V11

Computational Investigation of Thrombin Concentration in a Cerebral Aneurysm Treated with Flow-diverting Stent

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Background: Flow-diverting stent is an ongoing embolization device to treat cerebral aneurysms, and it diverts the flow direction to reduce the flow velocity inside the aneurysmal sacs and promote the thrombus formation. However, its effect for giant aneurysm embolization or occlusion of branch arteries is controversial. In order to investigate the effect of implantation of flow-diverting stents, the change of thrombin concentration in cerebral aneurysm models was evaluated.

Methods: Based on Wangenvoord model, a hemodynamic-biomedical coupling model was established to describe the generation and transport of thrombin in artery, and the coupling model was applied to investigate the variation of thrombin concentration in a patient-specific cerebral aneurysm with double aneurysmal sacs, a collateral artery located on one of the sacs. By employing computational fluid dynamics, the blood flow and the thrombin concentration in the anerysm model before and after treated with Pipeline flow diverting stents were simulated numerically.

Results: Normalized thrombin concentration inside the upper aneurysmal sac has been significantly improved, especially in the right side near the apex normalized thrombin concentration reaches the maximum, indicating that thrombus will start from this area most probably. Contrarily, there is hardly change of normalized thrombin concentration in the lower aneurysmal sac, suggesting that the process of thrombosis in the lower aneurysmal sac after Pipeline implantation will be very slow. See Figure 1.
Figure 1: Normalized thrombin concentration in the center plane of the aneurysm model before and after Pipeline implantation

Conclusions: Single Pipeline implantation is very effective to embolize a small aneurysm without collateral artery, but not effective to embolize a small aneurysm with a collateral artery on its sac. We believe that Pipeline combined with coils will be an optimal option to embolize the aneurysms with a collateral artery on its sac.

Figure **1**: