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Wall shear stress as a stimulus for carotid atherosclerotic plaque progression: An MRI-based CFD pilot study GADOR CANTON, BERNARD CHIU, TOM HATSUKAMI, WILLIAM KERWIN, CHUN YUAN, University of Washington — The aim of this study was to explore the hypothesis that intra-plaque hemorrhage, a feature associated with adverse outcomes and atherosclerotic plaque progression and destabilization, is more likely to occur in plaques with elevated levels of wall shear stress (WSS). We used multi-sequence in-vivo magnetic resonance imaging (MRI) to characterize ten human carotid atherosclerotic plaques and an MRI-based computational fluid dynamics (CFD) model to solve the equations governing the blood flow. Hemorrhage was detected within the necrotic core (intra-plaque hemorrhage) in five of these ten cases. WSS data were extracted from the results of the CFD simulations to compare patterns between the cases with and without hemorrhage. We computed the mean value of the WSS (for each time point of the cardiac cycle) at the region where a necrotic core was detected. The results from this pilot study indicate a possible link between the presence of hemorrhage within a lipid-rich necrotic core in human carotid atherosclerotic plaques and elevated levels of shear stress force acting on the luminal surface. Thus, elevated wall shear stress may be used as a high risk feature in advanced carotid atherosclerotic plaques.

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