Journal of Drug Delivery Science and Technology
Volume 93, March 2024, 105410

Magnetically guided nanoparticles in cancer treatment: Impact of non-Newtonian behavior, interaction force, and wall shear stress

Wala Almosawy [a], As'ad Alizadeh [b], Naser Koosha [c f], Nahid Najafi [d], Negar Abdi [e], Mohammad Najafi [f], Zahra Sadeghi [g] ✉, Aram Ardalan [h]

Show more

https://doi.org/10.1016/j.jddst.2024.105410 ↗

Abstract

Cancer is considered one of the leading causes of human death in the world. To date, there is a lack of a therapy that can safely and effectively deliver cancer drugs to deep tissue targets. Magnetic drug targeting (MDT) is widely acknowledged as an innovative approach in cancer therapy, offering a solution with minimal adverse effects. Hence, the current investigation focused on the capture of drug-loaded nanoparticles within a three-branched 3D blood vessel. Three cylindrical neodymium (NdFeB) magnets were utilized to produce an externally applied magnetic field. The two first ones are used to prevent carrier nanoparticles entering the first two branches, while the third magnet was responsible for capturing nanocarriers at the region of interest (ROI). The blood's non-Newtonian behavior was modeled by employing the power-law and Carreau models. The investigation focused on the effect of various factors, including wall shear stress (WSS), blood velocity, nanoparticles' diameter, and forces including magnetic, drag, and interaction, on the capture efficiency (CE) of drug-loaded nanoparticles. In all instances, except for the Newtonian scenario, the findings indicate a decrease in the captured nanoparticles as the particle diameter is increased. In the Newtonian case, when the particles' diameter is increased from 750nm to 1000nm, the CE decreases by approximately 18%. Maximum and minimum values of WSS in main vessel for Carreau model are 0.35054 and 0.060225 N/cm^2, respectively. It was concluded that taking into account the interaction force resulted in a reduction in particles captured at tumor site.