Opportunities and Challenges in Translational Nano-Therapeutics in Neurosurgery

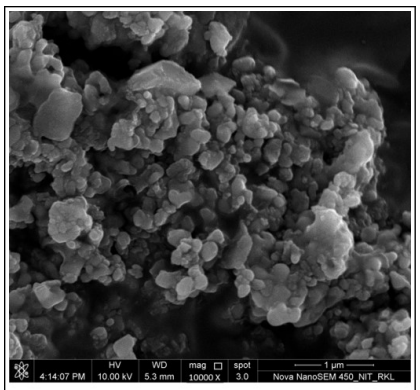
Komal Prasad Chandrachari MBBS, MS, DNB (Gen.Surg), M.Ch (Neuro); Bhaskar Vishwanathan; Pradipta Ranjan Rauta
Mazumdar Shaw Medical Center, NH Health City, Bengaluru, India

CNS 2017 ANNUAL MEETING
BOSTON, MASSACHUSETTS
OCTOBER 7–11, 2017

Introduction

There is a lot of interest and hope in incorporating the rapid advances in the field of nanotechnology into therapeutic strategies for neurological diseases including neoplasms. However, the initial phase of enthusiasm is tempered with the practical difficulties in extrapolating the results in-vivo.

We present our initial results of strategies at developing novel iron oxide nanoparticles and their functionalization for magnetic hyperthermia treatment in glioma.



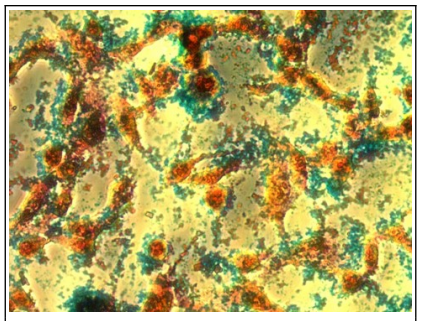
Scanning Electron Microscope Image of OA- IO NPs

Methods

Iron oxide nanoparticles (IO NPs) were synthesized by co-precipitation method and functionalized with oleic acid (OA). The formulated OA-IO NPs were characterized for the size (hydrodynamic diameter), zeta potential (surface charge) by dynamic light scattering (DLS) method, FTIR Spectroscopy, X-Ray Diffractometry analysis and magnetic property analysis.
The average size and zeta potential of the formulated OA -IO NPs were found to be 35.21±4.23 nm and -32.7± 5.92 mV respectively that confirmed increased stability of the nanoparticles
The morphology of the OA-IO NPs was investigated by scanning electron microscopy (SEM). Cellular uptake in MDA -MB 231, MCF 7 and U-87 cell lines were studied. The effects of alternating magnetic field of 10kW/ 20minutes (AMF) on these cell lines were then studied to evaluate the proportion of cell death by induced hyperthermia.
Functionality of the system for application in-vivo for glioblastoma therapy is to be evaluated and validated using animal experiments.

Results

The average size and zeta potential of the formulated OA -IO NPs were found to be 35.21±4.23 nm and -32.7± 5.92 mV respectively that confirmed increased stability of the nanoparticles. The OA functionalization on IO NPs surface confirmed from FTIR study through the analysis of bonding pattern of the carboxylic acids on the surface of the nanoparticles. The uniform size of formulated nanoparticles were confirmed through SEM analysis.
Magnetic characteristic of IO NPs indicated super paramagnetic properties making them more suitable for hyperthermia application.
In MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] assay of IO NPs and OA-IO NPs exposure on the three cell lines, the cytotoxic events were found to be dose and time-dependent.
The percentage viability decreased from 77% (24 hours incubation) to approximately 68% (48 hours incubation) in case of OA coated IO NPs.



Successful internalization of OA IO-nanoparticles in U-87 glioma cells were confirmed using Prussian Blue staining.

On subjecting the cells to magnetic hyperthermia treatment (50 µg/ml solution of OA IO-NPs, 10 kW/20 min), the cell viability reduced to 41% after 24 hours and further reduced to 35% after 48 hours.

Conclusions

The synthesized OA-IO NPs revealed many favorable properties- size, charge, structure and functionalization. Cellular uptake studies confirmed good internalization of OA IP-NPs and MTT assay showed good reduction in cell viability with Magnetic Nanoparticle Hyperthermia in U-87 glioma cell lines. Further in-vivo experiments are being focused for assessing the role of Magnetic Nanoparticle Hyperthermia in treatment of glioblastoma.

References

Silva AC, Oliveira TR, Mamani JB, et al. Application of hyperthermia induced by superparamagnetic iron oxide nanoparticles in glioma treatment. International Journal of Nanomedicine. 2011;6:591-603. doi:10.2147/IJN.S14737.
Mahmoudi K, Hadjipanayis CG. The application of magnetic nanoparticles for the treatment of brain tumors. Frontiers in Chemistry. 2014;2:109. doi:10.3389/fchem.2014.00109.
Verma J, Lal S, Van Noorden CJ. Nanoparticles for hyperthermic therapy: synthesis strategies and applications in glioblastoma. International Journal of Nanomedicine. 2014;9:2863-2877. doi:10.2147/IJN.S57501.