INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Bifurcating vessels are ubiquitous in cardiovascular and pulmonary systems, microfluidics, and several biomedical applications. The flow is distributed in the daughter vessels, and the streamlines become curved at the bifurcations. As a result, the flow becomes complex at the bifurcations. In this work, the steady and pulsatile flow of blood, assuming it to be a Newtonian fluid, is modeled in idealized symmetric and asymmetric bifurcations. The effect of different geometric parameters such as bifurcation angles, mother to daughter vessel ratio, area change near the bifurcation on the flow behavior is investigated computationally. In particular, the effect of these parameters on instantaneous and time-averaged wall shear stress, oscillatory shear index, and relative residence time, the potential biomarkers for atherosclerosis development, is presented. The results show that the shear rate can become significantly low in certain regions, especially around the bifurcation. Therefore, the fluid is also modeled as a shear-thinning fluid, and the results are compared with those obtained, assuming the fluid to be Newtonian. Further, the effect of pulse frequency on flow behavior is investigated in a patient-specific geometry available in the open literature.

In several cases, such as during movement of gas emboli, in gas embolotherapy, in mechanical ventilation, and in microfluidic applications, gas-liquid flow is encountered in bifurcating geometries. The dynamics of bubbles in symmetric and asymmetric bifurcations is investigated using the volume of fluid method in a planar, two-dimensional computational domain. The effect of bifurcation angle, Reynolds, and capillary numbers on the bubble is investigated. Bubble dynamics is also investigated experimentally in a symmetric bifurcation geometry. Results show two different regimes: splitting and non-splitting, depending on the flow and geometric parameters. A qualitative comparison between the experimental data and two-dimensional simulation is made.