Numerical Simulation of Saccular Aneurysmal Flow for the Analysis of Stent Porosity and Strut Geometry

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We use computational fluid dynamics to simulate the evolution of aneurysmal flow for different stent designs. This work can assist us in designing the optimal stent configuration in an aneurysm sac such that its growth can be minimized to avoid rupture.

Flow patterns in aneurysm sacs with different stent strut shapes were investigated in this paper. Fig. 1 shows that the vortex is highly reduced in the rectangular strut shape case compared to other circular and triangular shape cases. The rectangular strut stent shape seems to be an effective model prevents the aneurysm rupture, given the aneurysm flow reduction caused by this shape.

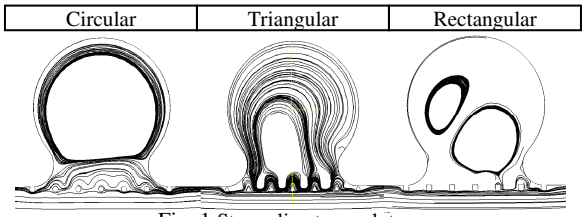

Fig. 1 Streamline trace plots

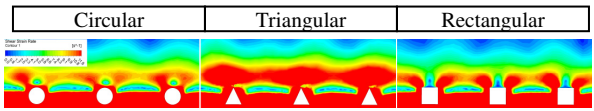

Fig. 2 Shear strain rate plots.

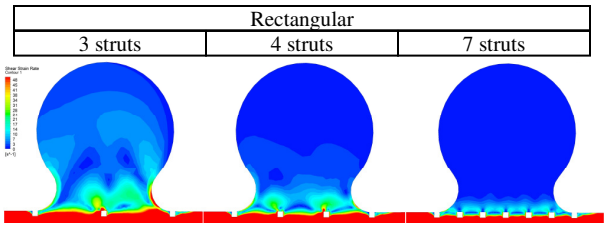

Fig. 3 Shear strain rate plots for variable stent porosities

Reduced vorticity in the aneurysmal sac also corresponds to a lower fluid shear stress and shear strain rate. Note that high shear stress is necessary for preventing platelet-dependent thrombosis. Therefore, the triangular stent shape is more suitable for the stent design on this aspect (Fig. 2). Also, by comparing the shear strain rate results of variable stent porosities (Fig. 3), fewer struts configuration will minimize platelet aggregation. However, our research shows that this comes at the expense of higher sac pressure, which can accelerate its rupture. Therefore, adjusting stent porosity and strut geometry (as free parameters) can reduce the vortex and pressure and maintain a high shear strain rate in the sac optimally (as key performance objectives).