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Background: Lenticulostriate arteries (LSAs) are small perforating arteries (0.1–1 mm diameter), perpendicularly departing from middle cerebral artery (MCA) and supplying blood flow to important cerebral subcortical and basal ganglia areas. LSAs are involved in silent strokes and cerebral small vessel disease, potentially leading to cognitive decline and vascular dementia. There is growing evidence that atrial fibrillation (AF), the most common cardiac arrhythmia, increases the risk of dementia even in the absence of clinical strokes. AF also increase the risk of small vessel disease. AF may alter deep cerebral hemodynamics per se, however no data exists regarding a possible impact of AF on MCA-LSA branching sites hemodynamics.

Purpose: To use computational fluid dynamics (CFD) analysis to study the hemodynamics of LSAs-MCA branching sites.

Methods: 7T high-resolution magnetic resonance imaging (HR-MRI) brain scans (Figure 1, panel a) were used to derive detailed geometrical models of LSAs-MCA branching sites. CFD analysis was then conducted, simulating AF conditions as well as sinus rhythm (SR), at different ventricular rates (from 50 to 130 bpm).

Results: Geometrical models were retrieved from HR-MRI scans of 7 patients. By means of the most significant metrics, such as wall shear stress (WSS; Figure 1, panel b), wall shear stress gradient (WSSG), and flow velocity (FV), a comparison between SR and AF was performed.

Conclusion: CFD analysis of LSAs-MCA branching sites using geometrical models derived from HR-MRI brain scans was feasible and allows to quantify the impact of AF on these critical ramifications of the MCA.

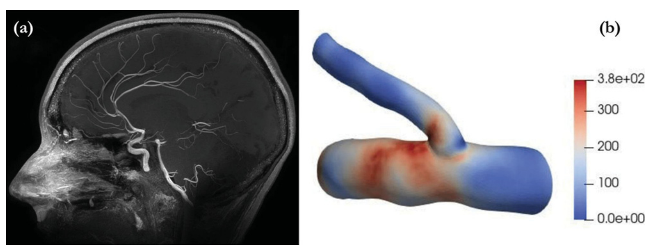

Figure 1. (a) Example of cerebral HR-MRI. (b) WSS map [dyn/cm^2]: zoom on the MCA-LSA bifurcation.