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Photodynamic cancer therapy and its future potentials

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Abstract

About 6 million people die of cancer every year in the world. Today, surgical operations, chemotherapy and radiotherapy are commonly used methods in cancer treatment. Chemotherapy and radiotherapy methods cause serious side effects because they damage healthy cells as well as cancerous cells. Photodynamic therapy (PDT) is a new therapeutic model that may provide an advantage to patients who are not suitable for surgical operations and traditional treatment methods. PDT is a minimally invasive treatment modality that provides selective cytotoxic activity against malignant cells. The basis of cancer treatment with PDT is the application of a photosensitizer, followed by light at the wavelength corresponding to the absorbance band of the photosentizer. PDT increases curing in early tumor stages and prolongs survival in patients who cannot be operated on. Since it has minimal healthy tissue toxicity, it is a therapy option with fewer side effects than other treatment methods.

Introduction

Every year, 10 million people are diagnosed with cancer in the world, and more than half of them die from this disease. Surgery, chemotherapy and radiotherapy are commonly preferred methods in the treatment of the disease. Radiotherapy and chemotherapy methods, which are preferably applied after surgical treatment, have serious side effects as they damage healthy cells as well as cancerous cells. These side effects include nausea, diarrhea, vomiting, alopecia, loss of appetite and fatigue. A new therapeutic model that may provide an advantage to patients who are not suitable for surgical operations and traditional treatment methods is photodynamic therapy (PDT) [1,2].

Results

Photodynamic therapy uses a photosensitive chemical substance, which is used together with light and molecular oxygen, to effect cell death [3]. In PDT, certain wavelengths of light and photosensitizers are activated over time in the tumor and vascular system and show an apoptotic effect. Due to the special structure of the tumor tissue, the photosynthesizing substance remains in the tumor tissue for a longer time compared to normal tissues. Then, cell death is promoted by applying certain doses of light to the tumor area [4]. As a result of the reaction of the cell with PDT, reactive oxygen molecules and superoxide anion radicals are produced and death mechanisms in the cell are activated. The effectiveness of PDT in cancer treatment differs according to the photosensitizing agent applied and the light source. While porphyrin and its derivatives are generally preferred as photosensitizing agents, laser and incoherent light sources are used as light sources [5].

Porphyrin is a macromolecule formed by the fusion of four pyrrole rings. It is a conjugated system consisting of 20 carbons and 4 nitrogens. It is an aromatic structure with an 18-Π electron system [6]. Porphyrins are N-heterocycle class molecules found in the form of vitamin B12 for cell metabolism, cytochrome for different

oxidative reactions, catalase for the decomposition of hydrogen peroxide, chlorophyll in green plants for photosynthesis, and hemoglobin in the blood for oxygen transport [7]. Porphyrins have been reported to exhibit a variety of biological activities. This is because natural or synthetic porphyrins have low toxicity in vitro and in vivo, have antitumor and antioxidant effects, and have the potential to form ion complexes [8]. Approaches to the application of porphyrin-derived molecules for the development of new non-toxic materials capable of destroying a wide variety of bacteria and fungi have been a sought-after target [9]. Porphyrin compounds have important functions such as photosynthesis, oxygen and electron transport. Synthetically produced porphyrins, which are widely used for photodiagnosis and cancer therapy in PDT, are generally produced from the meso position [10]. Singlet oxygen quantum yields of porphyrin-derived molecules are high. Considered as a long wavelength absorbent sensitizer for PDT owing to its talent to generate singlet oxygen [11].

For the use of PDT in cancer treatment, a photosensitizing substance is first injected into the blood stream. While this photosynthesizing substance is absorbed by all cells in the body, cancer cells are more involved than healthy cells. 24-72 hours after the injection, this agent leaves the normal cells, while leaving the cancerous cells later due to the tumorigenicity of the cancer cells. At this time, the tumor cells are exposed to light. The photosensor in the tumor absorbs the light and produces reactive oxygen, which also destroys the surrounding cancerous cells. PDT also activates the immune system against cancerous cells. In addition, the photosensitizer substance also damages the angiogenesis of the tumor and stops the metastasis of the cancer.

Laser and incoherent light sources are used for the light used in PDT. It can be delivered to the parts of the body by endoscopic methods with thin fiber optic cables transmitting laser light. Other light sources such as light-emitting diodes (LEDs) are used to treat surface tumors such as melanoma cancer.

Discussion

PDT is considered to be a promising antitumor strategy that has not yet become widespread in cancer treatment. Compared with other cancer treatment methods, the long-term reduction of morbidity and less side effects are the advantages of PDT. While many of the traditional antitumor treatments have immunosuppressant effects, PDT also activates the immune system against cancerous cells. In addition, the photosensitizer substance also damages the angiogenesis of the tumor and stops the metastasis of the cancer.

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