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Nanotechnology Systems in Cancer Treatment: A Review

Abdulrahman Altwaijri*

Department of Oral and Maxillofacial Surgery, College of Dentistry, Qassim University, KSA, Qassim, Saudi Arabia

Review Article

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***For Correspondence:**
Abdulrahman Altwaijri, Department of Oral and Maxillofacial Surgery, College of Dentistry, Qassim University, KSA, Qassim, Saudi Arabia

E-mail: a.altwaijry@qu.edu.sa

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ABSTRACT

Introduction: Nanotechnology is the science of using different materials in a nanometer scale, which mean at the level of atoms, molecules, and supramolecular structures. This term used and known to depict the process of construction and the functional characteristics for at least one dimension measured in nanometer. The goals of treatments are to optimize of the pharmacological action of the drug, and the minimize of its toxic side effect. Nanotechnology considers one of the solutions to solve these limitations.

Aim: This review attempted to summarize the use of nanoparticles in cancer treatment.

Conclusion: Promising filed to move the area of cancer treatment but still further research and human experiments need to be done.

INTRODUCTION

Following cardiovascular diseases, cancer consider the second most cause of mortality [1] Causing death of approximately 8 million people and has an impact on about 14 million [2]. Multiple factors consider integral part of high number of cancer incidence as time goes on, such as pollution, radiation, balanced diet and lack of exercise, among another important factor which is genetic [3]. Nanotechnology is the science of using a huge variety of materials in a nanometer scale, which mean at the level of atoms, molecules, and supramolecular structures. This term used and known to depict the process of construction and the functional characteristics for at least one dimension measured in nanometer. Another important term is nanobiotechnology which is the application of nanotechnology sciences in life sciences [4]. Treatments of cancer include radiation, surgery, chemotherapy and a combination of any of these treatments. Despite the effectiveness of all of those treatments options but there are

some critical challenges such as non-specificity and toxicity. The goals of future treatments are to optimize of the pharmacological action of the drug, and the minimize of its toxic side effect. Nanotechnology considers one of the solutions to solve these limitations. For example, designing nanoparticles loaded with multifunctional drugs utilizing proteins can target specific cancer cells [5,6]. The benefits of targeting only cancer cells and eliminate the effect on other healthy cells are crucial for increasing the effectiveness and decreasing the side effects of drugs [7].

Many nanotechnology-based therapy have been introduced and only few shows potential effectiveness, these therapies based on nanoparticles drug delivery system, such as HDL nanostructures, nanodisks, gold nanoparticles, and viral nanoparticles. Recently a forward step in research has been made to study molecular characteristics of cancer to enhance nanoparticles drug delivery system which is critical to overcome a complex biological barrier in recognizing cancer cells. The most important applications in healthcare are in diagnostics, drug delivery, and development of nanomedicine including nanosurgical procedures. Trend towards miniaturization of carrier particles, i.e., use of microparticles, had already started prior to the introduction of nanotechnology in drug delivery.

These technologies have been applied to improve drug delivery and to overcome some of the problems of drug delivery in cancer. Drug delivery in cancer is important for optimizing the effect of drugs and reducing toxic side effects. Several nanobiotechnologies, mostly based on nanoparticles, have been used to facilitate drug delivery in cancer. Although most of the initial research in nanotechnology has been done in academic environments, a considerable development for drug delivery application is now carried out in an industrial environment.

ENCLOSING DRUGS IN LIPID NANO-CAPSULES

Utilizing two antineoplastic gents' etoposide and paclitaxel. Etoposide is a semi-synthetic by-product, it stop relegation of the DNA strands, which lead to break up of DNA strand [8]. In order for cancer cell to survive and divide rapidly: it need enzymes more than any healthy cells, Therefore, this causes errors in DNA synthesis and promotes apoptosis of the cancer cell [9,10]. Paclitaxel is a natural product derivative from *Taxus brevifolia* [11]. Paclitaxel is one of the most effective drugs to target tubulin. It targets cell have defects in mitotic spindle assembly, segregation of chromosome, and cell division. It starts with stabilizes the microtubule polymer and protects it from disassembly. Chromosomes are thus unable to achieve a metaphase spindle configuration. This lead to block of mitosis and prolonged activation of the mitotic checkpoint triggers apoptosis. Both Paclitaxel and Etoposide are very hydrophobic and should be combined with solubilisers for their use in parenteral solutions. However, such solubilisers are well known for being responsible of major adverse effects such as hypersensitivity reactions [12]. The goal to improve drug solubility and cancer cell targeting which ultimately lead to better therapeutic effect [13]. A small size (25 to 110 nm) lipid nanocapsules (LNC) are proposed for the intracellular drug delivery of anticancer drugs to cancer cells. LNC of different diameters were loaded with etoposide or paclitaxel and subsequently tested for drug release kinetics and their efficiency to reduce cancer cell growth in cell culture. The anticancer drug release after intracellular uptake was found to be an efficient approach in cell culture. Preliminary studies resulted in a distinct higher efficiency in cancer cell death induction compared to free drug. LNC demonstrated to be an interesting carrier system for an innovative tumor treatment based on a promising therapeutic strategy [14,15].

