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Blood Flow Simulations to Understand the Role of the Distal Vascular Branches of Carotid Artery in the Stroke Prediction

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Abstract : Atherosclerosis is the main reason of stroke, which is one of the deadliest diseases in the world. The carotid artery in the brain is the prominent location for atherosclerotic progression, which hinders the blood flow into the brain. The inclusion of computational fluid dynamics (CFD) into the diagnosis cycle to understand the hemodynamics of the patient-specific carotid artery can give insights into stroke prediction. Realistic outlet boundary conditions are an inevitable part of the numerical simulations, which is one of the major factors in determining the accuracy of the CFD results. The Windkessel model-based outlet boundary conditions can give more realistic characteristics of the distal vascular branches of the carotid artery, such as the resistance to the blood flow and compliance of the distal arterial walls. This study aims to find the most influential distal branches of the carotid artery by using the Windkessel model parameters in the outlet boundary conditions. The parametric study approach to Windkessel model parameters can include the geometrical features of the distal branches, such as radius and length. The incorporation of the variations of the geometrical features of the major distal branches such as the middle cerebral artery, anterior cerebral artery, and ophthalmic artery through the Windkessel model can aid in identifying the most influential distal branch in the carotid artery. The results from this study can help physicians and stroke neurologists to have a more detailed and accurate judgment of the patient's condition.

Keywords : stroke, carotid artery, computational fluid dynamics, patient-specific, Windkessel model, distal vascular branches
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