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Single-walled carbon nanotube as a novel drug delivery system for cyclosporine

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Background and Aims: Carbon nanotubes (CNTs) are considered as hollow cylinders with diameters of 0.5-100 nm and lengths of 20 nm–50 μm. These nanostructures are described as rolled sheet(s) of graphene built from hexagonal arrangement of sp2-hybridized carbon atoms and are classified as single-walled (SWCNTs) and multi-walled carbon nanotubes (MWCNTs). CNTs display remarkable physicochemical properties, providing extensive diverse applications and offering a promising approach for drug delivery. In the present study, it was hypothesized that by grafting of cyclosporine (CsA) onto the surface of SWCNTs, the immunosuppressive activity of CsA may considerably improve in comparison to its commercially available parenteral form.
Methods: SWCNTs were first functionalized noncovalently with phospholipid polyethylene glycols (Pl-PEGs) through PEGylation process in order to improve their solubility. In the second step, the effect of SWCNTs PEGylation on viability and proliferation of Jurkat cell line was evaluated. The third part of the present research was designed to prepare a CNT-based liquid formulation containing CsA. Drug loading, stability of PEG-SWCNTs-CsA complex and in vitro release of the drug were then evaluated. Finally, the effect of CsA-loaded SWCNTs on human T- cells was evaluated by LTT and ELISA methods.
Results: Noncovalent PEGylation of SWCNTs was confirmed with a high loading efficiency using various analytical techniques. Results also showed that aqueous solubility of SWCNTs improved considerably following functionalization. Cytotoxicity studies indicated improved biocompatibility of PEGylated SWCNTs on Jurkat cell line in comparison to pure nanotubes. Elemental analysis and UV-Vis spectroscopy also confirmed that CsA loading has been achieved. It was observed that the drug-loaded SWCNTs may cause a significant decrease in the production of Interleukin II by T lymphocytes.
Conclusions: It was concluded that PEGylated SWCNTs could be considered as a promising novel delivery system for improving the bioavailability and increasing the immunosuppressive activity of cyclosporine.

Keywords: SWCNTs; Cyclosporine,; PEGylation