Kazakidi, A. and Drakopoulos, F. and Sadasivan, C. and Chrisochoides, N. and Ekaterinaris, J. and Lieber, B. B. (2016) Simulation of flow diversion in cerebral aneurysms. In: 7th European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS Congress 2016, 2016-06-05 - 2016-06-10. ,

SIMULATION OF FLOW DIVERSION IN CEREBRAL ANEURYSMS

A. Kazakidi[1, 2*], F. Drakopoulos[3], C. Sadasivan[4], N. Chrisochoides[3], J. Ekaterinaris[2], B. B. Lieber[4]

[1]Institute of Computer Science, Foundation for Research & Technology - Hellas
Heraklion, Greece
kazakidi@ics.forth.gr

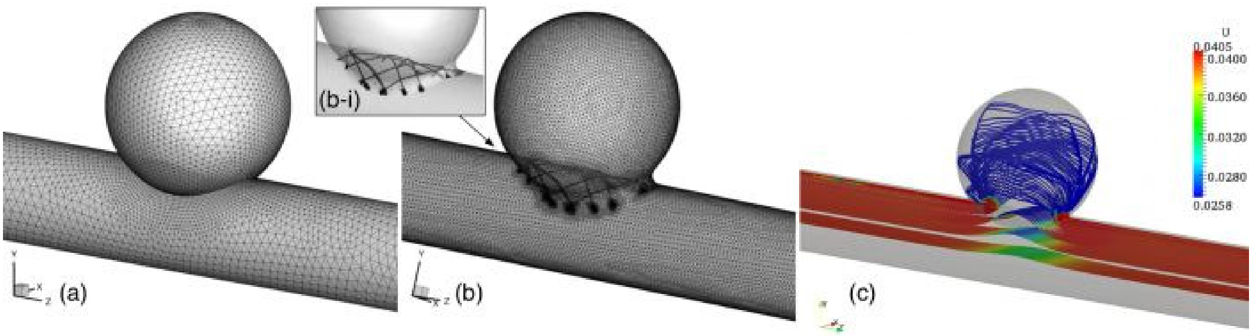
[2]Department of Aerospace Engineering, Embry-Riddle Aeronautical University
Daytona Beach, 32114 FL, USA
ekaterij@erau.edu

[3]Department of Computer Science, Old Dominion University
Norfolk, VA, USA
{fdrakopo, npchris}@gmail.com

[4]Department of Neurological Surgery, Stony Brook University
Stony Brook, NY, USA
{Chandramouli.Sadasivan, Baruch.Lieber}@stonybrookmedicine.edu

ABSTRACT

Intracranial aneurysms are abnormal focal enlargements of the vascular walls that necessitate surgical intervention once detected. Emerging stent technology involves an innovative type of finely-braided stents, called flow diverters, which abruptly impede the arterial flow into the aneurysm, upon deployment, and induce thrombosis, vascular remodelling and complete aneurysm occlusion in under a year [1]. The understanding of the dynamics of blood flow within this radically modified environment is thought to be pivotal in increasing the efficacy of both stent design and prolonged treatment. The aim of this study is to numerically simulate the blood flow within stented arterial segments and to evaluate critical hemodynamic factors around the aneurysm neck, validated with clinical and experimental data [1,2]. These objectives create many geometric challenges around the flow diverter due to the tessellation and resolution of features with very large ratio (artery-to-stent) in the input i.e., medical images and stent models. Following a novel Body-Centric Cubic (BCC) mesh generation method [2], high-fidelity tetrahedral meshes of aneurysmal dilatations that incorporate flow diverters across the aneurysm neck are now possible with an accurate image-to-mesh (I2M) conversion scheme from micro-CT images (Fig. 1a,b). Preliminary results involve arterial segments both with and without flow diverters (Fig.1c), utilising the CFD software OpenFOAM® to solve the incompressible Navier-Stokes equations, under steady and physiologically-correct pulsatile flow conditions.



Idealized sidewall aneurysms: (a) Simple mesh of CAD geometry without stent. (b) High-quality BCC-based mesh from micro-CT reconstruction of silicone replica with embedded flow diverter. (c) Steady flow simulation with no flow diverter, at Re=42.

References

[1] C. Sadasivan, L. Cesar, J. Seong, A. Rakian, Q. Hao, F.O. Tio et al. *Stroke,* **40(3)**, 952-8, 2009.
[2] F. Drakopoulos et al. *24th International Meshing Roundtable*, Austin, TX, USA, October 12-14, 2015.