Simulation-Based Intervention Planning for Cerebral Aneurysms Using Patient-Specific Haemodynamics

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Objective: We demonstrated a constant and realistic models of fluid dynamics in patient specific aneurysm models with both morphological and velocity information based on MRA.

Methods: A time of flight magnetic resonance angiogram of the vascular region of interest is segmented to generate a fully descriptive three-dimensional reconstruction of the arterial lumen. Subsequently, we discretize this arterial lumen into an adequate number of control volumes producing a volume grid in which to cast the governing blood flow equations. We then solve these equations for three different proximal inflow boundary conditions, a realistic pulse, an idealized pulse and a steady-state flow. Phase contrast flow data is used to provide a realistic estimate of the blood velocity at a section proximal to the aneurysm.

Results: Information on the velocity magnitude and the secondary flow patterns are presented in this work. Quantitative and qualitative differences are found among the three scenarios examined. Together with consideration of time and effort differences between the techniques these will guide us in establishing a protocol of application, based on the efficacy of each approach to depict a realistic and comprehensive haemodynamic image.

Conclusions: Computational haemodynamics in realistic geometries makes possible exploration of parameters such as shear stress and vorticity not easily accessible by other means. Depending on the target parameter, a compromise between realism and computational requirements can be made.