Abstract ID-13

NUMERICAL INVESTIGATION OF WALL PRESSURE FLUCTUATIONS DOWNSTREAM OF IDEAL AND REALISTIC STENOSED VESSEL MODELS

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Keywords: Stenosis, pressure fluctuations, acoustic radiation, blood flow, computational fluid dynamics

Summary: Cardiovascular diseases, the most common of which is atherosclerosis, are the leading global cause of death. Atherosclerosis leads to a plaque built up inside an artery, narrowing it down and forming a stenosis. It may lead to coronary artery disease, stroke or peripheral artery occlusive disease, depending on the location of the lesion. The flow turning into turbulent regime after passing the stenotic obstruction leads to pressure fluctuations at the arterial wall. The generated sound is transmitted through the surrounding tissue and reaches the skin. This acoustic radiation may give important information about the stenotic region. In this study, the effect of using real and ideal stenosed vessel models on the generated acoustic radiation is investigated using numerical simulations. The idealized vessel-like model with an eccentric elliptical stenosis and a real vessel model with a realistic stenosis shape inspired by the MR image of a stenosis. Inlet diameters are 6.4 mm for ideal and realistic models. Both these models have a stenosis severity of 87%.Steady flow simulations at a Reynolds number of 1000 (based on average velocity and un-constricted vessel diameter) are performed with dynamic Smagorinsky LES turbulence model of OpenFOAM. After the mean wall pressures reach steady-state, time history of fluctuating pressure data is recorded on the vessel wall downstream of the stenosis exit and converted into acoustic pressures, which are investigated in terms of amplitude and frequency content. It is seen that although spectral behavior shows similarities, both acoustic pressure levels and maximum excitation points are different. Maximum activity point of flow in realistic vessel is just at the exit of stenotic region whereas it is located at about 10 mm after the exit of the idealized stenosis geometry. Furthermore, changing vessel and stenosis geometry from ideal to realistic leads to up to 10 fold increase in the acoustic pressure level.