Abstract

Obstructive sleep apnea (OSAS) is characterized by repeated episodes of airway collapse and airflow limitation during sleep. OSAS is prevalent and has negative long-term health effects. A better understanding of OSAS might allow for more effective diagnosis and treatment. Image-based computational fluid dynamics (CFD) has been used to study OSAS, but is limited to a brief moment in time because simulations take a long time to run, and require user inputs to set up.

Tools were developed to quickly estimate upper airway pressures, with few user inputs. Data from 5 OSAS subjects were used. Starting data for each subject included airway shapes for 960 frames in time. An automated CFD procedure was developed that assumes steady flow and uses coarse meshes to decrease simulation times. The coarse mesh was picked from a mesh study. Airway centerlines were computed with the Vascular Modeling Toolkit (VMTK), and centerline sections were used to simply represent airway quantities. Outputs from CFD were used to train a neural network as an alternative way to predict airway pressures. Finally, geometry and pressure data over many frames were processed to summarize effective compliances (EC) for each subject.

The mesh study showed that coarse meshes and steady simulations give reasonable results compared to higher resolution CFD. The automated CFD procedure computed airway pressures for many frames, but many frames were also skipped due to bad input geometries. The neural network modeled airway pressures for some subjects well, but predictions had high errors for other subjects. The causes of the errors were identified to be bad training data, and training data not being representative of test data. Post-processing of data over many frames revealed that ECs varied more in time during sleep compared to while awake, and at the oropharynx and hypopharynx. Inspiratory ECs also varied more over time than expiratory ECs. Errors were identified with the post-processing method that could cause these EC characteristics.