Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 5, Issue 6; October-December, 2018, pp. 460-461

http://www.krishisanskriti.org/Publication.html

Iron Oxide Nanoparticles as Potential Drug Delivery Agents in Cancer Treatment- A Review

Aarif H Shah[1] and Mushtaq A Rather[2]

[1]*Ph.D. Candidate, Department of Chemical Engineering, NIT Srinagar*
[2]*Associate Professor, Department of Chemical Engineering, NIT Srinagar*
E-mail: [1]hs1.aarif@gmail.com, [2]marather_nit@yahoo.co.in

Abstract—*Cancer being the second leading cause of death all over the world, alternate tools are required for its diagnosis and treatment. Iron oxide nanoparticles (IONPs) are being used as therapeutic agents for detecting and treating cancer. They are biocompatible, non-toxic and super paramagnetic and therefore used for anti-tumor drug delivery and cancer therapy. Many methods have been used to synthesize effective and stable IONPs. Because of their success, core-shell nanotechnology is fast emerging as a new advanced therapy. This paper discusses in brief the types of IONPs and their use in diagnosis, treatment and monitoring of cancer*

1. INTRODUCTION

Cancer at present is the second leading cause of death all over the world and as of date is responsible for about 9.6 million deaths in 2018. Looking at the statistics, globally, about 1 in 6 deaths is due to cancer [1]. Even at such an alarming situation the current tools in diagnosis and treatment of cancer are insufficient in view of success rates and the side effects involved. Accordingly there is a need of developing alternate tools in diagnosis and treatment of cancer.

The science of nanotechnology involves marriage between various fields like molecular biology, chemistry, physics and engineering to diagnose and treat cancer. Promising results have been achieved over the last decade in the development of nanoparticles (NPs) as therapeutic agents for detection and treatment of cancer. The study of NPs has also been carried out in imaging and drug delivery vehicles [2].

2. NANOPARTICLES AS DRUG DELIVERY AGENTS

In intravenous use, nanoparticles are better suited than micro-scale particles. Because of their nano-size, there is no risk of formation of blood clot (vessel embolism) even in the smallest capillaries (5 µm diameter). They diffuse with ease across the biomembranes and reach target cells and tissues. Nanoparticles (<100 nm diameter) have the potential to circulate in the blood for several hours as they are generally less recognized by body's immune system [3].

Gold and Iron oxide nanoparticles are the two most studied inorganic nanomaterials. Because of their biocompatibility, non-toxicity and unique physical properties, they are front runners for anti-tumor drug delivery and nanoparticle-mediated thermal cancer therapy [3].

3. IRON OXIDE NANOPARTICLES

Three forms of Iron oxide nanoparticles (IONPs) are known. These are hematite (α-Fe_2O_3), magnetite (Fe_3O_4), and maghemite (γ-Fe_2O_3). Among these three, only magnetite and maghemite are used as theurapetic agents owing to their low toxicity and high biocompatibility. In addition to these properties, they are super paramagnetic in nature. Under external magnetic field, single domain IONPs below the critical size of 30-40 nm have super paramagnetism, high saturation magnetization and magnetic energy, and zero residual magnetization. IONPs below 100 nm size disperse well in physiological media and are therefore used *invivo* [3].

4. SYNTHESIS METHODS

A number of methods have been developed to synthesize stable and biocompatible IONPs. Efficient and most common methods include sonochemical synthesis, co-precipitation, thermal decomposition, hydrothermal synthesis, micro emulsion. Methods like electrochemical synthesis, laser pyrolysis and bacterial synthesis have also been used to prepare nanoparticles [4].

Bare IONPs are unstable, agglomerate and precipitate quickly when dispersed in water or physiological fluids. To overcome this, they are coated with polymers like dextran which also provide NPs with functional terminal groups for binding targeting agents.

5. IMAGING & THERMAL THERAPY

IONPs were successfully first used in liver cancer imaging.[5] And currently IONPs are used as contrasting agents for highly sensitive detection of cancer noninvasively by *invivo* technique called MRI. They offer relatively higher and dark contrast effects, higher blood retention time, biodegradability and low toxicity [6].

Specifics of IONPs find its use in therapy by hyperthermia. Super paramagnetic NPs have been used to demonstrate magnetic hyperthermia either *in vitro* or *in vivo*. Hyperthermia therapeutic process involves increase in the temperature using external device resulting in the death of the cancer cells, or making them more sensitive to radiation treatment or chemotherapy. The magnetic NPs are directly injected into tumors and excited with alternating magnetic fields (AMFs) that produces heat to affect the surrounding tissue [7].

6. CONCLUSION

Concluding, nanomaterials like IONPs have scope for offering many ways of cancer diagnosis and therapy. The magnetic properties of IONPs are utilized in medical application, either in diagnosis as contrast agents, or as drug and gene delivery agents and magnetically induced hyperthermia. Core-shell nanoparticle technology is emerging as new futuristic advanced therapies. Combining various types of nanomaterials can boost up their advantages in cancer diagnosis and treatment.

REFERENCES

[1] http://www.who.int/news-room/fact-sheets/detail/cancer, updated 12th September, 2018 and accessed 25th September 2018.

[2] Farokhzad, O. C., & Langer, R. (2006). Nanomedicine: developing smarter therapeutic and diagnostic modalities. Advanced drug delivery reviews, 58(14), 1456-1459.

[3] Gotman, I., Psakhie, S. G., Lozhkomoev, A. S., & Gutmanas, E. Y. (2016, August). Iron oxide and gold nanoparticles in cancer therapy. In AIP Conference Proceedings (Vol. 1760, No. 1, p. 020020). AIP Publishing.

[4] Wu, W., He, Q., & Jiang, C. (2008). Magnetic iron oxide nanoparticles: synthesis and surface functionalization strategies. Nanoscale research letters, 3(11), 397.

[5] LaConte, L., Nitin, N., & Bao, G. (2005). Magnetic nanoparticle probes. Materials Today, 8(5), 32-38.

[6] Thoidingjam, S., & Tiku, A. B. (2017). New developments in breast cancer therapy: role of iron oxide nanoparticles. Advances in Natural Sciences: Nanoscience and Nanotechnology, 8(2), 023002.

[7] Giustini, A. J., Petryk, A. A., Cassim, S. M., Tate, J. A., Baker, I., & Hoopes, P. J. (2010). Magnetic nanoparticle hyperthermia in cancer treatment. Nano Life, 1(01n02), 17-32.