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# Uncertainty quantification of wall shear stress in intracranial aneurysms using a data-driven statistical model of systemic blood flow variability

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## Abstract

Adverse wall shear stress (WSS) patterns are known to play a key role in the localisation, formation, and progression of intracranial aneurysms (IAs). Complex region-specific and time-varying aneurysmal WSS patterns depend both on vascular morphology as well as on variable systemic flow conditions. Computational fluid dynamics (CFD) has been proposed for characterising WSS patterns in IAs; however, CFD simulations often rely on deterministic boundary conditions that are not representative of the actual variations in blood flow. We develop a data-driven statistical model of internal carotid artery (ICA) flow, which is used to generate a virtual population of waveforms used as inlet boundary conditions in CFD simulations. This allows the statistics of the resulting aneurysmal WSS distributions to be computed. It is observed that ICA waveform variations have limited influence on the time-averaged WSS (TAWSS) on the IA surface. In contrast, in regions where the flow is locally highly multidirectional, WSS directionality and harmonic content are strongly affected by the ICA flow waveform. As a consequence, we argue that the effect of blood flow variability should be explicitly considered in CFD-based IA rupture assessment to prevent confounding the conclusions.

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