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Research Article

Hemodynamic Effect of Unequal Anterior Cerebral Artery Flow Rates on the Anterior Communicating Artery Bifurcation: A Computational Fluid Dynamics Study

Thomas Rau,[1] Xing He,[2] Prem Venugopal,[2] Fernando Viñuela,[2] Gary Duckwiler,[2] and Daniel J. Valentino[2]

[1]Department of Radiology, University of Colorado Health Sciences Center, Aurora, CO 80045, USA
[2]Department of Radiological Sciences, University of California, Los Angeles, CA 90095, USA

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Abstract

Computational fluid dynamics techniques were used to investigate the hemodynamic effect of unequal anterior cerebral artery flow rates on the anterior cerebral and anterior communicating artery (ACA-ACOM) bifurcation. Hemodynamics have long been implicated as a major factor in cerebrovascular disease. Using an idealized 2D symmetric model of the ACA-ACOM geometry, the flow field and wall shear stress (WSS) at the bifurcation regions are assessed for pulsatile inflows with left to right flow ratios of 1:1, 2:1, 3:1, and 4:1. Unequal flow rates through the ACA parent arteries result in bifurcation of the higher flow parent stream and a shifting of the impingement points along the A2-ACOM adjoining wall toward the contralateral ACA. Cross-flow through the ACOM is generally unstable and results in increased WSS at the impingement region from the higher flow parent artery and a double amplitude peak in the WSS at the contralateral bifurcation region from local recirculation effects. These results suggest that asymmetry in ACA flow rates result in increased hemodynamic stresses at the ACA-ACOM bifurcation regions and suggest a possible factor for vessel weakening and aneurysm formation.