DFD19-2019-003746

Abstract for an Invited Paper
for the DFD19 Meeting of
the American Physical Society

The use of fluid dynamics to predict success of intracranial aneurysm endovascular treatment: State of the Art and Potential for Translation to Clinical Use

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Endovascular placement of coils or stents have become the preferred method for treatment of intracranial aneurysms. These minimally invasive procedures aim to create hemodynamics conditions that promote a stable thrombus that fills the entire aneurysmal sac. No accurate method to predict the outcome of endovascular therapy exists, with failure to create a sac-filling thrombus occurring in 15-35endovascular treatments that needs retreatment involving significant risk to the patient and cost to the health care system. We simulate 60 patients treated with Flow Diverting Stents (FDS) or coils, both before and immediately after treatment. Synchrotron scans of the actual coils or stents deployed inside phantoms of the aneurysms are generated, allowing for comparison of the hemodynamics modeled with standard porous media versus homogenized anisotropic and heterogeneous models derived from the fully- resolved scans. We have developed both Eulerian and Lagrangian metrics to understand the hemodynamics that promote a successful embolization of the aneurysmal sac, and propose a risk score to predict the need to further treat or follow-up each patient during, or immediately after, endovascular treatment.