Numerical and One Dimensional Modeling of Systemic Circulation Along with Cerebral Vasculature

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The brain is one of the vital organs in the body. The main cerebral distribution center of blood flow in the brain is the circle of Willis (CoW). In more than 50% of healthy brains and in more than 80% of dysfunctional ones, at least one artery of the circle of Willis is absent or underdeveloped . These variations reduce the collateral flow availability and increase the risk of stroke and transient ischemic attack in patients with atherosclerosis. Thus it is essential to simulate the circle of Willis and investigate the effects of stenosis. In this work the systemic arteries along with the circle of Willis are simulated using the finite volume method and one-dimensional equations of conservation of mass and momentum. The structured tree is considered as the outlet boundary condition. The results show that blood flow rate, pressure and velocity through vessels are consistent with previous results. Meanwhile, the internal Carotid artery (ICA) stenosis is simulated and the collateral capacity of the circle of Willis is shown. As the area of the ICA decreases, the velocity of blood through communicating arteries is increased but this ability is reliable to a special extent of area reduction in the ICA.