FLOW PATTERN COMPARISON IN UPPER AIRWAYS OF TWO OSA SUBJECTS BEFORE AND AFTER SURGERY

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Introduction

Obstructive sleep apnea (OSA) is the most common type of sleep disorder which is usually caused by partial or complete narrowing of pharynx in the upper airway (UA) [Mihaescu *et al*., 2011]. The upper airway surgery is commonly performed for this disorder; however the success rate of this kind of surgery is very low. The post-operative complications after surgery are often results in a dilemma during the operation of how much tissue to resect: too little is ineffective, yet too much may make OSA worse. Therefore, accurate prediction of tissue reduction for this treat is urgently needed.

Methods

Due to the non-invasive nature, the Computational Fluid Dynamics (CFD) technique is used in this study to visualize the fluid flow in the upper airway. A verified and validated Large Eddy Simulation (LES) approach is employed to investigate the flow pattern of two severe OSA patients.

Results

Generally the flow oscillation due to separation is enhanced after surgery, and the wall shear stress is increased as well. For subject #1, the cross-sectional area at the minimum section is enlarged about two times after the surgery; and for subject #2, the area is enlarged about four times. The post-surgery upper airways, the reversed flow of #1 is much stronger than that of #2. Apnea-hypopnea index, or AHI, is an index used to assess the severity of sleep apnea based on the total number of obstructions of breathing occurring per hour of sleep. Table 1 tabulates the AHI variation for both subjects. After surgery, #1 subject has a lower AHI, indicating a better surgery outcome. This shows that the stronger flow oscillation would result in a lower AHI, which is consistent with our previous study [Liu *et al*., 2012].

Dicussion

It is showed that the CFD can predict the airflow in the upper airway satisfactorily. From the simulation, it is believed that it may not be good to widen the airway only for OSA subject, and the most important thing is to cut appropriate amount of tissue. CFD would play an important role in surgery planning and help to improve the surgery successful rate significantly.

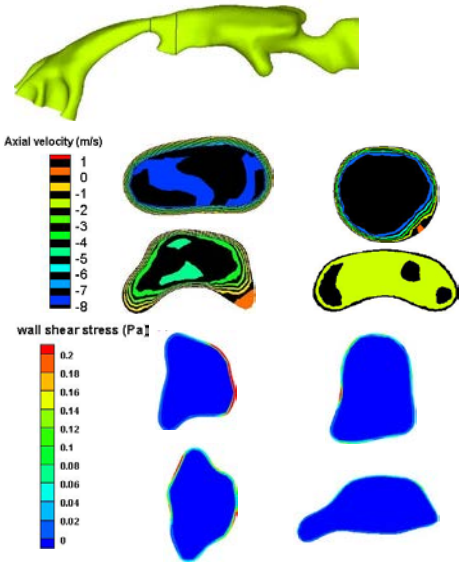

Figure 1: The left is axial velocity and wall shear stress of the two cross-section for subject# 1 and the right is that of subject# 2.

AHI	Before	After
Subject #1	64.8	15.8
Subject #2	60.7	23.9

Table 1. AHI measurement of OSA subjects

References

Liu Y. *et al.*, Flow oscillation-A measure to predict the surgery outcome for obstructed sleep apnea (OSA) subject, J Biomech, 45: 2284-2288, 2012.

Mihaescu M.*et al.*, Large Eddy Simulation of the pharyngeal airflow associated with Obstructive Sleep Apnea Syndrome at pre and post-surgical treatment, J Biomech, 44, 2221-2228, 2011.