Characterization of In Vitro Aortic Flow

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ABSTRACT

Thoracic Aorta and its three branches at the aortic arch are the inceptive zones of the aortic dissection and atherosclerosis. Due to the complicate aortic flow nature, the geneses of these highly fatal diseases are the abnormal pressures and shear stresses acting upon the vascular intima. Hence, it is important to determine the distributions of wall shear stress and pressure to predict these aortic disorders. In this study, the Phase-Contrast Magnetic Resonance Imaging (PC-MRI) method was used to obtain the true geometry of a normal human thoracic aorta which can be converted into transparent thoracic aorta model by the rapid prototyping (RP) technique. The thoracic aorta model is then used in the in-vitro experiment and numerical computations. Numerical calculations were performed using the computational fluid dynamic (CFD) software ACE+R to determine the flow characteristics of the three-dimensional, steady, incompressible and Newtonian fluid in the thoracic aorta model. The boundary conditions at the inlet and the outlet of the aortic flow were specified from the measured data in the in-vitro experiment. The predictions were in reasonable agreement with the PC-MRI measured velocity profiles in the sagittal plane of the thoracic aorta model. The computed results suggest the preferential development of the early aortic dissection and atherosclerosis being in the areas of either maxima or minima of wall shear stress and pressure.

Keywords : aortic arch ; biofluid mechanics ; numerical calculations

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