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Investigation on Relationship between Hemodynamic Factors and Cerebral Aneurysm Initiation by CFD

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Introduction: Inflammation of the blood vessel wall is considered to be the cause of cerebral aneurysm, and blood flow is said to cause inflammation of the vessel wall. The relation between hemodynamics parameter and cerebral aneurysm initiation has been reported previously, however, the mechanism of cerebral aneurysm initiation has not been fully elucidated. In this study, we investigate hemodynamic factors related to cerebral aneurysm initiation in the middle cerebral artery (MCA) using computational fluid dynamics(CFD).

Materials & methods: We performed transient blood flow analysis using CFD for 2 aneurysm initiation cases at MCA aneurysms. In this study, wall shear stress (WSS) and wall shear stress gradient (WSSG) were evaluated since the previous studies reported their relations to aneurysmal initiation. Additionally, we defined wall shear stress divergence (WSSD) to consider the direction of WSS. These hemodynamic parameter distributions were investigated at the initiation site before the aneurysm was occurred.

Results: The initiation regions were corresponded to high WSSG regions and high WSSD regions in both cases. Cerebral aneurysms had initiated in the vicinity of the blood flow impingement region with high WSSG and WSSD. WSS tend to be high in the initiation regions, however, low WSS regions were also existed. Our result indicated that increased WSSD and WSSG due to blood flow impingement might be related to the cerebral aneurysm initiation.

Conclusion: It is suggested that cerebral aneurysm initiation may associate with high WSSG and WSSD due to blood flow impingement.