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A simplified fluid-structure model for arterial flow. Application to retinal hemodynamics.

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Abstract

We propose a simplified fluid-structure interaction model for applications in hemodynamics. This work focuses on simulating the blood flow in arteries, but it could be useful in other situations where the wall displacement is small. As in other approaches presented in the literature, our simplified model mainly consists of a fluid problem on a fixed domain, with Robin-like boundary conditions and a first order transpiration. Its main novelty is the presence of fibers in the solid. As an interesting numerical side effect, the presence of fibers makes the model less sensitive than others to strong variations or inaccuracies in the curvatures of the wall. An application to retinal hemodynamics is investigated.

Keywords:
fluid-structure interaction, blood flow, fibers

1. Introduction

Fluid-structure interaction plays an important role in the cardiovascular system. In many situations, complex nonlinear models that include large displacements and deformations have to be considered. This is, for example, the case for valve simulation [1, 2, 3, 4] or in the aorta [5, 6, 7]. It is well-known that these simulations are very demanding, and in spite of the progress achieved in recent years ([8, 9, 10] to name but a few), they remain challenging and the subject of active research.

In this paper, we consider those situations where it is assumed that the problem under study can be addressed using simplified approaches. The idea is to radically simplify the solid model in order to replace the full fluid-structure problem by a fluid problem with non-standard boundary conditions