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4D-Flow validation, numerical and experimental framework
KURT SANSOM, HAINING LIU, GADOR CANTON, ALBERTO ALISEDA, CHUN YUAN, University of Washington — This work presents a group of assessment metrics of new 4D MRI flow sequences, an imaging modality that allows for visualization of three-dimensional pulsatile flow in the cardiovascular anatomy through time-resolved three-dimensional blood velocity measurements from cardiac-cycle synchronized MRI acquisition. This is a promising tool for clinical assessment but lacks a robust validation framework. First, 4D-MRI flow in a subject's stenotic carotid bifurcation is compared with a patient-specific CFD model using two different boundary condition methods. Second, Particle Image Velocimetry in a patient-specific phantom is used as a benchmark to compare the 4D-MRI in vivo measurements and CFD simulations under the same conditions. Comparison of estimated and measureable flow parameters such as wall shear stress, fluctuating velocity rms, Lagrangian particle residence time, will be discussed, with justification for their biomechanics relevance and the insights they can provide on the pathophysiology of arterial disease: atherosclerosis and intimal hyperplasia. Lastly, the framework is applied to a new sequence to provide a quantitative assessment. A parametric analysis on the carotid bifurcation pulsatile flow conditions will be presented and an accuracy assessment provided.

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