A New Approach to Measurement of Viscoelastic Parameters of Biological Structures

Stanislav Doubal, Petr Klemera, Monika Kucharova, Petr Rejchrt

Department of Biophysics and Physical Chemistry, Faculty of Pharmacy,
Charles University in Prague, Hradec Kralove 1203, 500 05, Czech Republic,
phone: +420 495 067 483, fax: +420 495 512 429, e-mail: doubal@faf.cuni.cz.

BACKGROUND:
Mechanical behavior of fascia and other soft tissues under dynamic loading depends on elastic as well as viscous properties of biological materials. Quantitative description of viscoelasticity is connected with solutions of the inverse problem, in other words, with the identification of viscoelastic models and with the estimation of theirs parameters [1] [2] [3]. Crucial, in this context, is correct measurement and adequate theoretical background. Unfortunately, available apparatuses are inaccurate, technically complicated and expensive. Also theory of inverse problem solution in viscoelastic bodies is unsatisfactory.

METHODS
In our laboratory, we developed appliances based on measurements of self-oscillations of samples of materials. To achieve periodical character of response, the samples of materials were connected with inertial body of mass significantly higher than the mass of samples, sufficient to achieve periodical character of response. Sensing of deformation was contactless. The appliances involved a computer with SW for automatic calculation of parameters of models. Measurements were simple, quick, and more precise in comparison with classical methodology.

RESULTS
Result of our work is a set of several inexpensive laboratory apparatuses that enable accurate and quick measurements. Apparatus for measurements in tension has minimal measurable displacement, 2 μm, and applied force range 0.049 - 0.98N (5g - 100g). It is possible to measure samples of length from 8 to 35 mm and cross section 3x3 - 7x7 mm. Other versions of apparatus enable measurements of viscoelasticity of surface and measurements of viscoelasticity of membranes.

CONCLUSION
Applicability of apparatuses was successfully tested and verified on several hundreds of measurements [4] on various kinds of soft tissues, including fascia.

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