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THE NUMERICAL HEMODYNAMICS ANALYSIS OF BIFURCATED CEREBRAL ANEURYSM: THE IMPACT OF ANEURYSM MORPHOLOGY ON RUPTURE RISK

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ABSTRACT

A brain aneurysm, also known as a cerebral or intracranial aneurysm, is a balloon-like formation arising from a weakened blood vessel. It is possible for an aneurysm to rupture and bleed into the brain space if it enlarges and the blood vessel wall becomes too thin. Hypertension, smoking, etc. are a number of factors that contribute to cerebral aneurysms. In the United States, an unruptured cerebral aneurysm affects about 6.5 million people or one in every 50 people. The annual rupture rate of cerebral aneurysms is around 8–10 per 100,000 persons.

In order to have a better understanding of the development, rupture, and treatment of cerebral aneurysms, computational fluid dynamics (CFD) modeling is increasingly being used as a research tool. Aneurysm growth and rupture are correlated with its spatial and temporal variation in wall pressure and wall shear stress. In the present study, under physiologically realistic pulsatile conditions, numerical modeling is used to investigate the hemodynamics of virtual aneurysms with different geometrical characteristics. The effect of geometric parameters on the fluid flow patterns is investigated to identify the risk of rupture of aneurysms. Both Newtonian and non-Newtonian fluid assumptions are considered in the simulations to investigate the effect of blood viscosity on cerebral aneurysm hemodynamics.

The study showed that vortices are more unstable under the Newtonian blood assumption as there are stronger viscous forces that prevent fluid flow from instabilities under non-Newtonian assumptions. Furthermore, it was seen that the aneurysm size has a considerable effect on aneurysmal inflow.

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