Abstract

The delivery of drugs into the central nervous system, specifically the brain, is difficult due to the blood-brain barrier preventing large molecules, such as biopharmaceuticals, to pass. In this study, we present a preliminary mathematical analysis of retro-convection enhanced drug delivery (R-CED), a new procedure which aids to circumvent the blood-brain barrier, using COMSOL multiphysics. R-CED was derived from the well-studied procedure, convection enhanced drug delivery (CED), which also helps to bypass the blood-brain barrier, but shows problems with regards to backflow or reflux, causing uncertainty with regards to the location of some of the infused drug molecules. R-CED does not have this problem, as the direction of fluid flow is opposite that of CED, extracting fluid out of the system instead of infusing drug molecules directly towards a desired area, e.g. a malignant tumor.

A sensitivity analysis of the various parameters associated with R-CED was conducted in order to show how one could manipulate the physiology of a specimen to promote drug delivery. Furthermore, the performance of the drug molecules after R-CED has stopped, or during a post-extraction phase, was analyzed to help obtain a thorough analysis of drug behavior for all values of time. The evaluation of the post-extraction phase was implemented into an area under the curve pharmacodynamic study, in which we derive a cumulative drug distribution for all values of time in the interstitial region for both CED and R-CED procedures.