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Magnetic field effects on 3D blood flow patterns of straight and stenotic arteries

Abstract

This paper investigates the mathematical modeling of the biomagnetic fluid (human blood) flow in arteries with different geometries, subjected to various externally applied non-uniform magnetic fields. In allowing for the effects of the magnetic field, the steady Navier-Stokes equation for the standard flow is expanded with inclusion of the Lorentz and magnetization forces. In addition, a simplified set of Maxwell's equations is prescribed to ensure the problem is mathematically closed. The model is then discretized employing the finite volume method and used for a parametric study involving arteries with and without stenosis under various magnetic strength exposures. It is evident that an existence of non-uniform magnetic field can create significant changes especially in the secondary flow patterns and flow streamlines, greater effects of which are shown in arteries with stenosis. On practical ground, the findings can offer interesting correlation in assisting the optimization of the magnetically targeted drug delivery, a nowadays commonly exercised but laboriously performed clinical application.

Keywords

Blood flow; Lorentz force; Magnetic drug targeting; Magnetic field; Magnetization force