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REVIEW ARTICLE

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Nanothermolysis and Photodynamic Therapy (PDT) for Cancer

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INTRODUCTION

Selective nanothermolysis of cancer can be done by the explosion of nanoparticles using laser. For the killing of cancer cells, explosion of nanoparticles may be accompanied by optical plasma, generation of shock waves with supersonic expansion and particle fragmentation with fragments of high kinetic energy.

By using laser of the appropriate wave length energy is absorbed by nanoparticles and they deliver heat to diseased areas. During the period of exposure heat may cost to the surrounding fluid so a tight focusing is required for a continuous-wave laser to sufficiently heat individual nanoparticles. The natural thermal confinement of pulse lasers minimizes this effect because of the finite thermal diffusion time. Which restricts the absorbed energy to a region around the particle that offers the potential for achieving high temperature that can promote phase change on the surface of a nanoparticle or even melting of the particle. For the measurement of this temperature a single walled nanotube (SWNT) of carbon as thermistor can be used.

Gold nanoparticles are heated by nanosecond laser pulses and can be used for in-vitro photo-thermal therapy of human tumor cells. Laser light at the tip of the fiber raises the temperature of the tumor cells and damages or destroys them.

Efficient conversion of strongly absorbed light by plasmonic gold nanoparticles to heat energy and their easy bioconjugation suggest their use as selective photothermal agents in molecular cancer cell targeting. In an experiment by Ivan H. El-Sayed et.al. two oral sequamous carcinoma cell lines (HSC 313 and HOC 3 clone 8)and one benign epithelial cell line (HaCaT) were incubated with anti-epithelial growth factor receptor (EGFR) antibody conjugated gold nanoparticles and then exposed to continuous visible Argon ion laser at 514 nm. It is found that malignant cells require less than half the laser energy to be killed than the benign cells after incubation with anti-EGFR antibody conjugated gold nanoparticles. No photothermal destruction is observed for all types of cells in the absence of nanoparticles at four times energy required to kill the malignant cells with anti-EGFR/gold conjugate bonded. Gold nanoparticles thus offers a novel class of selective photothermal agents using a CW laser at low powers.

Laser-photosensitizer assisted immuno therapy is another method for cancer treatment. Photo-sensitizer-enhaced laser treatment ,where dyes are activated in situ by lasers of appropriate wavelengths, provides highly selective tissue destruction, both spatially and temporally, through photophysical reactions.

Photodynamic therapy (PDT)is another type of cancer treatment that uses lasers. This method has emerged as one of the important therapeutic options in management of cancer and other diseases. Most photosensitizers are highly hydrophobic and require delivery systems. One type of classification of delivery system is based on presence or absence of a targeting molecule on the surface. Recent reports have described carrier nanoparticles with additional active complementary roles in PDT. So another type of classification for nanoparticles in PDT is that they are of two types. First is passive carriers and second is active participants in photosensitizer excitation. Active nanoparticles are distinguished from non-biodegradable carriers with extraneous functions, and sub classified mechanistically into photosensitizer nanoparticles, self-illuminating nanoparticles and upconverting nanoparticles. Although several challenges remain before they can be adopted for clinical use, these second-generation PDT nanoparticles probably offer the best hope for extending reach of PDT to regions deep in the body.

PDT in cancer treatment involves the uptake of a photosensitizer by cancer tissue followed by photoirradition. The use of nanoparticles as carriers of photosensitizer is a very promising approach because these nano materials can satisfy all the requirements for an ideal PDT agent . Recent advance in the use of nanoparticles, include inorganic oxide , metallic, ceramic and biodegradable polymer –based nanoparticle as carriers of photosensizing

agents. Nanoparticles can be described in terms of stability photocytotoxic efficiency, biodistribution and therapeutic efficiency. Photophysical properties of nanoparticle can be improved by means of biphotonic absorption and upconversion.

It is more than 25 years since PDT was proposed as a useful tool in oncology, but the approach is only now being used more widely in the clinic. The understanding of the biology of PDT has advanced and efficient, convenient and inexpensive systems of light delivery are now available. Results from well controlled , randomized phase III trials are also becoming available , especially for treatment of non-melanoma, skin cancer and Barrett's oesophagus, and improved photosensitizing drugs are in development. PDT has several potential advantages over surgery and radiotherapy: It is comparatively non-invasive, it can be targeted accurately, repeated dosage can be given without the total-dose limitation associated with radiotherapy, and the healing process results in little or no scarring.

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