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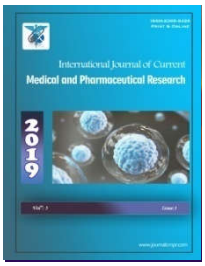

THE LIGHT THAT CURES: PHOTO-DYNAMIC THERAPY

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ABSTRACT

Technology advancements are occurring at a rapid pace and are enormous. Gingivitis and periodontitis is a very common condition, causing destruction of the supporting structures of the teeth due to inflammation is a chronic disease process caused by the pathogenic micro-organisms within the oral cavity. Photodynamic therapy [PDT], has now recognized and established its place as a non-invasive method to treat bacterial, fungal and viral infectionsand requires the use of photosensitizers which are responsive to light.

INTRODUCTION

Over the years technology has progressed at a rapid pace. Conventional modalities are being substituted with the latest advancements as they are more efficacious and provide better results, hence a better prognosis.

Gingivitis and periodontitis is a very common condition, however the severity of the disease varies for each individual and also the treatment required for each individual is different. The destruction of the supporting structures of the teeth due to inflammation is a chronic disease process caused by the pathogenic micro-organisms within the oral cavity.[1]

The primary conventional treatment for periodontal disease is to remove the pathogenic micro-organisms, however hindrances such as enamel pearl, furcation, uneven tooth surfaces makes it somewhat cumbersome to get rid of all the micro-organisms.[2] Hence, addition of chemotherapy isdone, however maintaining a stable concentration and the possibility of antibiotic resistance remains a major issue.[3]

Light being used as a therapeutic modality dates back to the ancient period. Its use was forgotten for a long period of time, but not for too long and was re-invented in the 20th century.[4] Photodynamic therapy[PDT],has now recognized and established its place as a non-invasivemethod to treat bacterial, fungal and viral infections.[7] Photodynamic therapy requires the use of photosensitizers which are responsive to light. Porphyrins, phthalocyanines and phenothiazines [methylene blue and toluidine blue O] are the antimicrobial photosensitizers bearing a positive charge which targets both the gram-positive and gram-negative bacteria.[9]

Table 1 The Ideal properties of photosensitizer for antimicrobial photodynamic therapy are enlisted in

S.I No	Ideal properties of photosensitizer
1.	High singlet oxygen quantum yield
2.	High binding affinity for microorganisms
3.	A high quantum yield of triplet state to obtain large concentration of the activated drug
4.	A broad spectrum of action.
5.	Low binding affinity for mammalian cells to avoid the risk of photo destruction of host tissues
6.	Low propensity for selecting resistant bacterial strains
7.	Minimal risk of promoting mutagenic processes
8.	Low chemical toxicity

Applications of Photodynamic Therapy

Conventional

1.Chronic Periodontitis
2.Aggressive Periodontitis
3.Peri-implantitis

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Advancements

1. Phototherapy
2. Antibody-targeted antibacterial approaches using photodynamic therapy
3. Nanoparticle –based antimicrobial photodynamic therapy

Chronic Periodontitis

Antimicrobial photodynamic therapy adjunctive to scaling and root planing has been found to be comparatively better than scaling and root planing alone, which has been demonstrated in several clinical randomized controlled trials. Many in vitro studies have supported the hypothesis that explicit photosensitizer and light source is bactericidal for periodontal pathogens.[15,16]

P. gingivalis, F. nucleatum, A. actinomycetemcomitans and S.sanguinis was effectively eradicated by the use of low level helium-neon laser irradiation with toluidine blue O or methylene blue.[14] Analysis of a number of in vitro studies supports the contention that antimicrobial photodynamic therapy with scaling is highly efficacious then scaling alone.
Several in vivo studies has shown efficacy in quashingperiodonto-pathogens, plummeting the signs of inflammation.[17,18]

Aggressive Periodontitis

The combination of scaling and root planning and photodynamic therapy is found to be efficacious in comparison to scaling and root planning alone
Rose Bengal stain used as a sensitizer for the evaluation of photo inactivation of A. actinomycetemcomitans showed a 45% biofilm reduction with no effects to the gingival fibroblast cells. Also Methylene blue and Erbium Yttrium AluminiumGarne has been effective against A. actinomycetemcomitans. Nevertheless, Er:YAG is more proficient in eradicating bacterial cells in planktonic [75%] and biofilm [77%] than MB [50 and 54% respectively].[26]

