عنوان مقاله:

Computational simulations of nanoparticle transport in a three-dimensional capillary network

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خلاصه مقاله:

Objective(s): Multifunctional nanomedicine is the new generation of medicine, which is remarkably promising and associated with the minimum toxicity of targeted therapy. Distribution and transport of nanoparticles (NPs) in the blood flow are essential to the evaluation of delivery efficacy. Materials and Methods: In the present study, we initially designed a phantom based on Murray's minimum work law using the AutoCAD software. Afterwards, the phantom was fabricated using lithography and imaged using a Siemens Magnetom 3T Prisma MRI scanner at the National Brain Mapping Laboratory, Iran. Finally, the velocity and pressure in the capillary network were simulated using the COMSOL software. Moreover, three-dimensional Navier-Stokes equations were applied to model the NP transport and dispersion in blood suspension. Results: According to the findings, particle size, vessel geometry, and vascular flow rate affected the delivery efficacy and NP distribution. Cerebral blood flow, cerebral blood volume, mean transit time, and curves for the capillary network were obtained at different times. The simulations indicated that the velocity and pressure in the capillary network were within the ranges of 0.0001-0.0005 m/s and 5-25 mm/Hg, respectively. Higher particle concentration was also observed in the non-uniform NP distribution profile near the vessel wall. Conclusion: We investigated the effects of the vessel size and geometry and particulate nature of blood on the delivery and distribution of NPs. For targeted drug delivery applications, a mechanistic understanding on the nanomedicine design was provided as well.

کلمات کلیدی:

Capillary network, finite element method, Nanoparticle, Simulation