OCCLUSION PHENOMENON IN CEREBRAL ANEURYSM MODEL INDUCED AT BIFURCATION BY STENT

Taiki Koizumi[1], Yuki Kato[1], Teruo Matsuzawa[2], Hiroshi Ujiie[3], Ryuhei Yamaguchi[1]

[1] Shibaura Institute of Technology, Japan; [2]Japan Advanced Institute of Science and Technology, Japan; [3]Tokyo Rosai Hospital, Japan

Introduction

Stents have been employed for the treatment of cerebral aneurysms [Yu, 2012]. In the present study, the effect of a metal stent on the flow occlusion within a globate aneurysm was experimentally investigated *in vitro*. The flow model basically simulates the cerebral aneurysm induced at the bifurcation to the anterior communicating artery from the anterior cerebral artery. As a major assessment variable for stent characteristics, the wall shear stress is examined for both stented and unstented models.

Methods

The aneurysm model simulates the geometry of a cerebral aneurysm at the bifurcation to the anterior communicating artery from the anterior cerebral artery. The flow model is constructed of silicone resin with a refractive index of 1.41. The simple bare metal stent is employed. The working fluid is a mixture of glycerol and water and has a refractive index equal to that of the silicone resin, i.e., 1.41.

In the measurement of flow velocity, the flow field is visualized by PIV (Lavision) and is processed using Devis 7. At this velocity, the wall shear stress is estimated at a distance of 0.4 mm from the wall.

Results and Discussion

In the pulsatile flow of the unstented and stent models, at Re_m= 435, α= 4.0, and A=0.68, the velocity vector is indicated in Figs. 2 and 3, respectively. In the unstented model, the flow entering into the aneurysm smoothly circulates clockwise. At all phases, the flow direction is the same, i.e., clockwise. At the maximum flow rate $\omega t=\pi/2$ (maximum systolic phase), the velocity reaches a maximum of 20cm/s. The velocity at $\omega t= 0$ is much larger than that at $\omega t= \pi$, in spite of the same Reynolds number of Re_m= 435.

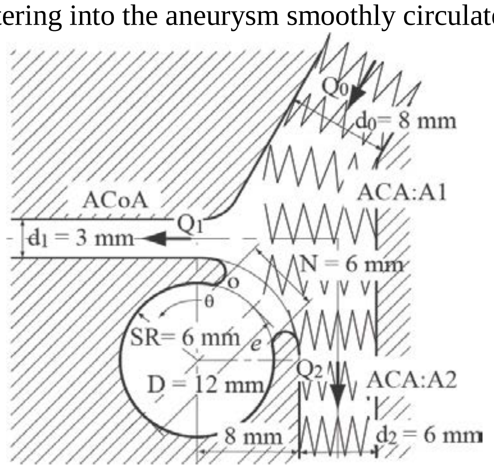

Fig. 1 Sketch of the aneurysm model

On the other hand, the flow at the stent model penetrates into the aneurysm, and the flow field divides two regions that are the large, high- and small, low-velocity fields at $\omega t = \pi/2$ and π. Particularly, this flow pattern is distinguished from that of the unstented model. Furthermore, the velocity magnitude of the unstented model is smaller than that of the stented model.

The results show that the flow velocity and the wall shear stress within the aneurysm with the stent are smaller than those without the stent. This indicates that the aneurysm occlusion proceeds by insert of the stent and prohibits the aneurysm rupture.

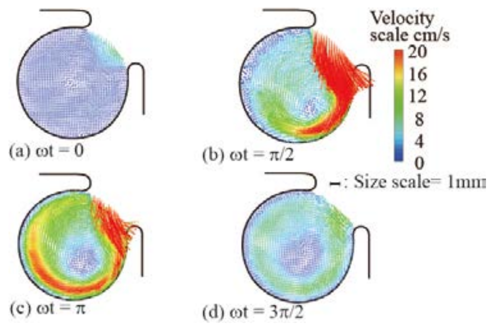

Fig. 2 Velocity within unstented aneurysm

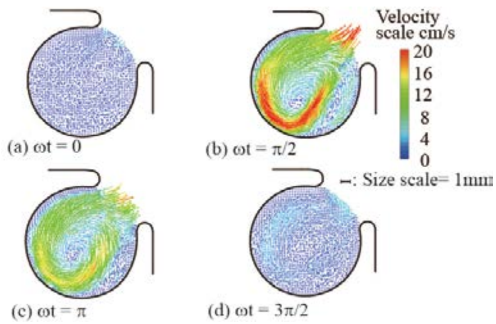

Fig. 3 Velocity within stented aneurysm

Yu *et al*, J Mech Sci and Tech, 26:1333-1340, 2012.