The study of hemodynamic patterns in large blood vessels, such as the ascending aortic artery, brachiocephalic trunk, right carotid artery and right subclavian artery presents the challenging complexity of vessel wall compliance induced by the high levels of shear stress gradients and blood flow pulsatility. Accurate prediction of hemodynamics in such conditions requires a complete Fluid Structure Interaction (FSI) analysis that couples the fluid flow behavior throughout the cardiac cycle with the structural response of the vessel walls. This research focuses on the computational study of a Multiscale Fluid-Structure Interaction on the arterial wall by coupling Finite Volumes Method (FVM) predictions of the Fluid Dynamics within the artery with Finite Elements Method (FEM) predictions of the Elasto-Dynamics response of the arterial walls and 1-D closed loop electrical circuit system to generate the dynamic pressure pulse. To this end, a commercial FVM Computational Fluid Dynamics (CFD) code (STAR-CCM+ 7.09.012) will be coupled through an external interface with a commercial FEM Elasto-Dynamics code (ABAQUS V.12). The coupling interface is written in such a way that the wall shear stresses and pressures predicted by the CFD analysis will be passed as boundary conditions to the FEM structural solver. The deformations predicted by the FEM structural solver will be passed to the CFD solver to update the geometry in an implicit manner before the following iteration step. The coupling between the FSI and the 1-D closed loop lump parameter circuit updated the pressure pulse and mass flow rates generated by the circuit in an explicit manner after the periodic solution in the FSI analysis has settled. The methodology resulting from this study will be incorporated in a larger collaborative research program between UCF and ORHS that entails optimization of surgical implantation of Left Ventricular Assist Devices (LVAD) cannulae and bypass grafts with the aim to minimize thrombo-embolic events. Moreover, the work proposed will also be applied to another such collaborative project focused on the computational fluid dynamics modeling of the circulation of congenitally affected cardiovascular systems of neonates, specifically the Norwood and Hybrid Norwood circulation of children affected by the hypoplastic left heart syndrome.

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The public is welcome to attend.