes of PDT as monotherapy are comparable to those of mechanical treatment in important ways.[9] Similarly, findings of a clinical trial showed that repeated PDT applications enhanced clinical outcomes in the treatment of residual pockets after six months.[10] Results of another clinical trial recommended that in periodontal pockets with PD>5 mm, PDT may be used as an additional therapy to scaling and root planing treatment to reduce risk of bleeding within these lesions.[11]

However, studies for single application of PDT did not exhibit significant positive results, like the findings of randomized trial, which showed that single cycle of PDT application proved ineffective as supplement to ultrasonic periodontal therapy. On probing, there were no additional reductions in bleeding or pocket depths. Although there are no additional effects compared to conventional treatment alone in terms of eradicating microorganisms.[12] Similarly, results of a randomized trial demonstrated that a single PDT application added as adjunctive therapy to scaling and root planing did not improve the reduction of probing pocket depth, plaque index/clinical attachment level; however, it significantly decreased gingival bleeding and inflammation.[13] Likewise, results of another trial depicted that a single PDT application in individuals with chronic periodontitis did not improve scaling and root planing in terms of clinical metrics or inflammatory markers three months after the intervention.[14]

Borekci et al described that as result of PDT antibacterial actions on periodontopathogens, as revealed in clinical studies, PDT emerged as unique non-invasive therapy method. PDT has the power to eradicate microbiological cells, including viruses, fungi, and bacteria. Given that standard non-surgical periodontal treatment would not be adequate to completely eradicate all periodontopathogens, it is strongly anticipated that utilizing PDT as adjuvant to non-surgical periodontal treatment will have tremendous success in treatment of periodontal disorders.[15] Souza et al narrated that bacterial resistance to antibiotics is always increasing, and that biofilms of bacteria in oral cavity have complex structures and hierarchies. PDT has emerged as viable additional therapy for treatment of periodontitis in addition to scaling and root planing. Research studies comparing effects of systemic antibiotic therapy with PDT in periodontal clinical treatment have revealed considerable improvements in periodontal clinical parameters compared to standard mechanical treatment in human clinical studies.[16]

The adjunctive use of PDT demonstrated an increased decrease in probing pocket depth, bleeding on probing, and improvement in clinical attachment levels when compared to scaling and root planing alone in individuals with periodontitis, according to a literature search and analysis of multiple controlled clinical trials. The driving force behind PDT is its powerful capacity to eliminate bacteria in biofilms and planktonic fluid. According to the available research studies findings, PDT can significantly aid in nonsurgical periodontal treatment.[17] With its significant advantages defined, PDT also has several risks. Antimicrobial PDT risks and side effects are classified into two categories: related to the effects of light energy and those related to the photochemical process and the photosensitizer. Even though the laser intensity used during therapy is relatively low, it must be rigorously avoided if patient's eyes could unintentionally be exposed to radiation. It is advised that the patient, the operator, and the assistant all wear safety eyewear. The interaction of the laser with the tissues during high-power laser therapy causes thermogenesis. The gingival tissues and root surfaces are not thermally altered by PDT, a low-level therapy that uses a diode laser and short irradiation times. Applying antimicrobial PDT is crucial when using photosensitizers and photochemical reactions to stain and kill targeted bacteria with little harm to surrounding periodontal tissues.[18,19]

In comparison to scaling and root planing alone, numerous randomized controlled clinical trials have demonstrated that antibacterial PDT plus scaling and root planing combinations generate considerable improvements in probing pocket depth and clinical attachment level. Antibacterial PDT should be used in conjunction with scaling and root planing in active periodontal treatments since antibacterial PDT alone is less effective than scaling and root planing at removing biofilm. On the other hand, there is limited proof that antibacterial PDT is beneficial during the periodontal maintenance phase.[20] Periodontal diseases have been successfully treated with PDT. Due to the difficulties of accessing confined spaces, mechanical removal of gold standard biofilm in the therapeutic management of periodontal diseases is impaired in difficult-to-access locations. Regarding its antibacterial action, the PDT has been proven to be promising as an adjuvant therapy to periodontal treatments. The approach involves the use of short-wavelength lasers combined with a photosensitizing chemical. PDT has no bacterial selectivity, no anti-inflammatory toxicity, no bactericidal/bacteriostatic side effects, and retains the oral flora. PDT's therapeutic window is useful in removing colonies or biofilm and could enhance the effects of traditional mechanical therapy. In order to lessen severity of inflammatory gum symptoms, periodontal therapy and PDT have been investigated in conjunction.[21] Available studies in the literature show variation regarding effects of PDT for treatment of periodontal diseases. Additionally, studies presented are scarce and limited to past times, necessitating the need for further research, including clinical trials and population-based studies, to elaborately study effects of PDT with different strengths and intervals for the treatment of periodontal diseases.

CONCLUSION

PDT is a safe and effective treatment that has results comparable to those of antibiotic therapy. PDT can be a

promising approach in today's era where antibiotic resistance is high; however, clinically, its long-term use at various intervals and strengths requires further research as limited evidence is available.

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