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Research Article

Inhalation Induced Stresses and Flow Characteristics in Human Airways through Fluid-Structure Interaction Analysis

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Abstract

Better understanding of stresses and flow characteristics in the human airways is very important for many clinical applications such as aerosol drug therapy, inhalation toxicology, and airway remodeling process. The bifurcation geometry of airway generations 3 to 5 based on the ICRP tracheobronchial model was chosen to analyze the flow characteristics and stresses during inhalation. A computational model was developed to investigate the airway tissue flexibility effect on stresses and flow characteristics in the airways. The finite-element method with the fluid-structure interaction analysis was employed to investigate the transient responses of the flow characteristics and stresses in the airways during inhalation. The simulation results showed that tissue flexibility affected the maximum airflow velocity, airway pressure, and wall shear stress about 2%, 7%, and 6%, respectively. The simulation results also showed that the differences between the orthotropic and isotropic material models on the airway stresses were in the ranges of 25–52%. The results from the present study suggest that it is very important to incorporate the orthotropic tissue properties into a computational model for studying flow characteristics and stresses in the airways.