V07

Vessel wall imaging enhancement of intracranial saccular aneurysms: Correlations with high fidelity CFD

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Introduction: High-resolution MRI vessel wall imaging (VWI) has been recently introduced as a promising accurate diagnostic approach to directly visualize and characterize vessel wall pathology affecting the intracranial circulation. VWI enhancement is considered a surrogate marker of aneurysm wall inflammation, which is an important rupture risk factor[1]. The purpose of this study is to investigate possible correlation between aneurysm wall enhancement (AWE) and various hemodynamic parameters using high fidelity computational fluid dynamics (CFD) in a consecutive series of unruptured intracranial saccular aneurysms (ISAs).

Materials & Methods: VWI was performed as described in Matouk et al., 2013[1]. Images were evaluated by two neuroradiologists for the presence of AWE on post-gadolinium images. Three dimensional model geometries were prepared for CFD using a watershed segmentation method from 3D-rotational angiograms. High-fidelity CFD was performed as described in Chnafa et al., 2018[2].

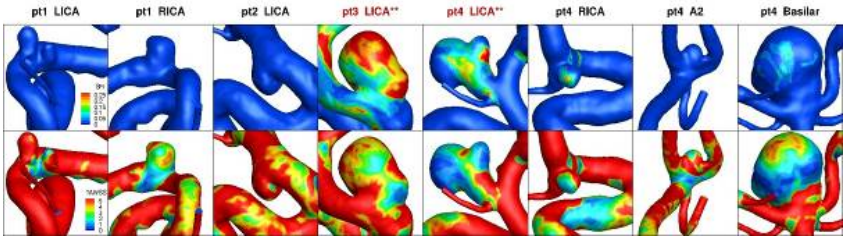
Results: Four patients with 8 ISAs were included. After the high-resolution VRI-MRI was performed, AWE was detected in total of 2 aneurysms. Per the top row of the figure, elevated spectral power index (SPI, a marker of high-frequency flow instabilities) was evident for the 2 cases that enhanced (identified in red with **). For pt4 with multiple aneurysms, only the aneurysm that enhanced had extensive elevated SPI, suggesting an inflammatory response to local hemodynamic rather than systemic risk factors. Per the bottom row of the figure, there was no such association between enhancement and low time-averaged wall shear stress (TAWSS).

Conclusions: VWI enhancement is associated with high SPI, suggesting that high-frequency fluctuations in WSS may promote inflammation leading to increased contrast uptake in the aneurysm wall, as opposed to low TAWSS causing stagnation and contrast diffusion into the wall.

1 Matouk C, et al. Vessel wall magnetic resonance imaging identifies the site of rupture in patients with multiple intracranial aneurysms. Neurosurgery 2013;72(3):492-496.

2 Chnafa C, et al. Better than nothing: A rational approach for minimizing the impact of outflow strategy on cerebrovascular simulations. AJNR Am J Neuroradiol 2018;39(2):337-343.

Figure 1:


pt1 LICA
pt1 RICA
pt2 LICA
pt3 LICA**
pt4 LICA**
pt4 RICA
pt4 A2
pt4 Basilar