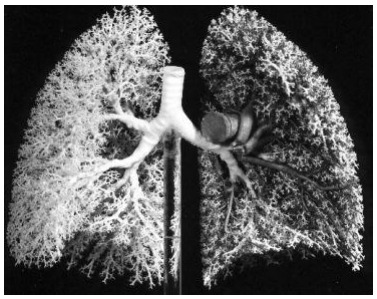
MODELLING OF THE RESPIRATORY SYSTEM



Motivation: Changes of the mechanical properties of the respiratory system significantly affect the intrapulmonary parameters during artificial lung ventilation. Pressure distribution, tidal volume distribution and other parameters may be studied to explain some effects observed during artificial lung ventilation in the clinical practice.

Fig. 1: Anatomical structure of the airways.

Aim: The aim of the project is to study the intrapulmonary conditions mainly during artificial lung ventilation including the high-frequency ventilatory regimens. A mathematical model of the respiratory system has been designed according to its

Methods: The model is designed according to a morphologic model of the respiratory system. It allows simplifying the real structure of the airways and mathematical description of the airways. Elementary airways are considered as acoustic wave-guides and described by acoustic parameters. Electro-acoustic analogy allows to model the airways as electric circuits. The final model of the respiratory system is depicted in Fig. 2, where each airway is represented by the appropriate electric circuit. The model has more than 68 million elements and its structure is similar to the anatomical structure of the bronchial tree.

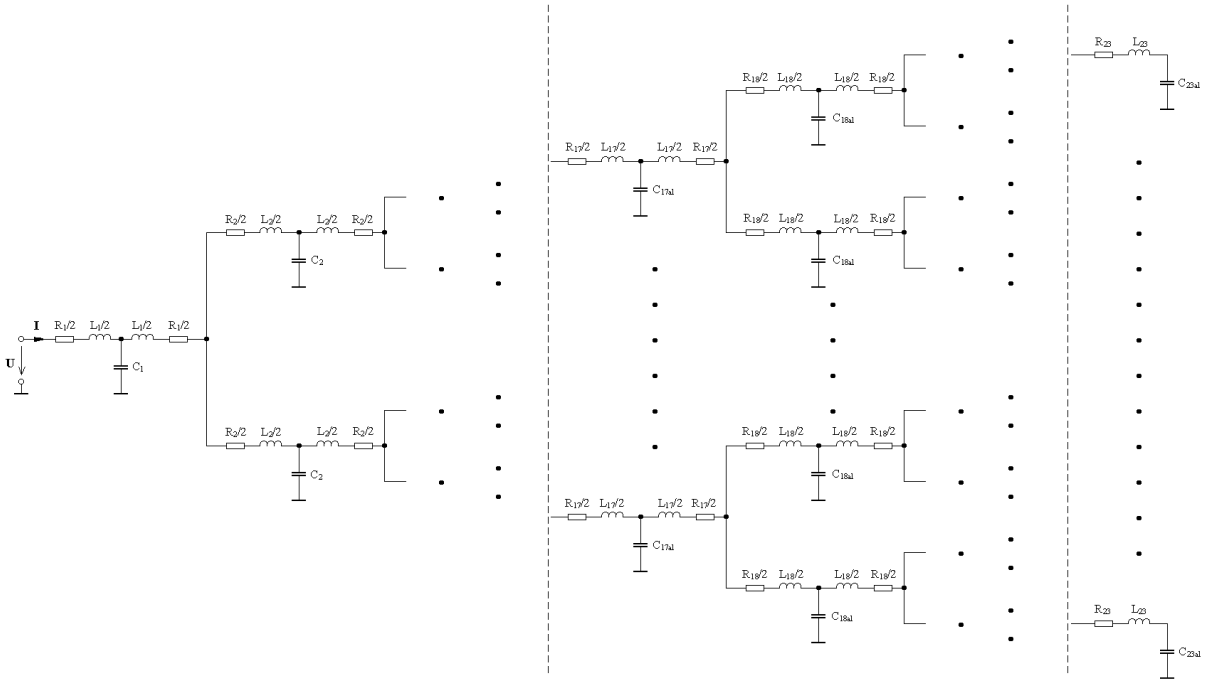


Fig. 2: Model of the respiratory system according to its anatomical structure.

Results: Conducted simulations show and describe differences between the use of conventional ventilation (CV) and high-frequency ventilation (HFV). The distribution of the pressure amplitude along the bronchial tree is depicted in Fig. 3. It can be seen that the pressure amplitude is much smaller during HFV compared with CV. Simulated results correspond with the effects observed during animal experiments (Fig. 4).

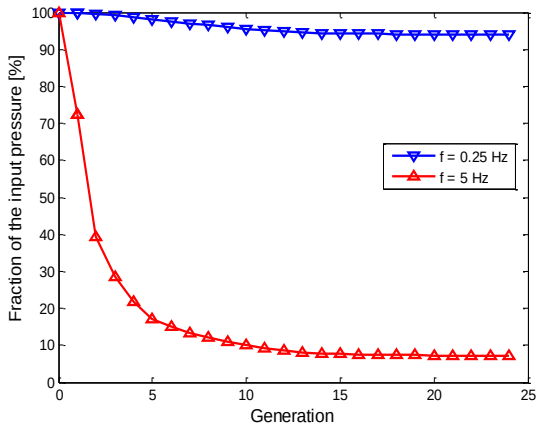


Fig. 3: Amplitude of dynamic pressure in the airways during CV and HFV – a model case.

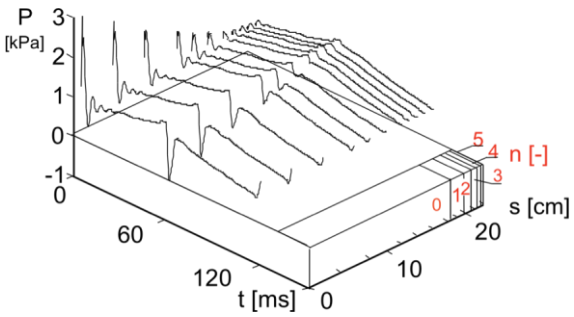


Fig. 4: Trend of pressure (P) in the airways during high-frequency oscillatory ventilation – an animal experiment. Parameter s represents the depth of the catheter tip in the bronchial tree, n is order of branches and t is time.

Conclusion: The model allows to study the intrapulmonary parameters. The results of conducted simulations can explain some effects of HFV observed during experiments or in the clinical practice, for example decrease of amplitude of the dynamic pressure in the airways during HFV.

Publication:

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Rožánek, M. - Roubík, K. *Mathematical Model of the Respiratory System - Comparison of the Total Lung Impedance in the Adult and Neonatal Lung.* In: International Journal of Biological and Medical Sciences [online]. 2007, vol. 2, no. 4, p. 249-252. ISSN 2010-3840.

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