ABSTRACT

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Title of Doctoral Thesis: **Biomechanical properties of bones in the experiment and the effect of homocysteine on bone health**

The Doctoral Thesis comprises two basic parts - the Experimental and Clinical. The former one addresses viscoelastic properties of biological materials, in particular bones under dynamic strain. The latter one focuses on the effect of elevated homocysteine levels on bone health. The Introduction includes detailed anatomical description and physiology of human bone, its development, metabolism, and finally some metabolic disorders, the impact of nourishment on its quality and the impact of homocysteine on bone health.

Furthermore, the Introduction contains description of Rheological models (described by Hooke's and Newton's elements). As porcine bones resemble human bones in their structure and biomechanical properties, they were used in the Experimental part with the main objective to verify, investigate and measure their characteristics.

Two series of measurement with moderate changes in configuration were conducted in the Experimental part using the less frequent Resonance method and RMA devices. Firstly, one of the objectives was to verify whether the storage period of samples (up to 15 days) affects bone viscoelastic properties. Secondly, the second series of measurement were supposed to prove potential frequency dependence of bone.

The results of the first series measurement did not prove any *post mortem* changes over the time subjected to the study. However, the second measurement indicated that the elastic and viscous coefficients were demonstrably frequency dependent. It may be concluded that the viscoelastic properties of the measured bones are nonlinear as far as the biomechanical point of view is considered. Another partial objective was to verify the functionality and applicability of devices being developed at the Faculty of Pharmacy in

Hradec Králové, Charles University in Prague. Practical experience from the measurement has contributed to improvement of both design and function of the aforementioned devices.

The Clinical part of the Doctoral Thesis focusses on the effects of elevated homocysteine levels on bone health of children and adolescents (37 subjects in total). In postmenopausal women the elevated serum homocysteine levels correlate with low bone mineral density and thus increase the risk of bone fracture. Notwithstanding, there are no coherent data on the relationship between the serum homocysteine levels (S-Hcy) and state of the skeleton. The laboratory results of blood serum showed, firstly, positive correlation between serum alkaline phosphatase levels and osteocalcin levels; secondly, serum alkaline phosphatase levels and CrossLaps levels; and thirdly, serum osteocalcin levels and CrossLaps levels. These results demonstrate increased bone turnover and the negative effect of elevated levels of S-Hcy on bone density in children. Higher serum homocysteine levels are perceived as a risk factor for bone health not only in postmenopausal women but also in childhood and adolescence.

The bones are in real conditions loaded mainly dynamically. Therefore, this dynamic strain often leads to bone fractures causing particular risk in bones with reduced bone mineral density. So far, biomechanical properties of bone have not been described in detail as far as dynamic strain is concerned. Theoretical and practical knowledge described in both the Experimental and Clinical part may be useful for the medical industry in future.