Review Article

ID: JCDR/2012/4654:2440

Nanotechnology – Its Application in Oral Cancer

Dentistry Section

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ABSTRACT

Nanotechnology has the potential to provide treatment modalities to fight cancer. Nano-materials have physical, electrical and optical properties, which can be utilized for the sensing and detection of cancer at the earliest that provide a greater survival possibility. In the 21st century, several treatment modalities are been widely accepted for the treatment of cancer, among which nanotechnology is the recent one. Nanotechnology has been found to be very effective in the detection, recurrence and the spread of oral cancer after the initial treatment. Two recent techniques, namely, the bio-active immune stimulation and the attacking integrin expressing vasculature which uses nano particles are in the research phases.

Key Words: – Bioactive Immune Stimulation, Nano- Particles attacking integrin expressing Vasculature.

INTRODUCTION

Oral cancer is any cancerous tissue growth which is present in the oral cavity. It mostly involves the tongue . It appears as skin lesions, lumps or ulcers. Tobacco, alcohol, genetic factors , the human papilloma virus and the consumption of spicy food are some of the main aetiological factors which are responsible for oral cancer. The treatment involves surgery, radiation therapy and chemotherapy.

Nanotechnology is a science which is used to manipulate the atoms and the molecules which lead to the production of structures in the nano-meter size, which range from 100nm or even smaller, which attain their unique properties.[Table/Fig-1]. The processes of the living organisms occur at a nano-meter scale, and the important biological units like the DNA proteins and the cell membranes are of this dimension [1]. The nano particles which are used as drug delivery vehicles are generally <100nm in size and they consist of different bio-degradable materials such as natural or synthetic polymers, lipids or metals. The nano particles which are under extensive research to determine the roles that they can play in cancer detection and treatment, include quantum dots, nano shells and dendrimers.

The quantum dots are nano- sized semiconductors that can emit light in all colours. The examples are semiconductor nano-crystals and core- shell nano-crystals. They are applied, particularly in cancer imaging studies.

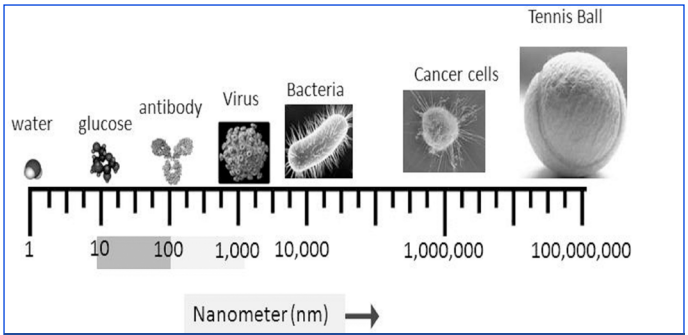
Dendrimers: The first dendritic molecule was discovered in around 1980.They are branched structures which are widely used in nano-medicine because of the multiple molecular hooks on their surfaces.

The nano- shells are different types of spherical nano particles which consist of di-electric cores which are covered by thin metallic shells. They are used in cancer therapy and in bio-imaging enhancement.

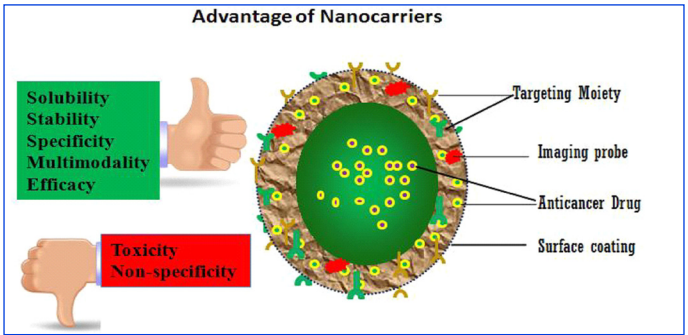
REVIEW

The nano particles are under research to develop a host of biomedical and biotechnological applications which include drug delivery, enzyme immobilization and DNA transfection (infection by transformation). For the past few years, quantum dots (QDs) have been an area of intense research. They have unique physical properties and they can be exploited for the detection of cancerous tumours. Quantum dots have enough surface area to combine therapeutic agents and tumour specific modalities for the combined results of drug delivery, imaging and tissue engineering [2]. The advantages of quantum dots are that they have a single light source and that different sizes of quantum dots preserve the narrow emission of each particle [3]. Recently, quantum dots are being used for near infra-red (NIR) imaging (700–1000 nm wavelength range) as imaging probes [4]. The most widely used nano particles are super-magnetic iron oxide (SPIO) nano particles. The recent toxicity studies on magnetic nano particles have proved their safety in the clinical use [5]. Nanotechnology has made a deep impact in solving the problems which are associated with the conventional anticancer drugs, because they can be made into very safe and injectable formulations. Doxill and Abraxane are two major nano-formulated drugs which are currently available in the market, which have made a major impact worldwide. The nano particles which are being most widely used for cancer treatment are the poly lactide-co-glycolide (PLGA)-based nano particles. The synthesis of an oral formulation of paclitaxel by using PLGA/montmorillonite PLGA/MMT) nano particles has been found to be of great use.6 Dendrimers are a unique group of nano particles which are highly suitable for an effective drug delivery, particularly in the cancer treatment.

