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Critical evaluation of three hemodynamic models for the numerical simulation of intra-stent flows

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Abstract

We evaluate here three hemodynamic models used for the numerical simulation of bare and stented artery flows. We focus on two flow features responsible for intra-stent restenosis: the wall shear stress and the re-circulation lengths around a stent. The studied models are the Poiseuille profile, the simplified pulsatile profile and the complete pulsatile profile based on the analysis of Womersley. The flow rate of blood in a human left coronary artery is considered to compute the velocity profiles. "Ansys Fluent 14.5" is used to solve the Navier-Stokes and continuity equations. As expected our results show that the Poiseuille profile is questionable to simulate the complex flow dynamics involved in intra-stent restenosis. Both pulsatile models give similar results close to the strut but diverge far from it. However, the computational time for the complete pulsatile model is five times that of the simplified pulsatile model. Considering the additional "cost" for the complete model, we recommend using the simplified pulsatile model for future intra-stent flow simulations.

Keywords: intra-stent flow; restenosis; hemodynamic models; left coronary artery; computational fluid mechanics

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1. Introduction

According to the World Health Organization, 29% of the 56 million deaths worldwide in 2001 could be attributed to cardiovascular diseases (Murray et al., 2002). They are often due to a decrease in the artery diameter called stenosis

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