New tool to visualize near wall flow in cerebral aneurysms

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Problem: The assessment of rupture risk of cerebral aneurysms is a still unresolved problem. The data in the international literature show an influence of the shape of the aneurysm, which determines both the tensile stresses of the wall and also the flow. Regarding the latter, the flow close to the wall is regarded as the major influence. This near wall flow causes the wall shear stress – WSS –, which is well investigated - in its distribution at the wall, its strength and course over time. However, no conclusive hypothesis has yet evolved.

Methods: The wall shear stress was simulated with the flow solver Fluent (Ansys Inc., USA). Rigid walls were assumed and a now-Newtonian model was used. The anatomical basis was assessed with the rotational angiography of five unruptured and four ruptured aneurysms. From these data the grid for the computation was derived. The boundary condition for inflow and outflow were taken from the literature and Murray’s law. The resulting instationary field of wall shear stress was exported and analyzed by ZIBAmira program (Zuse Institute Berlin, Germany). This new tool permits to visualize the instationary near wall flow in animated form.

Results: The new tool permits to visualize the highly complex flow inside an aneurysm. It extracts points of zero wall shear stress from the dynamic field of the near wall. Points and near wall flow fields were visualized. Usually 5 to 8 of these points are detected on the dome each aneurysm. Some of these points are stationary, other move around over the whole cycle.

Discussion: A discrimination of the ruptured aneurysms has not yet been achieved. More cases are needed for statistical evaluation of flow field features differences between the ruptured and unruptured group of cerebral aneurysms.