A NUMERICAL FLUID-STRUCTURE INTERACTION ANALYSIS OF CEREBRAL ANEURYSM

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Although the risk of rupture of cerebral aneurysms is known to be less than 0.1% [1], aneurysms are usually operated if they are identified. On the other hand, the risk of surgical interventions is over 10% [1]. Thus it is important to predict risk of rupture of cerebral aneurysms in order to avoid unnecessary surgeries. Since it is suggested that growth and rupture of aneurysms are associated with hemodynamic force, the authors have been conducted numerical analyses of hemodynamic force acting on arterial wall for basis of prediction of rupture of cerebral aneurysms. In this paper, a numerical fluid-structure interaction analysis is performed in order to investigate the relationship between hemodynamic force and wall deformation near cerebral aneurysm. In particular, the authors focus on wall shear stress, because it is an important factor of vascular disorders [2].

Blood flow with moving boundary is calculated using DSD/SST method [3]. Arterial wall is assumed to be linear-elastic body and its motion is calculated using FEM with Newmark-β time integration. Fluid and structural motions are coupled through the force equilibrium on the contact surface of blood and arterial wall. The bifurcation of the middle cerebral artery with an aneurysm was selected as an object of computation.

The result of this study shows that wall shear stress distribution is sensitive to wall deformation near the aneurysm on Y-shaped bifurcation of artery. In Y-shaped bifurcation of artery, magnitude of wall shear stress is very large around the bifurcation because blood flow impinging to arterial wall of the bifurcation makes velocity gradient significantly high near the stagnation point. Since high velocity gradient near arterial wall of the bifurcation is easy to vary with deformation of arterial wall, wall shear stress is sensitive to wall deformation. This implies that both of blood flow characteristics and mechanical property of arterial wall may play an important role in growth and rupture of aneurysms.

References

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