On the stability of the upper airways system

A.K Lazopoulos[1], K.A. Lazopoulos[1], G. Palassopoulos[2]

Summary

Simple models for the upper faryngeal obstruction, describing the sleep apnea syndrome are proposed. Stability is discussed, of two and three individualized elements, with and without elastic connections, interacting with the steady flow. Considering the flow as the controlling parameter, critical steady state flows are located and their post-critical behavior is discussed for various models. It is pointed out that the non-linear constitutive elastic laws are necessary contrary to the linear ones introduced by Fodil [1998]. Finally the three element model will be presented and studied with non-linear constitutive relations and side connections. Applications of the theory will be performed and discussion for the three models will be presented. It is pointed out that the sleep apnea syndrome is due to the instability of the upper faryngeal region.

The two-element (non-interconnected) Model

The two–element model is structured from three walls and two independent wall elements which move without friction. These independent elements create two pipes whose cross-section remain rectangular but with variable area. The breadth b and length l are the same in every element. The area of every element is given by $A = b \cdot h$ where h is the height of the fluid passage. A is varying only with the change of height h. This model is congruent with the physiology of the upper respiratory system. The movement of each element is connected with the balance between inner and outer forces applied to the moving element, given that every element has its own elastic behavior.

References

1. Fodil,L., (1998), Mechanismes de base de L'interaction fluid-paroi dans les voies aeriennes superieures, *Ph.D Thesis*, Paris XII- Val de Marne

---

[1]Department of Mechanics, Faculty of Applied Mathematical and Physical Sciences, National Technical University of Athens,5 Heroes of Polytechnion Ave., 15773, Zografou campus, Athens, Greece

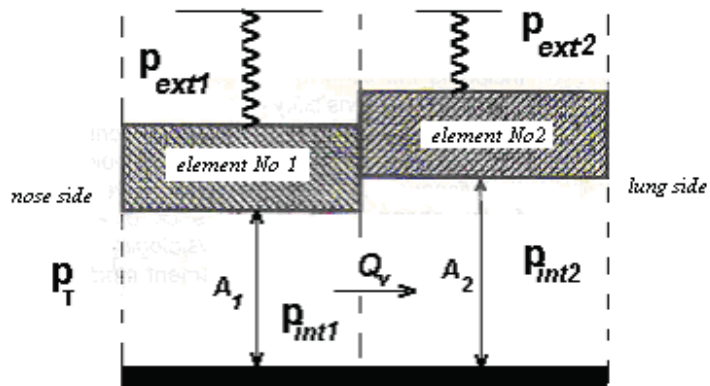[2]Department of Mathematics & Mechanics, Military School of Greece, Vari, Greece

Figure 1: The two–element (non-interconnected) model