

## **Irregularity of cerebral aneurysms based on oscillatory velocity index associated with morphological risk factors of future rupture of unruptured cerebral aneurysm**

*S. Tanioka<sup>1</sup>, F. Ishida<sup>1</sup>, T. Kishimoto<sup>1</sup>, K. Tanaka<sup>1</sup>, S. Shimosaka<sup>1</sup>, H. Suzuki<sup>2</sup>*

<sup>1</sup>Mie Chuo medical center, Neurosurgery, Tsu, Japan

<sup>2</sup>Mie University Graduate School of Medicine, Neurosurgery, Tsu, Japan

**Introduction:** Previous cohort studies demonstrated that rupture risk of cerebral aneurysms is associated with aneurysm size, site of occurrence and their shape. However, it is difficult to discriminate objectively between irregular aneurysm shape and smooth aneurysm shape. Therefore, we divide the aneurysm irregularity using a novel hemodynamic parameter, oscillatory velocity index (OVI). OVI measures the directional change of flow velocity vector in the 3D fluid domain. We suppose that irregular-shaped aneurysms are more likely to have high OVI and these aneurysms have certain differences in morphological and hemodynamic characteristics.

**Materials and methods:** Morphological and hemodynamic analyses were performed in 167 patient-specific aneurysm geometries generated using 3DCT angiography. Seven primary dimensions such as dome height, maximum size and neck width were measured using ImageJ. In addition, four shape indexes were calculated using the primary dimensions. CFD simulations were carried out under pulsatile flow conditions and 16 hemodynamic parameters including wall shear stress (WSS), WSS-related hemodynamic parameters and OVI were calculated. We divided these aneurysms into irregular shape group and smooth shape group based on the median value of OVI in all aneurysms. Statistical analysis was performed to clarify the morphological and hemodynamic characteristics in the irregular shape group.

**Results:** Wilcoxon rank-sum test revealed that irregular shape group had significantly higher aneurysm size, shape indexes such as aspect ratio, size ratio, volume-to-ostium area ratio, low shear area ratio, oscillatory shear index, gradient oscillatory number, relative residence time and standardized pressure difference. On the other hands, inflow area ratio, WSS, WSS gradient and flow velocity at inflow area were significantly lower hemodynamic parameters.

**Conclusion:** These findings revealed that irregular-shaped aneurysms based on OVI had morphological features such as large size and high aspect ratio that are corresponding to rupture risk of unruptured cerebral aneurysms demonstrated in clinical cohort studies. Therefore, high OVI and the hemodynamic parameters in irregular shape group may be potential parameters to predict future rupture of unruptured cerebral aneurysms.