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Yakov A. Gataulin , Dmitri K. Zaitsev , Evgueni M. Smirnov , Andrey D. Yukhnev

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Yakov A. Gataulin, Dmitri K. Zaitsev, Evgueni M. Smirnov, Andrey D. Yukhnev

Peter the Great St. Petersburg Polytechnic University 29 Politekhnicheskaya St., St. Petersburg, 195251, Russian Federation

Abstract

A numerical study of the secondary flow in two geometrically different models of a common carotid artery has been carried out. One of the models (Model 1) is characterized by a statistically averaged curvature, and the second one (Model 2) is attributed to the maximal curvature of the artery. It was shown that the most intensive swirl occurred at the phase of flow rate decreasing, the maximum values of the swirl parameters were observed at the interface of the cervical and thoracic segments of the artery. This interface is the place where the Dean vortices are transformed into a single vortex forming a swirling flow. The swirl intensity averaged over the systole and characterized by the ratio of the maximal values of the axial and circumferential velocities was evaluated as 0.20 for Model 1 and 0.25 for Model 2. Generally, it was in accordance with the data of clinical measurements.

Keywords

Common carotid artery; Swirling flow; Computational fluid dynamics; Navier–Stokes equations.

Introduction

Carotid arteries are the major blood vessels delivering blood from the heart to the brain. The left common carotid artery originates from the aortic arch and the right one from the brachycephalic artery. Both split into the internal carotid artery, which supplies blood to the brain, and the external carotid artery, which feeds blood to the rest of the head.

Recent studies on the effect of spatial curvature of the common carotid artery on blood flow [1–3] suggest that flows with axisymmetric velocity distributions in the arterial cross-sections virtually never occur. As proved by the results of the computations performed for spatially curved geometry of the common carotid artery in Ref. [1], a flow with a skewed axial velocity profile evolves in the artery, even at a moderate curvature of its cervical segment. The maximum velocity is shifted towards one of the walls due to the development of secondary (cross) flows. The computations performed in [2] for a tortuous carotid model also point to