INTRODUCTION
The compliance of upper airway tissues during respiration could lead to snoring in human subjects and collapse of the airway in patients of obstructive sleep apnea (OSA). The patterns of dynamic wall movement of human upper airway and the causes of OSA are still not fully understood. This study attempts to simulate the movement of human soft palate during respiration using fluid-structure interaction (FSI) simulation.

METHODS
MRI images of a 35 years old healthy Chinese male were obtained for model reconstruction. Figure 1(A) shows the sagittal view of the MRI image. The human soft palate was coloured in green. Figure 1(B) shows the 3-Dimensional (3D) model of the airway. The fluid domain consists of the nasal cavity, the nasopharynx and the oropharynx. A hemisphere was incorporated with the human face for zero gauge pressure prescription. Velocity magnitude corresponding to ventilation rate of 7.5 L/min was applied at the pharynx. The soft palate was assumed as elastic, isotropic and homogeneous. The interface between the soft palate and the airway was the only FSI interface which could be displaced during the simulation. There are three models that have been simulated: the pure fluid model without any distortion of the airway (model I), the FSI model with modulus of the soft palate to be 7539 Pa (model II) and the FSI model with palatal modulus of 3000 Pa (model III).

RESULTS
Figure 2 shows the displacement of the soft palate at peak inspiration and expiration. In both models II and III, the displacement at peak expiration is considerably larger than inspiration. With lower modulus of soft palate, the displacement in model III is larger than model II. The soft palate mainly moved anteriorly during inspiration and posteriorly during expiration with less displacement in the other two directions (sagittal and axial directions).

DISCUSSION AND CONCLUSIONS
The airway was reported to be collapsed during inspiration due to sub-atmospheric pressure [1]. However, the upper airway was also observed to be collapsed at the end of expiration [2]. The reason for expiratory occlusion is yet to be discovered. Based upon the current study, the expiratory occlusion might be triggered by the posterior movement of soft palate during expiration. A more compliant palate with softer material property in model III was observed, indicating that the relaxation of the soft palate might induce larger posterior displacement and smaller retropalatal space during expiration. In addition, limited influence of displacement of the soft palate on flow properties was found during calm breathing, while the displacement increased with decreased Young’s modulus of soft palate.

REFERENCES

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