Peri-implantitis

The use of high level lasers on contaminated dental implant surface showed bactericidal and detoxification effects in several studies.[28]

Haas *et al*. in his clinical case series studied the clinical effects of treatment with antimicrobial photodynamic therapy in amalgamation with guided bone regeneration using autogenous bone graft on 24 patients, showed improvements in [21] patients after a time period of 9 months.[30]

Antimicrobial PDT is highly recommended as the drug is administered locally and eliminates the systemic side effects and at the same time ensures complete bacterial elimination. Hence, its use in periodontal disease and implant related condition is beneficial. Several studies have already proven that the adjunctive use of PDT to scaling and root planning in patients with chronic periodontitis, aggressive periodontitis and peri-implantitis, may result in reduced inflammation due to decrease in the bacterial load.[4] Also, same studies have reported clinical attachment level gains.[4,9]

The ultimate combination of photosensitizer and light source with either of them being more or equally important is not yet understood or quantified, which leads to the dilemma and the need for further research in this aspect.However the hypothesis that it is bactericidal on pathogenic micro-organisms is proven to be true, but its effects on oral microflora is still debatable.[5]
The effect of photosensitizers on supporting periodontal structures is still not understood and also there is no quantification or the exact drainage mechanism of the photosensitizer which is explained. Temporary pigmentation and challenge to clear the photosensitizer dyes from periodontal pockets are the shortcomings of the Antimicrobial PDT.[5]

Over the time, as the progression with the technological advancements increased so did the resistance of the bacteria and the difficulty in using the antimicrobial PDT in treating the complex bacterial complexes increase. To counteract the same molecular level research is highly recommended for a better understanding of the same, which will give a better end result.

Phototherapy

Herein, there is use of the photosensitizer which is naturally present in the oral black –pigmented species, which are activated when visible light in the range of 380 to 520 nm is applied. In patients with chronic periodontitis, it was observed that there was a threefold decrease in the evolution of P. gingivalis, P. intermedia, P. nigrescens and P. melangencia in dental plaque samples obtained from human.[9]Further other investigators have shown that visible light inactivates black-pigmented bacteria.[11]

Antibody-Targeted Antibacterial Approaches using Photodynamic Therapy

Staphylococcus aureus has been targeted with photosensitizers conjugated to antibodies.[11]Murine monoclonal antibody against P. gingivalis lipopolysaccharide in conjugation with toluidine blue O, was found to be effective in eradicating P. gingivalis.[9]

For photo-thermal sensitizer gold nanoparticles were used in conjugation with antibodies.[19]At the time of irradiation the energy was absorbed andconverted into heat with the bubble-formation phenomena around the clustered nanoparticles, leading to irreversible bacterial impairment.[9]

Nanoparticle –based Antimicrobial Photodynamic Therapy

The complex oral microflora and its resistance causing a hindrance for the penetration of methylene blue in the oral biofilms has steered towards the development of novel delivery systems which significantly improve the pharmacological characteristics of methylene blue.

The encapsulation of methylene blue within poly D,L-lactide-co-glycolide [PLGA] nanoparticle [150-200 nm in diameter] that may offer a novel design of nano-platform for enhanced drug delivery and photo-destruction of oral biofilm, has been proposed by many investigators.[15]

The incubation of nanoparticles with cell demonstrated a time-depended discharge of PS with phototoxicity and activation of the photodynamic nanoagent.[9]It was found that the nanoparticles were intense on the cell walls, but not internalized.

CONCLUSION

The technological progress in the field of medicine is immense; however it is still lacking all the data that is required to exactly prove the hypothesis true. The use of photodynamic therapy with the use of agents has shown a ray of hope for

better prognosis, but still needs research for a complete understanding of the technique. Further research will help in better understanding of the technique, the quantization and the wavelength of the light which is most effective for the disease process.

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