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Three Dimensional Large Eddy Simulation of Blood Flow and Deformation in an Elastic Constricted Artery

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Abstract : In the current work, a three-dimensional geometry of a 75% stenosed blood vessel is analysed. Large eddy simulation (LES) with the help of a dynamic subgrid scale Smagorinsky model is applied to model the turbulent pulsatile flow. The geometry, the transmural pressure and the properties of the blood and the elastic boundary were based on clinical measurement data. For the flexible wall model, a thin solid region is constructed around the 75% stenosed blood vessel. The deformation of this solid region was modelled as a deforming boundary to reduce the computational cost of the solid model. Fluid-structure interaction is realised via a two-way coupling between the blood flow modelled via LES and the deforming vessel. The information of the flow pressure and the wall motion was exchanged continually during the cycle by an arbitrary lagrangian-eulerian method. The boundary condition of current time step depended on previous solutions. The fluctuation of the velocity in the post-stenotic region was analysed in the study. The axial velocity at normalised position Z=0.5 shows a negative value near the vessel wall. The displacement of the elastic boundary was concerned in this study. In particular, the wall displacement at the systole and the diastole were compared. The negative displacement at the stenosis indicates a collapse at the maximum velocity and the deceleration phase.

Keywords : Large Eddy Simulation, Fluid Structural Interaction, constricted artery, Computational Fluid Dynamics
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