Chapter 15

Mathematical Model of Unsteady Flow of Cerebrospinal Fluid in the Perivascular Region

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Abstract

Cerebrospinal fluid (CSF) transport through the perivascular space (PVS) plays an impotent role in the glymphatic system of the brain, supporting nutrient delivery and metabolic waste clearance. Here we describe the unsteady flow of CSF in the perivascular region. The governing equations are derived from the Navier–Stokes equations coupled with a solute transport equation. The model Darcy is the permeability parameter, and chemical reaction parameter. The governing equations are non-dimensionalized and solved using the Laplace transform technique. Analytical expressions for velocity and concentration fields are derived and discussed. The results demonstrate that wall motion significantly enhances the CSF transport while buoyancy and porous medium resistance affect the velocity distribution. The proposed model provides deeper insight into fluid dynamics in the glymphatic pathway and can contribute to improved understanding of neurological diseases associated with impaired CSF circulation.

Keywords: Perivascular Space, Cerebrospinal fluid, Permeability, Darcy number, Pressure, diffusivity.

ISBN 978-816855385-9