Superparamagnetic nanoparticles SPIONs for the Development of Blood-Stage Malaria DNA Vaccines

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**Abstract**

DNA vaccine is a promising therapeutic approach for treating diseases. However, a crucial feature in effective DNA vaccination is antigen delivery to the site of action. In this way, any delivery system having higher transfection efficacy and subsequent superior antibody production needs to be further investigated. Our previous study demonstrated for the first time the promising results of utilizing the magnetic nanovectors comprised of superparamagnetic iron oxide nanoparticles (SPIONs), Polyethylenimine (PEI) polymer, and hyaluronic acid (HA) to deliver malaria DNA encoding Plasmodium yoelii (Py) merozoite surface protein MSP119 (SPIONs/PEI/DNA + HA gene complex) to dendritic cells DC which showed high gene transfection efficiency *in vitro*. In this study, the immunostimulatory effect of the magnetic SPIONs/PEI/DNA+ HA gene complexes was examined *in vivo* application. Groups of BALB/c mice were immunized either with SPIONs/PEI/DNA+HA complexes or SPIONs/PEI/DNA complexes with and without applying external magnetic field, and naked DNA by two different routes of administration; intraperitoneal (i.p.) and intramuscular (i.m.). Our results show that higher serum antibody titers against PyMSP119 were elicited when magnetic gene vectors SPIONs/PEI/DNA+HA were given via intraperitoneal injection under external magnetic field. In addition, predominant IgG subclasses induced were IgG2a followed by IgG1 and IgG2b subclass responses were also observed when mice vaccinated by SPIONs/PEI/DNA+HA complexes via intraperitoneal route.

Activation was also measured as induction of interferon INF-γ secretion, production of interleukin 4 (IL-4) and interleukin 17 (IL-17) levels in the spleen cells as confirmed by flow cytometry. The complexes elicited high levels of interferon gamma (IFN‐γ), and moderate levels of interleukin (IL)‐4 and IL‐17 antigen‐specific splenocytes, indicating induction of T helper 1 (Th1), Th2, and Th17 cell mediated immunity. The results illustrate that the ability of SPIONs/PEI/DNA+HA gene complexes across the i.p. route of administration to induce cytophilic antibodies together with broad-spectrum cellular immunity may benefit malaria vaccines.



**Dr. Fatin M. Nawwab AL-Deen** is a Senior lecturer (Microbiology and Parasitology) at Kirkuk University/ Iraq, she received her B.S. and M.S. in Biology (Parasitology) from the Department Biology /College of Science (1991) (1994) at Mosul University/ Iraq, respectively. She obtained her Ph.D. in Parasitology (2013) under the supervision of Professor Cordelia Selomulya in Chemical Engineering Department and Professor Ross Coppel in the Department of Microbiology at Monash University/VIC Australia. Dr. Fatin Nawwab AL-Deen current research focuses are on the improvement of Molecular technique for diagnosis parasitic diseases, developing new nanomaterial as an antimicrobial agent, and evaluation of medicinal plant products as antimicrobial agents.