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Abstract title

Using two-way fluid-structure interaction to study the collapse of the human upper airway of OSA patient
Obstructive Sleep Apnea (OSA) is a common sleep disorder characterized by repetitive collapse of the upper airway (UA) during sleep. Treatment options for OSA include mandibular advancement splints (MAS), worn intra-orally to protrude the lower jaw to stabilize the airway. However, not all patients will respond to MAS therapy, and individual effects on the upper airway are not well understood. Simulations of airway behavior may represent a non-invasive means to understand this disorder and treatment responses in individual patients. The aim of this study was to perform analysis of upper airway (UA) occlusion and flow dynamics in OSA using the fluid structure interaction (FSI) method and secondly to observe changes with MAS. Magnetic resonance imaging (MRI) scans were obtained at baseline and with mandibular advance splint (MAS) treatment in a patient known to be a treatment responder. Computational models of the anatomically correct UA geometry were reconstructed for both pre- and post-treatment (MAS) conditions. By comparing the simulation results, the treatment success of MAS was demonstrated by smaller deformation (maximum 2.03mm) post-treatment UA structure relative to the pre-treatment fully collapsed (maximum 5.83mm) counterpart. The UA collapse was located at the oropharynx and the low oropharyngeal pressure (-51.18 Pa to -39.08 Pa) was induced by the velopharyngeal jet flow (maximum 10.0 m/s). The results verified previous OSA modeling studies which used the computational fluid dynamic (CFD) method, and lay a firm platform for the application of computational models for the study of the biomechanical properties of the upper airway in the pathogenesis and treatment of OSA.
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