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Dental Science

APPLICATION OF PHOTODYNAMIC THERAPY IN PERIDONTAL THERAPY

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ABSTRACT Mechanical removal of the biofilm and adjunctive use of antibacterial disinfectant have been conventional methods of periodontal therapy. In recent years, the combination of laser light and photosensitizer known as photodynamic therapy (PDT) has been found to be advantageous in periodontal therapy. Even though PDT is still in the experimental stages of development, the method can be use as an alternative to periodontal therapy. Therefore the aim of this review was to describe in detail application of photodynamic therapy in periodontal therapy.

KEYWORDS : Periowave, Photodynamic therapy, Periodontal therapy, Photosensitizers

Introduction:

Periodontal diseases result from accumulation of bacterial biofilms on tooth surfaces. The mechanical removal of the bio-film and adjunctive use of antibacterial disinfectants or various antibiotics have been conventional methods of the periodontal therapy. Recently there have been a number of reports about the bacterial strains becoming resistant particularly due to the frequent use of antibiotics. As the scientific community is seeking alternatives to antibiotic treatment, periodontal researchers found that photodynamic therapy (PDT) is advantageous for suppressing anaerobic bacteria that lead to periodontal diseases (Pfitzner et al 2004)[1].The German physician Friedrich Meyer-Betz performed the pioneering study which was at first called photo radiation therapy (PRT) with porphyrins in 1913. PDT was first approved by the Food and Drug Administration in 1999 to treat pre-cancerous skin lesions of the face or scalp. John Toth renamed the therapy as Photodynamic therapy (PDT). Therefore the aim of this review was to describe in detail application of photodynamic therapy in periodontal therapy.

Principle of PDT:

PDT is based on the principle that a photo-activatable substance (the photosensitizer) binds to the target cell and can be activated by light of a suitable wavelength. During this process, free radicals are formed (among them singlet oxygen), which then produce an effect that is toxic to the cell. To have a specific toxic effect on bacterial cells, the respective photosensitizer needs to have selectivity for prokaryotic cells.

Mechanism of action:

PDT involves two stages. In the first stage, a light-sensitive drug is applied. The second stage involves shining a light or laser directly on the area treated with the drug. When the light is combined with the drug, phototoxic reactions are induced which destroy bacterial cells. Briefly, upon illumination, the photosensitizer is excited from the ground state to the triplet state. The longer life time of the triplet state enables the interaction of the excited photosensitizer with the surrounding molecules. The generation of the cytotoxic species takes place during PDT while in this state only. The cytotoxic product, usually 1O2 cannot migrate >0.02 mm after its formation, thus making it ideal for the local application of PDT without endangering distant molecules, cells, or organs.

Photosensitizers:

More than 400 compounds are known with photosensitizing properties including dyes, drugs, cosmetics, chemicals and many natural substances (Santamaria 1972)[2]. Methylene blue (MB), toluidine blue (TB), and acridine orange are potent photosensitizers. Riboflavin (vitamin B2) is a potent photosensitizer absorbing at wavelength 450 nm. Chlorophyll is a photosensitizer absorbing light maximally at 683 nm. Tetracyclines used as antibiotics in periodontal diseases are effective photosensitizers producing singlet oxygen.

Light Sources

Low-power visible light at a specific wavelength, most photosensitizers are activated by red light between **630 and 700 nm**, corresponding to a light penetration depth from 0.5 cm (at 630 nm) to 1.5 cm (at ~ 700 nm) (Kübler, 2005)[3].

Advantages:

- reducing the treatment time,
- no need for anesthesia,
- destruction of bacteria in a very short period of time (<60 seconds),
- unlikely development of resistance by the target bacteria, and
- avoidable damage to the adjacent host tissues.
- the reduced need for flap procedures and shorter treatment time;
- as local therapy, with lack of micro flora disturbance in other sites of the oral cavity,
- beneficial during the maintenance of periodontal therapy because it may act on the biofilm and
- eliminate the need for the removal of additional root substance by mechanical retreatment.
- the patient may experience less dentinal hypersensitivity.

Side-effects

- Burning pain, stinging or itching restricted to illuminated area during light exposure, rarely continues for few hours
- Erythema and mild edema of treated area
- Light overdose causes blistering, ulceration or excessive necrosis
- Cutaneous photosensitivity with systemic PDT for 4 to 6 weeks, even upto 6 months Ordinary indoor lights safe photoinactivation
- Residual hyper and hypopigmentation, resolves soon
- Allergic reactions like urticaria to photosensitizer
- Systemic PDT using various sensitizers can cause nausea, vomiting, liver function abnormalities
- Can aggravate SLE

APPLICATIONS OF PDT IN PERIODONTICS

1. **Non-surgical treatment of aggressive periodontitis:** de Oliveira et al (2007)[4] stated that 10 patients with aggressive periodontitis treated with PDT using a laser source with a wavelength of 690 nm associated with a phenothiazine photosensitizer or scaling and root planning (SRP), at 3 months PDT results were comparable to SRP alone.
2. **An adjunct in non surgical periodontal treatment:** Various studies of use of PDT along with SRP in treatment of chronic periodontitis failed to result in an additional improvement in terms of pocket depth reduction and CAL gain, but it resulted in a significantly higher reduction in bleeding scores compared to scaling and root planning alone.
3. **Destruction of periodontopathogenic bacteria:** Various studies have shown that Gram-positive bacteria are most susceptible to PDT. Photo-killing of Gram negative bacteria is also possible. However, experiments were published showing PDT resistant Gram-negative bacteria. Resistance to the light action, are mostly the consequence of poor cellular uptake of the sensitizer.
4. **Effect on periodontal bone loss in furcations:** A study evaluated the influence of PDT on bone loss in furcation areas in rats with experimentally – induced periodontal disease and concluded that PDT may be an effective alternative for control of bone loss in furcation areas in periodontitis (de Almeida et al 2008)[5].

Conclusion:

PDT application has an adjunctive benefit besides mechanical

treatment at sites with difficult access (e.g. furcations, deep invaginations, concavities). Necessity for flap operations may be reduced, patient comfort may increase and treatment time decrease. PDT removes the biofilm in residual deep pockets during maintenance; no more root substance is removed by mechanical retreatment. Even after such a detailed knowledge and published data there is no routine application of PDT in periodontal diseases as well as in general practice because of no controlled studies proving superior effect than traditional SRP with or without antimicrobials. Therefore, the concept of PDT is plausible and could foster new therapy concepts for periodontal disease. The available knowledge should enable and encourage steps forward into more clinical oriented research and development.

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