Nanooncology: Drug-delivery in Neurological Cancers

Ian Kanterman, *Biomedical Engineering, University of Rhode Island*
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***Abstract*—Nanooncology is the utilization of nanomedicine in cancer diagnosis and treatment. There are various kinds of nanoparticles that are currently being tested in order to progress into clinical trials. These tiny particles can be utilized in novel drug-delivery systems that are healthier for the patient. Presently, there are certain nanoparticles being researched in combating brain cancer.**

I. Introduction

Cancer is the cause for a staggering amount of deaths in children, teens, and adults all over the globe. Cancer affects a wide variety of areas in the body, specifically are brain tumors (known for high mortality and morbidity rates) that face massive barriers in efficient treatment methods that can increase the patient's survival rate. Chemotherapy and radiotherapy are two widely known options that patients are subject to. However, they also come with side effects of a drastically weakened immune system, nausea, and hair loss. These therapies lack accuracy and inefficiency when seeking out the malignant tumor(s) and can target healthy cells as easily as the cancerous ones. Treating brain tumors is barred by the lack of knowledge of the pathophysiology of the brain tumor (e.g. Glioblastoma multiforme), and the limited access of chemotherapeutic agents to the site of the brain tumor, etc.

II. Methods

Glioblastoma multiforme (GBM) is a primary brain tumor that is a major cause for innovation in neurooncology treatment because there is no definitive cure for GBM. In contrast to chemotherapy, the nanoparticle-based drug could potentially access the brain without leaking the anti-cancer drug to the metabolic system of the organism. Another aspect of its drug delivery is the nanoparticle's ability to hone in on the specific tumor site, and thus sparing the healthy tissue from potential cytotoxicity. The ability to both diagnose and treat glioblastomas "via an intrinsic heating mechanism" comes from magnetic nanoparticles (MNPs) that induce hyperthermia. The use of alternating magnetic fields, or AMFs, induces "hyperthermia induction" via the MNPs. Hyperthermia in the tumor can lead to protein denaturation and DNA cross-linking with the nucleus, causing apoptosis. In addition, due to increasing oxygenation of the tumor's microenvironment can lead to increased susceptibility to brain tumor chemoagents.

Figure 1 - Early Prototype of AMF Administrator

III. Results

Implementing MNPs in model rodents with GBMs were the first step in testing of the efficacy of hyperthermia in the malignant brain tumor. By employing aminosilane-coated iron-oxide nanoparticles in 120 male Fisher rats, the survival rate of the rats increased. A human clinical trial was performed in the same manner, with the nanoparticles entering the brain matter exposed with an AMP of 100kHz. The result was successful induction of hyperthermia, with no side affects of nausea, headaches or other neurological abnormalities occurring in the patient. The overall results demonstrated an increased survival rate in patients treated with the MNPs and the induction of hyperthermia in the brain matter.

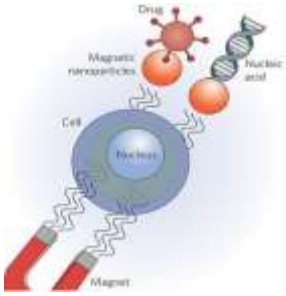

Figure 2 - Magnetic Nanoparticle (MNP)

IV. Discussion

Through continuous research and testing, nanotechnology and the development of safe nanomedicine will serve as a suitable means of enhanced brain tumor therapeutics. While this is true, nanotechnology has a great trek to make in terms of cost, implementation and safety. In order for MNPs and other nanomedicines to become FDA approved, additional short-term and long-term toxicity studies will have to take place for further approval. For the future, scientists envision a "smart" multifunctional nanoparticle that can carry 1) one or more drugs, 2) specific targeting moiety, 3) an imaging agent, 4) a cell-penetrating agent, 5) a stimulus-sensitive element for controlled release of drugs and 6) a stabilizing polymer for biocompatibility. Nanooncology provides a promising strategy of diagnosing and treating brain cancer via magnetic nanoparticles and other means.

References

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