VOLUMETRIC LATTICE BOLTZMANN SIMULATION FOR BLOOD FLOW IN AORTA ARTERY PUMPED THROUGH AORTIC HEART VALVE

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Complicated moving boundaries pose a major challenge in computational fluid dynamics for complex flows, especially in the biomechanics of both blood flow in the cardiovascular system and air flow in the respiratory system where the compliant nature of the vessels can have significant effects on the flow rate and wall shear stress. We develop an innovative approach to treat arbitrarily moving boundaries in Lattice Boltzmann Method (LBM) using a volumetric lattice Boltzmann representation, which distributes particles in fluid lattice cells. A volumetric bounce-back procedure is applied in the streaming step while momentum exchange between the fluid and moving solid boundary are accounted for in the collision step. Additional boundary-induced migration is introduced to conserve fluid mass as the boundary moves across fluid cells. We use the volumetric LBM to simulate blood flow in aorta pumped from heart focusing on the flow rate, flow structure, pressure distribution within the aorta for different heart pumping conditions. For validation, the volumetric LBM is compared with Navier-Stokes computation and good agreements are achieved. We study the flow dynamics within the aorta in the cardiac cycle (systole and diastole) through alternatively opening and closing the inlet boundary to mimic the heart pumping mechanism.