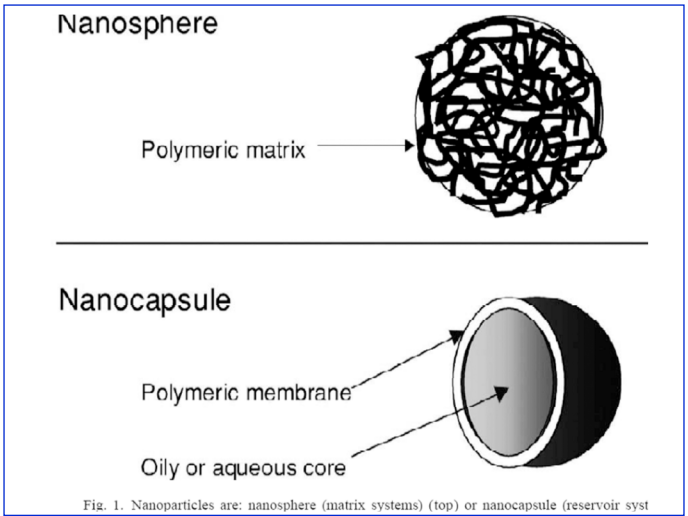
Biomarkers can be proteins or pieces of proteins or DNA or RNA-based biomarkers, specifically the cancer biomarkers, which indicate and detect cancers. The gold nano particles have a size-tuned optical property which helps in absorbing and scattering



[Table/Fig-1]: Relative sizes of different matters



[Table/Fig-2]: Advantage of Nanocarriers



[Table/Fig-3]: Advantage of Nanocarriers

light from the visible to the near infra-red region [7]. Various other nano particles are getting investigated for cancer biomarker detection [Table/Fig-3]. The metallic, magnetic and silica nano particles are already under research due to their unique properties. The encapsulated phase change nano particles have been proved to be multiplexed, highly sensitive, cancer biomarker detection agents [8].Recently, studies were done by using fluorescence resonance energy transfer nano particles, to monitor the cancer cells9. Magnetic nano particles are widely used in cancer cell imaging. After the discovery of fullerene, carbon nano tubes (CNTs) were re- discovered in 1991 by Iijima [10]. These semiconducting CNT biomolecules are adsorbed on the cell walls, thus causing changes in the local electrostatic environment. Hence, they are used as biomarkers widely by the medical fraternity. A multifunctional dendrimer-modified multi walled carbon nano tube (MWNT) has been recently developed, which has further increased their usefulness as biomarkers. Various nano wires are being applied in biomarker detection, which include silicon nano wires [11]. The silicon nano wires (SiNW) are semiconducting nano wires that have excellent physical, optical and electronic properties and an excellent biocompatibility [12]. The functionalized gold nano wires enhance the sensitivity and the selectivity for cancer biomarker detection, by providing a high surface-to-volume ratio. Nano pores, both the synthetic, and the protein-based types, are of great interest to many researchers for detecting biomolecules.

DISCUSSION

This review summarizes the recent developments in the cancer detection and therapy methods which use nanotechnology. The development of various nano-materials and nanotechnology has enabled the detection of cancer biomarkers with great precision and accuracy .The dentists, in future, will ask the patients to rinse with a solution which contains millions of microscopic elements which are called nano assemblers, which will reveal the presence of oral cancer, even in its incipient stages. One scenario some scientists' project is that efficient cancer nano medicine may completely eradicate cancer, the second commonest cause of death and hence cause an increase in the population [13]. Doxill is a doxorubicin HCL liposome injection which is used as an intravenous infusion. It is primarily used in the treatment of ovarian cancer. The possible side – effects include allergic reactions, congestive heart failure, decreased bone marrow functions and blood related diseases. Currently, it is not used as a treatment and it is not available in the market also. Abraxane is an anti- cancer chemo- therapeutic drug. It is used for treating breast cancer after chemotherapy has failed. The side- effects include weakness, fatique, low blood counts, nausea, hair loss, vomiting, infections, etc. The 2 most common chemotherapeutic drugs which are used in oral cancer are cisplatin and 5 flurouracil. The less commonly used drugs include carboplatin, bleomycin, methotrexate, etc. The 3 new drugs which are under trial for the treatment of oral cancer are doxetaxel, paclitaxel and gemcitabine.

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FINANCIAL OR OTHER COMPETING INTERESTS:
None.

Date of Submission: **Jun 17, 2012**
Date of Peer Review: **Jul 17, 2012**
Date of Acceptance: **Jul 24, 2012**
Date of Publishing: **Sep 30, 2012**