NANO-DIAMONDS

Nondiamond has a high biocompatibility compared to most nanoparticles, these nanoparticles composed of microscopic carbon-based agents. Nanodimond can be loaded with anticancer drug and carry it to metastatic tumor cells or be used as biomarkers and tracers that label cancer [16] have used nanodiamonds target cancer cells from inside and delivering doxorubicin directly to the mitochondria which kills the cancer cells by eliminating its power source from inside and inhibiting growth and regular cell function. Targeting mitochondria specifically in cancerous cells will overcome ant typical resistant to doxorubic.

VIRAL NANO-DRUGS

It's a way of utilizing the viral mechanism as a mean of drug delivery system, this technique just introduced in recent years. They are naturally and biocompatible nanoparticles that that encode their own building instructions using resources from a host cell. Their packaging could be used for delivering chemotherapy to tumor. Pegylation used to improve the virus survivability, also targeting tumor can be achieved by their natural host specificity [17]. The construction of virus-like particles can be designed for targeting cancer cells without worrying about any viral infection of the organism [18]. Due to absent of nucleic acid material inside the cowpea mosaic virus; it's a perfect for that purpose. When we say its empty then there is no harmful effect on cells as other viruses do. In previous experiments they found that injection of this virus in tumor microenvironment will trigger the immune system, which lead to releasing large quantities of neutrophils. Afterward T lymphocyte will attack metastasis to complete eliminating the cancer. This method utilizing neutral human defense system against cancer cells. Still there is little research has been done and future opportunities are high and in rapid development [19].

GOLD NANO-PARTICLES

Gold nanoparticles considered as another good nanoparticles option as treatment for cancer. The same mechanism of liposome, the tumor specific antibodies will attach to the surface of the gold particles to target the cancer cells [20]. The particles around 10 nm wide congregate in the tumor microenvironment whilst leaving the other tissues alone. The ligand attached to the gold will specifically bind to cancer cells and work their way inside. After that gold particles will aggregate and then a laser of infrared light can be focused on the tumor site. The main function of the light is to superheat the gold particles bubbles start to form when the cell will no longer can survive and eventually will lyse [21]. This method is good substitute to surgery when tumor is in very sensitive anatomical location or its too risky for patient prognosis.

DISCUSSION

When comparing between recent nanotechnologies in cancer treatment each technique work in specific way. For lipid nanocapsules, exerts their affect by promotes apoptosis of the cancer cell in different mechanism,[12,13] and they are very hydrophobic so should be combined with solubilisers which as well increase cancer cell targeting as evidenced with higher efficiency in preliminary studies with risk of hypersensitivity [14,15]. Nanodiamond is more biocompatible and composed of carbon-based agent's works as a carrier for anticancer drug and targeting mitochondria specifically in cancerous cells therefore eliminating its power source from inside [16].

Recently viral nanodrugs introduced which is biocompatible and works in specific way utilizing the viral mechanism for delivering chemotherapy to tumor. It is construction in way that targeting cancer cells without risk of infection [18]. As will activate the immune system allow releasing neutrophils and afterward T lymphocyte will attack metastasis to complete eliminating the cancer that evidenced by little of studies [19].

CONCLUSION

Lastly the gold nanoparticles work by allow the tumor specific antibodies which attached to the gold to bind specifically to cancer cells and work their way inside. Their aggregation around tumor helps in cell lysis as a laser of infrared light cause superheat which leads the gold particles bubbles start to form and eventually cell will lyse. Nanoparticles are promising filed to move the area of cancer treatment but still further research and human experiments need to be done.

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