Photodynamic Therapy : A Review

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Abstract

Photodynamic therapy, a relatively new treatment modality for the neoplastic and non- neoplastic disease is discussed in this article. It involves interaction of certain dyes (photo sensitizer) with absorbed light of specific energy. This review discusses basic components, mechanism of action and clinical application in the oro-facial region.

Key Words: photodynamic therapy, photo sensitizer, singlet oxygen.

INTRODUCTION

The therapeutic properties of light have been known for thousands of years, but it was only in the last century the concept of photodynamic therapy began with studies by Oscar Raab. Photodynamic therapy is a light based therapy to ablate tumors. Originally it was developed as a tumor therapy but nowadays some of its most successful applications are for non malignant diseases. Photosensitizing agent is applied and then it is activated by a specific wavelength and energy of light. This light energy in the presence of oxygen will lead to photodynamic reaction which is cytotoxic and vasculotoxic photophrin is the first photosensitizing drug approved for the treatment of selected tumors.

Photosensitizer should be retained selectively in the tumor. It is necessary to optimize the distribution of the delivered light to coincide with geometric and optical characteristics of the tumor tissue, thereby minimizing damage to surrounding normal tissue. Photodynamic therapy is being investigated for the treatment of a variety of tumors, also in the non cancerous application including ophthalmology, dermatology, cardiology, virus inactivation, and blood purification.

COMPONENTS OF PHOTODYNAMIC THERAPY

Photodynamic therapy is a result of combined action of three components- photosensitizer, light and oxygen. One of these alone can't make the reaction possible.

PHOTOSENSITIZER: Photosensitizer is a drug or chemical that is non toxic, selective and sensitive to light of specific wavelength thereby causing physicochemical reaction in the presence of oxygen in target tissue in which it get accumulated and cause generation of highly toxic free radicals. Uptake of sufficient amount of photosensitizer by target tissue is prerequisite for the optimum response. Retention of the photosensitizer in the neoplastic tissue may be due to increased blood vessel permeability and poor lymphatic drainage.

Hematoporphyrin derivative was the 1st clinically studied photosensitizer. Photofrin is the extensively used and clinically studied photosensitizer which is commonly used for diagnostic purposes.5-aminolevulinic acid is a 2nd generation photosensitizer. It is an intrinsic photosensitizer where it converts to photosensitizer insitu. It can be used orally and topically. So it is used in the premalignant and malignant lesions of oral cavity.

ACTIVATING LIGHT:

Light with specific wavelength and sufficient quanta of energy is used as activating light .sources of this include lasers ,arc lamp, or fluorescent light. Choice of photosensitizer is depending on light source used. Helium Neon laser (633nm), gallium-aluminum arsenide diode laser and argon lasers are commonly using light sources. No coherent light sources (tungsten filament, xenon, quartz) are indicated for larger lesion. LED sources are inexpensive and have light weight properties.

OXYGEN:

Oxygen is a critical component of photodynamic therapy where studies shows hypoxic cells are resistant to photosensitization and hyperbaric oxygen might accelerate photosensitization.

MECHANISM OF ACTION

On absorbing a photon of energy, sensitizer undergone excitation from ground state to highly unstable singlet state. This singlet state has 2 fate in which either it comes back to ground state by emitting fluorescence or transform to triple excited state via intersystem crossover. This tripled excited sensitizer undergoes 2 oxidative pathways they are:

• In type 1 pathway radical form of photosensitizer react with oxygen to produce

peroxide, superoxide, and hypoxyradicals.

• In type 2 pathway insitu generation of singlet oxygen which has high cytotoxicity.

Ultimately these two pathway result in necrosis and apoptosis of cell.

Type 2 pathways are considered to cause microbial destruction by damage to cytoplasm membrane of bacteria (inactivation of membrane transport system, inhibition of plasma membrane enzyme activities, and lipid per oxidation).

APPLICATIONS OF PDT

1. PDT ON DYSPLASTIC TISSUE

• used to treat small dysplastic lesions in buccal mucosa ,retromolar trigone ,floor of the mouth

• Used as post operative adjuvant therapy in patients with positive dysplasia

• Used in the diagnosis of circulating potential dysplastic cell.

• ALA induced fluorescence spectroscopy is nowadays commonly used for premalignant lesions

• Commonly using photosensitizer for the treatment of dysplasia are porfirmer sodium (Photofrin), aminolevulinicacid and MTHPC (Foscan).

• It is also used in palliative management of advanced head and neck invasive carcinoma.

• Non homogenous leukoplakia and erythroplakia are least affective to PDT as it as high reccurence and risk of malignancy.

2. ORAL LESIONS

As PDT have immunomodulatory effects PDT cause apoptosis in the hyper proliferating inflammatory cells. For this reason PDT is nowadays used in treatment of psoriasis and lichen planus. Antimicrobial photodynamic therapy is nowadays used in the treatment of antifungal resistant oral candidiasis. Photofrin is the potential agent for this candidal therapy. Nowadays laser therapy found a place in treatment of herpes labialises by decreasing vesicle recurrence.

3. PHOTODYNAMIC ANTIMICROBIAL CHEMOTHERAPY

Photodynamic therapy finds an immense role in the elimination of pathogenic microorganisms on teeth. The use of laser or LEDs with photosensitizing dyes can remove dental plaque.

Recently it has been used to treat various localised infections and periodontitis. Antimicrobial photodynamic therapy shown to reduce progression of periodontal disease, destruction of periodontal tissue significantly by reducing bacterial colonization from the periodontal pockets. Toluidine blue and erythrosine is the commonly widely using photosensitizer against oral bio films. Nowadays laser induced PDT is widely accepted. It also used in the prevention of bacterial invasion on the implant surface. So it is a very effective non invasive treatment modality for the various periodontal diseases.

In Endodontic field it is very effective for the disinfection of root canaled space and studies shown that PDT significantly reduces the E.faecalis in the root canal space, which is a common etiologic factor of persistent endodontic infection.

4. PDT AND CANCER MANAGEMENT

The sixth common cancer in the world is oral and oropharyngeal carcinoma. Conventional treatment option like surgery and radiotherapy can be associated with astronomically immense morbidity and disfigurement for the patient. Treatment of carcinoma using PDT in the head and neck is an attractive proposition. Maintaining facial and anatomical structure and function is imperative for good cosmetic and functional results.

CONCLUSION

Photodynamic therapy is becoming a new promising treatment modality in the various medical fields. In dentistry its role ranging from the treatment dental caries to various premalignant and cancerous lesion. Selection of ideal photosensitive agent with light of optimal wavelength is required for the effective results with minimal side effects.

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